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FOREWORD

Chance favours the prepared mind.
Louis Pasteur

Dear colleagues,

It is our great pleasure to introduce you Proceedings of the 1st International Scientific and Expert Conference TEAM 2009.

The Conference is held in Slavonski Brod, Croatia, December 10 & 11, 2009. It is organized by the International TEAM Society and the organization activities this year are coordinated by University of Applied Sciences of Slavonski Brod, Croatia. TEAM 2009, as the result of fruitful international cooperation in recent years, is designed to gather around scientists and experts in fields of Technics, Education, Agriculture and Management (TEAM) from Croatia and neighbouring countries. More than 70 participants will present their papers either by oral presentations or by posters. Keynote lectures of 4 distinguished scientists from Croatia and Hungary will provide *state of art* insight into different scientific areas of wide interest.

High interest in Conference will ensure quality dissemination of presented achievements, encouragement to interdisciplinary approach in all scientific fields mentioned as well as mobility of teachers. These Conference objectives will lead to intensive international cooperation between higher education institutions and hopefully enhance knowledge transfer from academia to industry.

International TEAM Society always supports young scientists and experts with the potential to make a breakthrough in different scientific fields. Because of the best innovative work and clear presentation of paper, an award will be presented to a PhD student as a motivation to maintain present efforts dedicated to scientific progress.

The Organizing Committee would like to thank all authors and international reviewers for scientific and expert contribution to Conference as well as sponsors for their strong support in organisation of 1st International Scientific and Expert Conference TEAM 2009.

Krunoslav Mirosavljević
Chairperson of the Organizing Committee

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MAG welding process – how to achieve desired weld quality

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Abstract

Metal Active Gas (MAG) welding process is performed in the presence of chemically active carbon dioxide (CO_2). In the case of MAG welding process, the quality of obtaining welds depend on number of different influences like base metal type and thickness, type of filler metal, selected welding parameters and shielding gas composition as well. In this paper, the geometry of weld bead reinforcement area at MAG welding process is analyzed with regard to heat input (depending of weld current, voltage and weld speed) as well as filler metal, gas type and flow rate. Also the comparison of the basic welding costs for selected combination of filler metal and shielding gas is presented.

Keywords: MAG process, welding parameters, weld reinforcement area, welding costs

1. Introduction

Today, one of the frequently used welding processes in production of welded construction is arc welding process in shielding gas atmosphere – Gas Metal Arc Welding. Depending of the shielding gas type it can be applied as MIG (Metal Inert Gas Welding) process where welding is performed in inert gas atmosphere (argon or helium) or MAG (Metal Active Gas) welding performed in active carbon dioxide (CO_2) or gas mixture with the significant amount of carbon dioxide. Figure 1 presents the factors influencing on MAG welding process. To optimize the welding process performance and to achieve the best possible weld quality: (a) Primary inputs, (b) Disturbing inputs and (c) Intermediate outputs have to be controlled [1].

Due to fact that the selection of primary inputs (Figure 1) has dominant influence on the MAG welding process, in this paper, the influence of some primary inputs (main welding parameters) on the weld quality is analyzed. Correct choice of filler material, shielding gas type and welding parameters will result in stable welding process without appearance of weld bead failures and quality degradations,

Filler metal is melted during welding process and together with melted base metal forms the weld bead. Therefore, the composition of filler metal influence on weldability, metallurgical processes and weld quality [2]. The type of shielding gas has significant effect on welding process stability. Shielding gas type selection depends on former experience and practice, conditions cited in contract (related to individual welded construction), but also on welding costs [3].

The main goal of performed investigation was to confirm the hypothesis: there is the correlation between heat input and gas flow rate with the cross section of weld reinforcement area at MAG welding process. Experimental investigation of MAG welding process with two types of filler material and two types of gas shielding composition are presented in the following text.

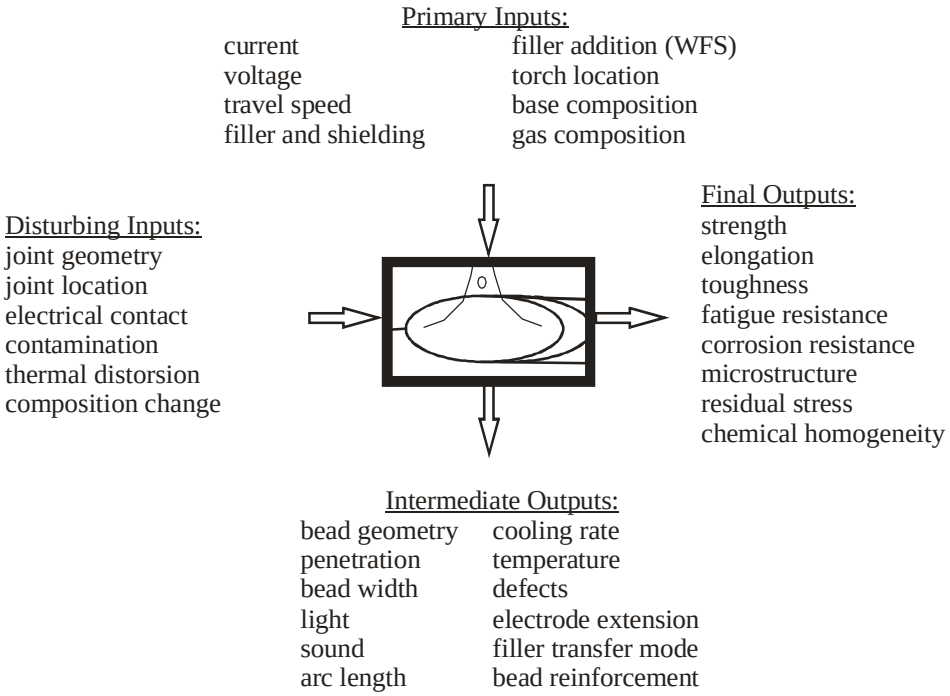


Figure 1 Welding process input and output [1]

2. Design of experiment

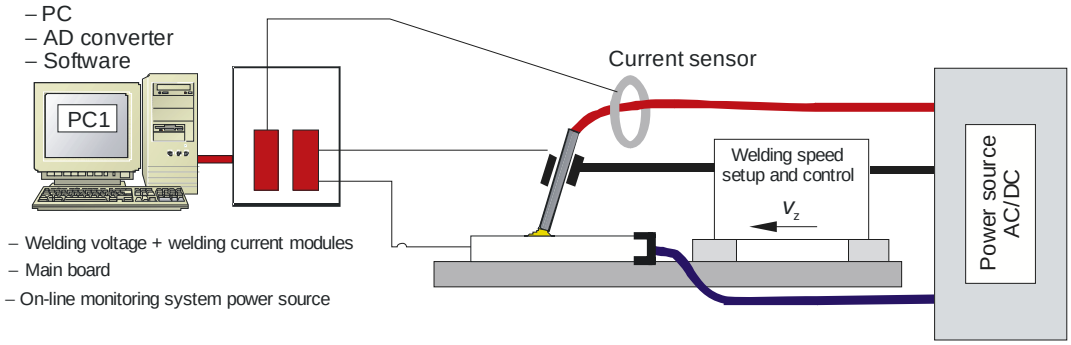
For this experimental investigation the two of factors (primary inputs) are selected: gas flow rate (l/min) and heat input (kJ/mm). The filer metal types and marks as well as diameter of welding wire used in experiment are shown in Table 1. With cited filler materials, the experimental welding was performed using shielding gases: (a) carbon dioxide (C1 according to EN 439) and (b) mixture of 18 % carbon dioxide and 82 % argon, called Krysal 18 (M21 according to EN 439).

Table 1. Filler materials and shielding gasses used in experimental welding.

Filler metal type	Filler metal mark according to standard	Wire diameter, ø mm	Producer mark	Producer	Shielding gas
Solid wire	G Mo Si (EN 12070)	1,2	DMO-IG	Böhler, D	C1 (EN 439)
Rutile flux cored wire	T MoL P M 1 H5 (DIN EN 12071)	1,2	Fluxofil 25	Oerlikon, D	M21 (EN 439)

The investigation was a part of a larger experiment [3, 4, 5].

Monitoring of welding parameters and electric arc stability was performed by acquisition of welding current and voltage with a developed on-line monitoring system. Figure 2 shows pictorial diagram of experimental setup. Surfacing was performed by automatic MAG welding process with TPS 4000 power source (Fronius International GmbH, A). Tracking Vehicle FTV 4 connected to Control Unit FCU – 4 – RC for remote control (both made by Fronius International GmbH, A) was used for the welding speed setup. Weld surfacing was performed on horizontal position on 16 Mo 3 steel plates (according to EN 10028-2).



a)

b)

Figure 2 Pictorial diagram (a) and experimental setup (b)

The influence of the selected welding parameters on the weld reinforcement area cross section is analyzed on two examples: (a) welding with solid wire with shielding gas CO_2 and (b) welding with rutile flux cored wire with shielding gas Krysal 18 (Table 1). For each combination of the filler metal and shielding gas there are 9 experiment levels (Table 2). Full factorial designs in three levels 3^2 were used to obtain the required information. All together, there were 2×27 specimens (3 replication of each factor levels combination) surfaced with different heat input and gas flow rate. On the end of the experiment the reinforcement area cross section was determined for all cases.

Additionally, to observe the influence of the shielding gas absence, two weldments are made without shielding gas. Welding parameters for these trials are shown in Table 3.

The values of the welding current and voltage are specified as the mean values of the measurement recorded by on-line monitoring system (sampling frequency was 10 kHz). The heat inputs E_{ef} (kJ/mm) where calculated according to equation:

$$E_{ef} = \frac{U \cdot I}{\eta} \cdot v, \qquad (1)$$

where:

U – arc voltage, V,
I – welding current, A,
η – thermal efficiency related to the type of welding process used, –,
v – the welding speed, mm/s.

The value $\eta = 0{,}85$ was adopted from literature [2, 6].

In order to measure the weld reinforcement cross section area A_{DM} the macrophotographs of the etched surfaces were taken. The measurements were done by using an UTHSCSA ImageTool (IT) software, developed by Department of Dental Diagnostic Science at The University of Texas Health Science Center, Texas USA [6]. A schematic illustration of weld bead geometrical characteristics is shown on Figure 3.

The results of all measurements are shown in Table 4. The factors (A – heat input and B – gas flow rate) and their levels are defined.

Table 2 Plan of experiment and welding parameters.

Experiment's name: PC (Filler metal: Solid wire, Shielding gas: CO_2)					
Weld	Gas flow rate f_g l/min	Welding speed v, mm/s	Arc voltage U, V	Welding current I, A	Heat input E_{ef}, kJ/mm
PC11	5	7,5	33,8	313,44	1,201
PC12	15				
PC13	25				
PC21	5	10			0,901
PC22	15				
PC23	25				
PC31	5	12,5			0,720
PC32	15				
PC33	25				

Experiment's name: RK (Filler metal: Rutile flux cored wire, Shielding gas: Krysal 18)					
Weld	Gas flow rate f_g l/min	Welding speed v, mm/s	Arc voltage U, V	Welding current I, A	Heat input E_{ef}, kJ/mm
RK11	5	5	26,89	314,23	1,436
RK12	15				
RK13	25				
RK21	5	7,5			0,957
RK22	15				
RK23	25				
RK31	5	10			0,718
RK32	15				
RK33	25				

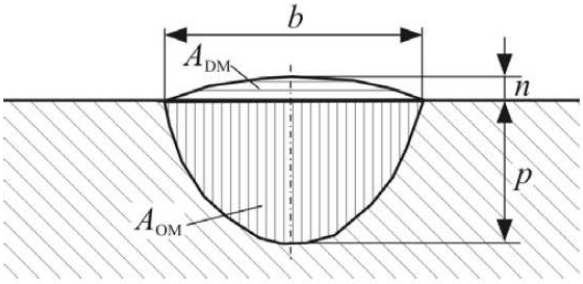


Figure 3 The cross-section of a weld bead, where p is penetration, mm; n is reinforcement, mm; b is width of the bead, mm; A_{DM} is reinforcement area, mm^2; and A_{OM} is penetration area, mm^2

Table 3 Welding parameters for weldments without shielding gas.

Weld	P0	R0
Filler metal type	Solid wire	Rutile flux cored wire
Shielding gas type	–	–
Welding current I, A	285	309
Welding voltage U, V	31,1	32,4
Welding speed v, mm/s	7,5	7,5
Shielding gas flow rate f, l/min	0	0

Table 4 Measured values of weld reinforcement area A_{DM}.

Experiment's name: PC (Filler metal: Solid wire, Shielding gas: CO_2)									
Factor A (heat input)	A_1 E_{ef} = 1,201 kJ/mm			A_2 E_{ef} = 0,901 kJ/mm			A_3 E_{ef} = 0,720 kJ/mm		
Factor B (gas flow rate)	B_1 f_g=5 l/min	B_2 f_g=15 l/min	B_3 f_g=25 l/min	B_1 f_g=5 l/min	B_2 f_g=15 l/min	B_3 f_g=25 l/min	B_1 f_g=5 l/min	B_2 f_g=15 l/min	B_3 f_g=25 l/min
Level combination	A_1B_1	A_1B_2	A_1B_3	A_2B_1	A_2B_2	A_2B_3	A_3B_1	A_3B_2	A_3B_3
Repetition	21,16	21,34	21,26	17,93	16,79	16,36	12,87	14,83	12,96
	20,71	20,94	21,28	18,04	16,78	16,36	12,73	14,83	13,25
	20,92	21,78	21,51	18,02	16,62	16,43	12,91	14,99	13,16

Experiment's name: RK (Filler metal: Rutile flux cored wire, Shielding gas: Krysal 18)									
Factor A (heat input)	A_1 E_{ef} = 1,436 kJ/mm			A_2 E_{ef} = 0,957 kJ/mm			A_3 E_{ef} = 0,718 kJ/mm		
Factor B (gas flow rate)	B_1 f_g=5 l/min	B_2 f_g=15 l/min	B_3 f_g=25 l/min	B_1 f_g=5 l/min	B_2 f_g=15 l/min	B_3 f_g=25 l/min	B_1 f_g=5 l/min	B_2 f_g=15 l/min	B_3 f_g=25 l/min
Level combination	A_1B_1	A_1B_2	A_1B_3	A_2B_1	A_2B_2	A_2B_3	A_3B_1	A_3B_2	A_3B_3
Repetition	28,11	29,09	29,98	20,75	19,77	19,27	14,51	14,57	14,63
	28,06	29,07	30,35	20,68	19,86	19,03	14,65	14,37	14,54
	28,51	29,64	30,16	20,84	19,13	19,24	14,57	14,35	14,44

3. Analysis of experimental results

Analysis of the measured values is performed by Analysis of Variance [7-11] and the results are shown in Table 5.

Table 5 Analysis of variance.

Experiment's name: PC (Filler metal: Solid wire, Shielding gas: CO_2)					
Source of variation	Degree of freedom *DF*	Sum of squares *SS*	Mean of square *MS*	Variance ratio v_o	*F* (95% confidence)
A	2	260,54	130,27	3905,51	3,55
B	2	2,24	1,12	33,59	3,55
AB	4	9,81	2,45	73,53	2,93
Error	18	0,60	0,03		

Experiment's name: RK (Filler metal: Rutile flux cored wire, Shielding gas: Krysal 18)					
Source of variation	Degree of freedom *DF*	Sum of squares *SS*	Mean of square *MS*	Variance ratio v_o	*F* (95% confidence)
A	2	997,61	498,80	10937,82	3,55
B	2	0,18	0,09	1,968	3,55
AB	4	9,51	2,38	52,15	2,93
Error	18	0,82	0,05		

For the both cases, the analysis of variance has shown the significant influence of the heat input on the weld reinforcement area. Also, the interaction of the heat input and gas flow rate has variance ratio larger then the value F for 95% confidence.

Besides statistical analysis, the influence of the shielding gas type and heat input on the geometrical properties of weld reinforcement area cross section can be observed from the macro sections of the weld bead (Figure 4).

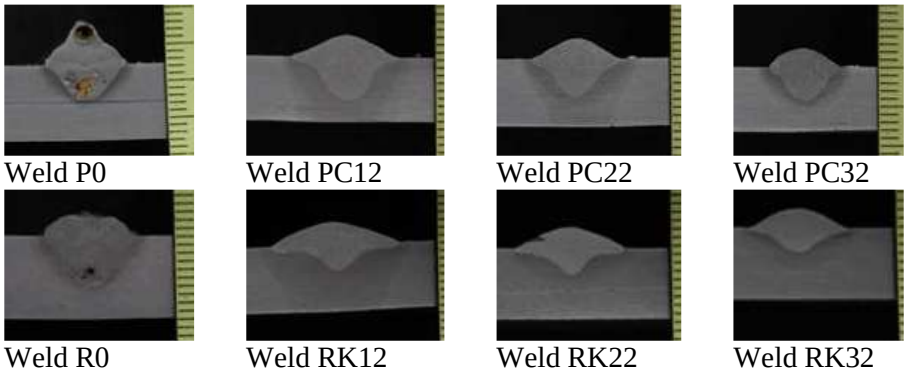


Figure 4 Macro sections of beads on plate welded with solid and rutile flux cored wire (plan of experiment from Tables 2 and 3)

4. Analysis of main welding costs

Besides desired weld quality an important factor in selection of filler metal and shielding gas are welding costs. The main costs of MAG welding are: energy, filler material, shielding gas, operator and machine [12]. Regarding to possibility of porosity in weld bead if there is a lack or overflow of shielding gas (macro sections in the Figure 3), for welding costs calculation, experiments with gas flow of 15 l/min (PC22, RK22, Table 2) are selected. The calculated welding costs are shown on the Figures 5 and 6.

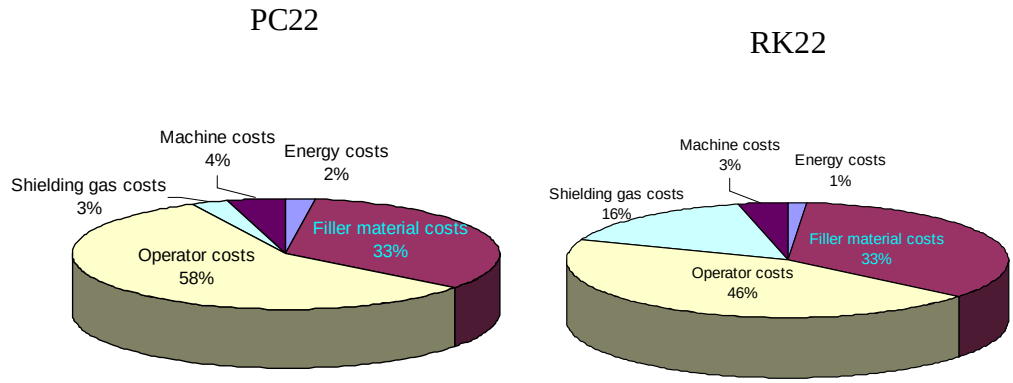


Figure 5 Individual welding cost amounts for the two selected expereiments

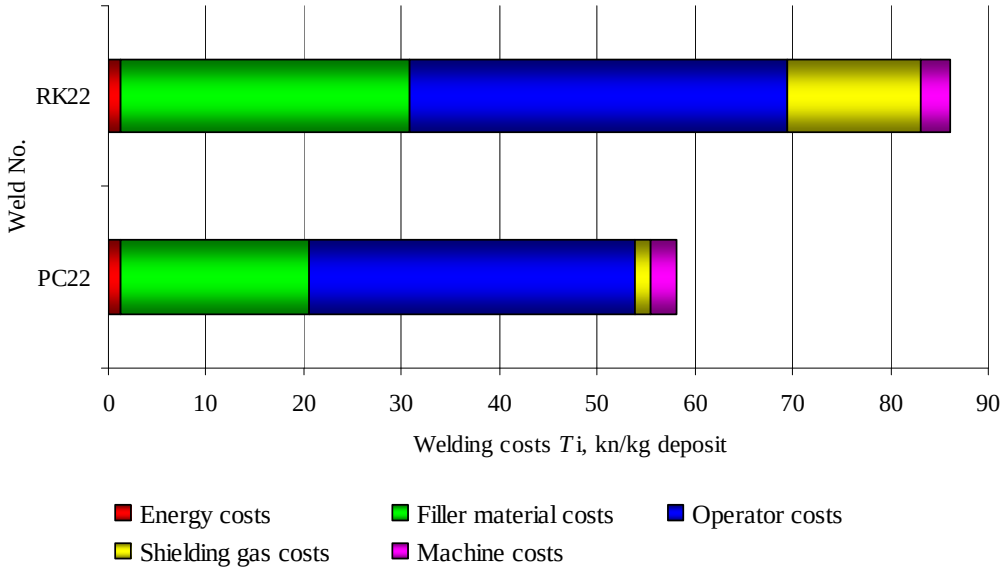


Figure 6 Individual welding costs amounts for welding with solid and rutile flux cored wire

It can be noticed that the largest influence on the MAG welding costs has welding operator costs and filler material costs. Additionally, especially if the expensive gas protection is used, shielding gas cost has to be taken in consideration. But, on the other hand, the welding stability is improved by using expensive filler material and shielding gas (rutile flux cored wire and gas mixture) [3]. Therefore it is necessary to make a compromise between those two demands and take also into consideration other demands depending of the desired weld properties, like, mechanical strength, corrosion resistance, spatters on the base metal surface.

5. Conclusion

Problems of achieving desired weld properties for MAG welding process can be observed from several points of view. Two of them, weld reinforcement geometry and weld costs are described in this paper.

First, after conducted experimental welding and preparation of the specimen, macrophotography was done and the reinforcement area dimensions are measured. The influence of the two effects: heat input (welding speed) and gas flow rate on the values of the bead on the plate reinforcement area are investigated. Analysis of variance where performed for two cases:

(a) welding with solid wire with shielding gas CO_2 and (b) welding with flux cored wire with shielding gas Krysal 18. The results of mentioned analysis have shown that in both cases (a) and (b) there is a significant influence of heat input and of mutual effect of heat input and gas flow rate. In the case of further investigation of the mutual effect of heat input and gas flow rate on the weld geometry at MAG welding process, the plan of experiment should be redefined.

Second, taking into consideration main welding costs, increased costs due to selection of more expensive filler material or shielding gas can be, however, reduced by application of cost effective automation (shorting the weld preparation time). Also, other methods of weld cost reductions can be applied, like for example, selection of the optimal type of weld groove.

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Modelling and rapid manufacturing of customized medical implants

P. Raos, J. Kopač, A. Stoić

Keywords: *customized implants, rapid prototyping (RP), machining,*

1. Introduction

In the recent years several research institutions, medical companies and commercial organizations have integrated Computer Aided Design (CAD) and Rapid Prototyping (RP) to produce 3D physical medical models. These models are being used for several applications: visualization, diagnosis, surgery planning, design of implants, external prosthesis, surgical templates, production of artificial organs, communication (between the medical team and/or medical doctors and patients), and teaching, or didactic aids. Another application field is the production of medical surgical instrumentation tooling.

The use of RP in medicine is not satisfactory high since it is relatively young field with very wide potentials to be reached. The main limitations for wider application of this manufacturing procedure, so far, are: biological incompatibility of the existing materials used in RP processes; relatively high costs of model production; time and work intensive process to achieve an appropriate model quality (surface finish and anatomical accuracy).

Therefore, it seems that the most practical way of surgery is early implant machining (on milling machine) and fixing on the certain tolerances (using the user friendly interface and visualization techniques) based on the CT data (enhanced with additionally SSD technique for 3D object obtaining). This platform containing digital model data provides that implant materials produced in blocks can be machined or even tested on the model of the origin bone material before the surgery act starts in practice. This procedure doesn't suffer from sterilization problem as one can expect if the implant is made during the surgery (that means reshaping of the implants produced in the sheet (folia) forms.

Finally, the product created in this way i.e. modeled from one massive piece of biomaterial, will match exactly (3D shape) patient's anatomical region to be cured (changed or replaced). For each patient the customized 3D models of anatomical regions to be surgically treated and replaced after the tumor process has been removed, will be manufactured. This approach exhibits a huge benefit for surgery practice, because it ensures properly postoperative functioning of patient's anatomical/organic system, which by this means, becomes in fact almost the same to its original natural model.

2. Background

The possibility of exact preoperative, non-invasive visualization of the spatial relationships of anatomic and pathologic structures, including extremely fragile ones, size and extent of pathologic process, and of precisely predicting the course of surgical procedure, allows the surgeon to achieve considerable advantage in the preoperative examination of the patient and to reduce the risk of intraoperative complications, all this by use of virtual surgery (VS) or diagnosis *per viam* 3D models. It could be done by using patient's images created for diagnostic purposes. Storage of the patient's images and diagnoses in a multimedia form in computer systems allows them to be subsequently searched and some specific cases re-examined for analysis and physician education, even *via* Internet (e.g. *Eurorad Project*). By use of DICOM protocol, not only image recordings but all general data of the patient, that have previously been entered onto the diagnostic device console as well as all data on the device setting during patient's image production are transferred from the diagnostic device to computer systems [1].

Concerning the implants, medical models obtained by RP are normally used indirectly, as masters, to produce prosthesis in biocompatible conventional materials (e.g. titanium, cobalt-chrome alloys,

medical-grade aluminum, medical-grade silicone etc.) mainly by casting and spray metal molding [2,3].

However, RP technology has the ability to fabricate models with complex geometric forms, and so is very suitable to reproduce the intricate forms of human body. By using of RP models, visualization of intricate and hidden details of traumas by surgeon is enhanced.

The majority of the references found in literature on this subject are concerned with the production of medical models via Stereolitography (SL). However, SL medical models, unfortunately, cannot be used inside the human body, as direct implants, due to the resin toxicity, which creates concerns about the long-term biocompatibility of SL models. Nevertheless, the range of applications of those models is very large [3].

Some recent researches aiming to improve the use of RP in the production of medical implants are directed toward producing implants of biocompatible materials directly in the RP process. Among this group of materials, high-purity calcium phosphate ceramics (hydroxyapatite, HA or HAp) alone, or in composites with biodegradable polymers (poly (L-lactide), PLLA) offer long-term biocompatibility and therefore have a large potential to be used in medical applications [3,4].

On the other hand, there is a group of porous polymeric materials (e.g. Porex) which can be used as implants while these materials are biocompatible [5]. Those materials can be produced either in thin films forms and be individually reshaped for certain application either in block forms for wider application. This technique allows the in-vitro planning and implant shaping while the first one means shaping on the human body models (produced by RP) or directly during the surgery on real object.

3. Basics of rapid prototyping of medical models

Rapid prototyping (RP) is one of the fastest developing manufacturing technologies in the world today. It is different to the conventional manufacturing procedures (i.e. milling, casting, injection molding etc.). RP is additive type manufacturing procedure, because parts are built on a layer-by-layer basis [2].

The prototypes can be made of plastic, paper, wax, ceramics and metals, and, in general, RP systems can be classified into three different categories based on the initial form of materials used: Liquid-based (e.g. SL); Solid-based (e.g. LOM) and Powder-based (e.g. SLS) [2].

A distinct advantage of creating a part layer-by-layer is that the geometric complexity of the part has significantly less impact on the manufacturing process than in the case of conventional manufacturing technologies. Other advantages are: no need of tools, short time to produce the parts, very little human intervention and set-up time, and lower manufacturing costs.

Some of the more popular RP processes are Stereolitography (SL), Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Laminated Object Manufacturing (LOM), Three Dimensional Printing (3DP) and Solid Ground Curing (SGC).

Depending on the system, post-processing is usually necessary after the part is built (i.e. cleaning, removal of supports, sanding, painting, post-curing, infiltration, etc.).
The manufacturing of medical models using RP technology starts with the acquisition of three dimensional shape data of both internal and external human body structures, allowing the production of 3D physical object, via CAD/CAM system, in a RP apparatus. This is a so-called Reverse Engineering (RE) process. The common systems used in medical imaging to obtain anatomical information are: Computer Tomography (CT), Magnetic Resonance Imaging (MRI), Ultrasound System (US), Mammography, Radiography (Plain X-Ray) and Laser Digitizer. Most medical models are produced via CT for bone structures and MRI for soft tissue [6-7].

4. An approach to customized implants manufacturing

We have been continuously investigating technique of individually (customized) shaping of appropriate metal materials (mainly stainless steel) as well as porous polymeric material. This approach seems to become more comprehensive and it is going forward in slight different, more practical way [8,9]. Such procedure includes few phases: 1. CT–scanning, 2. Digitalization of the data and CAD model building, 3. RP for creation of the environment which surgeries will be faced in during the surgery, 4. CAM (machining planning and simulation on computer),

and 5. Real implant machining on CNC milling machine using the G-code after the CAM results.

This procedure, where the implant is produced by milling, could be cheaper than the one where the implants are produced in RP process and even more if the RP model does not produce.

This procedure is revolutionized since it could be planed and starts at the moment when the preventive CT is performed. All the phases are based wholly on CT data and also the procedure of implant production is automatically linked with CT report. That means that the human errors and its leakage are reduced to minimum and the surgery results because of that become more successful. Basic idea of the investigations to be carried out is summarized by the scheme in Fig. 1.

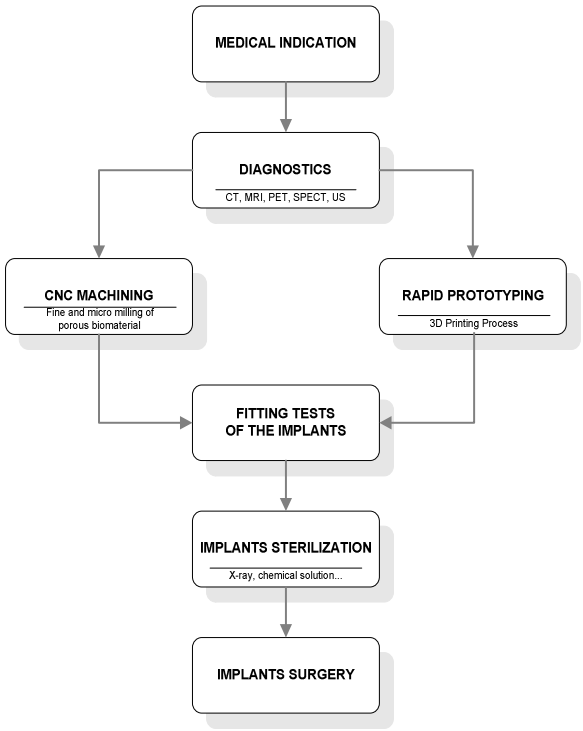

Figure 1. An approach to manufacturing of customized implants

Machining of PE-UHMW and PE-HD with conventional manufacturing processes is possible and is not problematic but nevertheless it is specific technique and suffer from some restricted demands. Generally, there is no necessity for classic application of coolants because of relatively low specific cutting forces. Furthermore, cutting speeds can be increased in order to obtain better surface quality till the value when the temperature rapidly becomes higher and so far that can damage or even destroy the implants. Assuming that the implants have to be machined with very low roughness and neck free some test have to be performed in order to define acceptable overlapping of the milling tool paths. Because of porousity of the material blocks (e.g. Porex), machining has to prevent that residual particles with micro size left into porous structure. Nevetheless, residual particles could be reduced by posterior cleaning with air.

Geometrical complexity of geometry of implants is oneother constraining parameter concerned with material handling and fixing since the implants geometry could be very thin and so far the selection of the base plane for fixing and applied value of fixing forces is of big importance. Complex geometry of implants result with demands on construction of machine tool which has to allow 4D or even 5D machining. Nevertheless, application of tools with small diameter for obtaining very small radii of convergence on implants is possible only if the main spindle can rotate at very high values. Concerning depth of cutting, there is restriction when the production is close to final shape of implants.

Also, attention has to be paid on tool trajectory in the area where the radii of the curvature is small in the way that cutting feed has to be lowered. This restriction is powered when the tools with small diameter are used and when the surface feeding speed is high. This condition, with very high value of acceleration and deceleration of the spindle (frequently higher than 1 G – 9,81 m/s^2), could be problematic on the geometric accuracy of the implants. Appropriate tool geometry and cutting feed and depth of cutting has to be chosen in order to achieve good chip transportation.

The RP models obtained by 3D Printing process (*Z-Corp ZPrint 310 System*) will be used in planning of implants surgery i.e. to test whether the implants produced by machining of porous biomaterial blocks fit appropriately in complex neighboring anatomical structure modeled by RP technique. Secondly, we will compare shape characteristics of implants obtained by machining with those produced in RP process.

5. Case study

The modeling of an upper part of the human hip bone was chosen as a case study to show the possibility of

using technology of rapid prototyping and rapid machining in medical implant producing.

To visualize hip bone we have used Computerized Tomography System *Sytec 2000+* (GE). Based on CT scan pictures a file containing 3D shape data, so-called STL-file was created (Fig. 2). From created STL-file, a physical RP model of an upper part of hip bone was generically produced in 3D Printing technology on *Z-Corp ZPrint 310* rapid prototyping machine (Fig. 3).

To materialize a part of hip bone we have used cylindrical block (diameter 70 mm and 130 mm length). Milling was performed on *Mori Seiki Frontier M CNC machining centre* with three tool (smallest diameter was 2 mm). Some details during the milling of implant are shown in Figs. 4 and 5 and a final implant shape is displayed in Fig. 6.

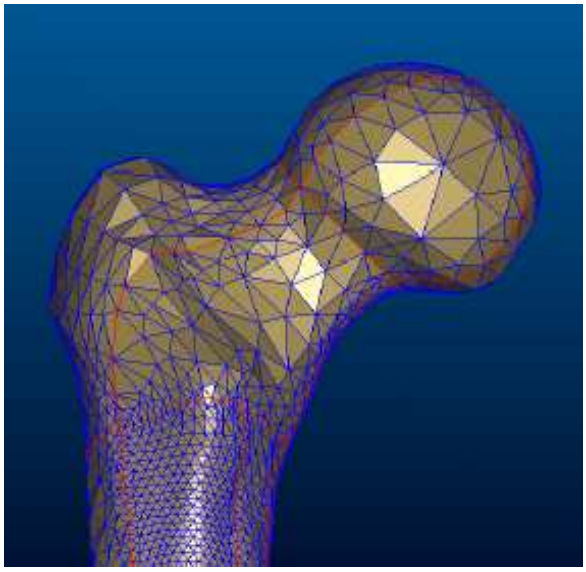

Figure 2. STL model of the hip bone

Figure 3. Hip bone shape obtained in 3D printing RP technique

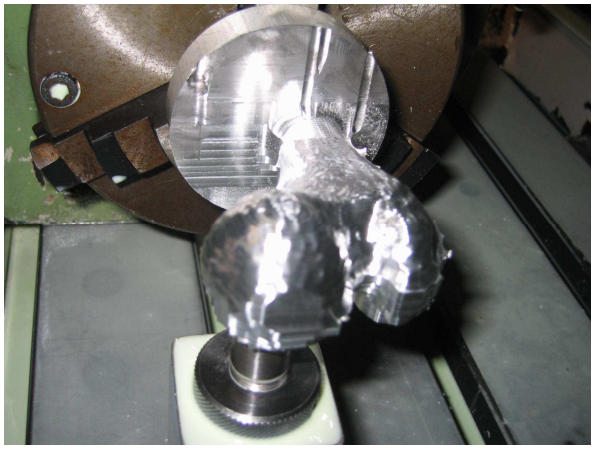

Figure 4. Hip bone after rough machining

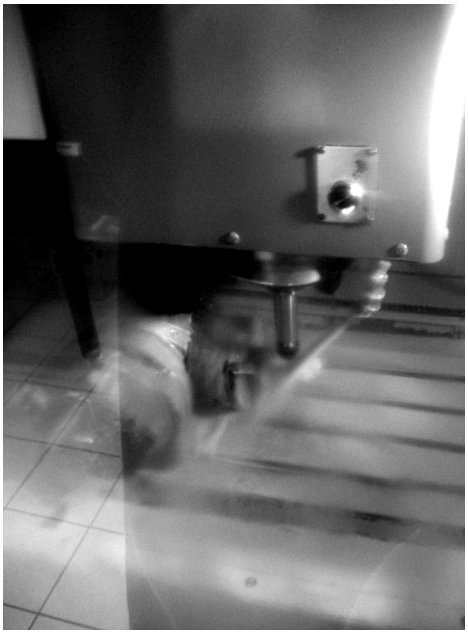

Figure 5. Machining process of the hip bone

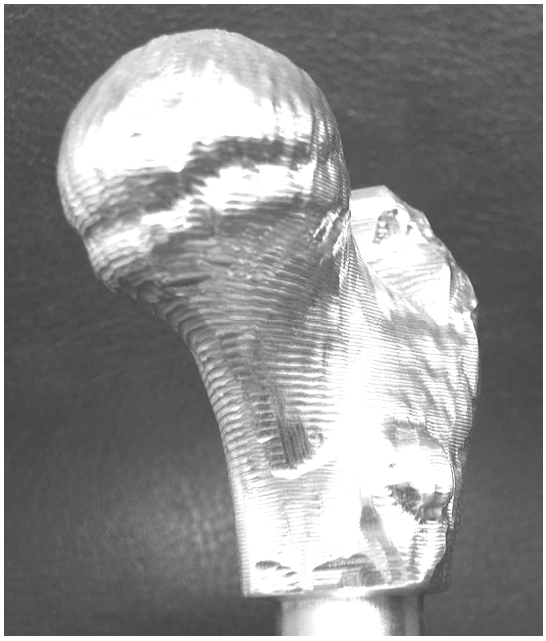

Figure 6. Final shape of the machined hip bone

While implant is machining, it is very important to minimize scallops and burrs on machined surface of the implants [10]. Therefore grove profiles and large tool path spacing are not convenient. However, if tool overlapping is increased machining time is dramatically increased. Currently, a lot of machining shops employ the traditional method of constant feed rate cutting for sculptured surface parts. This can result in significant tolerance deviations. By varying the feed rate based on the cutter chip load predicted by machining models, a more constant tool deflection can be attained, resulting in much better tolerances in the same machining time or similar tolerances in less time.

In order to minimise number of tool changes either automatic or interactive, cutting parameters are dynamically optimised and a single tool is selected for each machining feature. Feature tool selection depends on the geometry to be machined. It has been pointed out that number of tool changes is not crucial as the volume of material left behind for smaller tool. Issues coverings the effects of residual material left behind by oversized cutters are also not adequately addressed.

6. Conclusion

In accordance with solid model obtained after CT it is possible to manufacture hip bone implants from block material on milling machine. Approach in bone surgery treatment that was presented in this paper offers great potentials in time saving and eventually possible postoperative treatments. This procedure is revolutionized since it could be planed and starts at the moment when the preventive CT is performed. All the phases are based only on CT data and procedure of implant production is automatically linked with CT report. That means that the human errors and its leakage are reduced to minimum and the surgery results because of that become more successful. Machining time has to be improved and we pointed out a tool selection (number and paths) as very important and critical in that manner. Also, there is consideration regarding tool path overlapping to achieve better surface quality. In following work we will try to apply our theoretical considerations addressed on machining process. Also, our future work will be directed toward investigation of machining capabilities of special biocompatible polymeric materials.

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Investigation of high flow rheology of polymers

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Abstract

Injection moulding is one of the most widely used techniques producing complex final product in one manufacturing step. The rheological characterization of polymers is necessary in the simulation of the injection process working with CAE (Computer Aided Engineering) systems. Maintaining and improving of the quality of the plastics product requires the detailed knowledge of the cavity filling process. Polymer melts are non-Newtonian fluids therefore their viscosities, addition to temperature, pressure and molecular weight, depend on the deformation rate. The main object of this research was to develop new measuring techniques for the determination of the viscosity of the polymer melts. A special injection mould was designed for the measurements. A quick-change capillary system was built into the moving side of the mould and three pressure sensors and a P-T combo sensor were built into the fix side of the mould. The capillary system is an open one, so the molten polymer can flow out freely from the mould during the filling. The mould was equipped an electrical temperature control system, so the maximum mould temperature is around 250°C. LDPE material was measured. Material temperature, mould temperature and injection speed were changed. The injection and the cavity pressure were measured, and the viscosity curves were calculated. It was found that there was not any significantly different after the Bagley and Rabinowitsch corrections in the measured flow curves compared to the ones measured by traditional capillary rheometer.

Keywords: design, polymer, rheology, mould.

1. Introduction

Due to the improved properties of polymer materials, engineers use more and more polymers in their designs. Nowadays not just simple articles are made from plastic, but special high quality complex parts too. It is necessary to know the mechanical, rheological and thermal properties of polymers for design. In the last years, the numerical simulation of the injection moulding process has acquired a great relevance for supporting important decisions in part, mold and process design. The reliability of filling simulations results depends mainly on the following four factors [1]: input data, process parameters, software applications and numerical models. In particular, among the process parameters, the rheological characteristics of polymers have the largest influence on the simulation of the filling phases [2–4]. Flow of polymers is a complex process. The viscosity of plastics, apart from temperature and pressure, depends on the molecular mass, molecular mass distribution and the deformation rate. These things make the plastic processing rather difficult. In practice, the flow and the viscosity curves are used to characterise the flowing behaviours of polymers (Figure 1.).

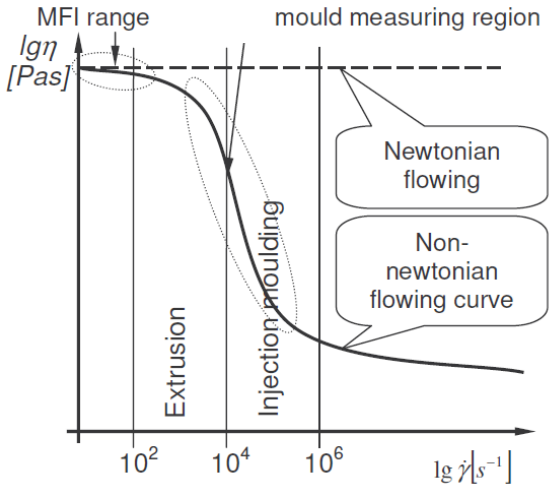

Fig. 1. Viscosity curves

In industrial practice, the most widely used measuring technique of flow of plastics is the melt flow index (MFI). It should be emphasised that this very simple method gives no detailed information on the rheological behaviour of the polymer melt, namely the flow curve of the material can not be characterised by it. Expensive rheometers can be used for determining the flow curves in laboratory environment. The melting techniques of rheometers are different from the plasticizing of an injection moulding machine. It was

investigated by P. F Bariani and M. Salvador [5]. A special spiral injection mould was made by I. Claveria, C. Javierre and L. Ponz [6]. Rheological properties of origin and recycled polyethylene were determined by the mould in their article. They managed to define the flow curve in wide shear rate range but they did not have measurements to determine the effect of the mould temperature and the flow cross section.

Our goal is to develop a measuring system that can work in industrial environment. A special injection mould was designed with changeable slit die inserts. Flow properties of polyethylene were determined by two different methods. Standard HAAKE rheometer and the capillary injection mould were used for the measurements. Preliminary experiments were carried out applying different injection parameters to measure the flow behaviour of the material.

2. Experimental

2.1. Material

TIPOLEN FA 2210 (Tisza Chemical Group Public Limited Company) low density polyethylene was used in the research. This type of material is used for film blowing technology. The melt flow rate of the material is: MFI(190 °C,2.16 kg)=0.28 g/10 min.

2.2 Technology, injection mould

ARBURG Allrounder 270 C 350-70 injection moulding machine was used in the experiments (Figure 2.).

Fig. 2. Arburg injection moulding machine

The injection rates were changed from 5 to 90 cm^3/s and the material temperatures were 180 °C, 200°C and 220 °C.

The other parameters are summarized in Table 1.

Table 1. Parameters of the injection moulding.

Injection pressure	1500 bar
Screw rotation speed	150 mm/s
Back pressure	20 bar
Packing pressure	0 bar
Switch over point	1 cm3
Cooling time	20 s

2.3. Measuring system

Some researcher groups work on the developing rheological measuring systems [5,6,8,9,11]. Our mould is basically different from the conventional injection moulds. A quick-change slit die system was built into the moving side of the mould and three pressure sensors (Kistler 6157BD) and a P-T combo sensor (Kistler 6190A) were built into the fix side of it. The sensors can be used up to 300 °C and 2000 bar. The capillary system is an open one, so the molten polymer can flow out freely from the mould during the filling (Figure 3.). The mould was equipped with an electrical temperature control system, so the maximum mould temperature can be around 250°C. The height of the applied inserts were 2 mm, the width were 16 mm. Three different die lengths were used for the measurements because of the Bagley correction. The useful measuring lengths of the slit die were 80 mm, 60 mm and 40 mm.

Fig. 3. Fix side of the mould and the raw material

A virtual instrument was developed by LabView software environment for data processing. It can control the database and calculate the rheological properties from the measured pressure in Windows XP environment. The applied sampling rate was 1000 Hz

during the filling. This relative high sampling rate is necessary for studying the melt fracture effect.

In Figure 4, the four measured pressure curves and the pressure differences are plotted as a function of time. It can be seen that the cavity filling has two different phases. The material flows into the cavity in the first stage. The pressures are increasing continuously until the melt front reaches the outlet of the die. After this time a more or less constant pressure is measured. These constant pressures were used in the calculations.

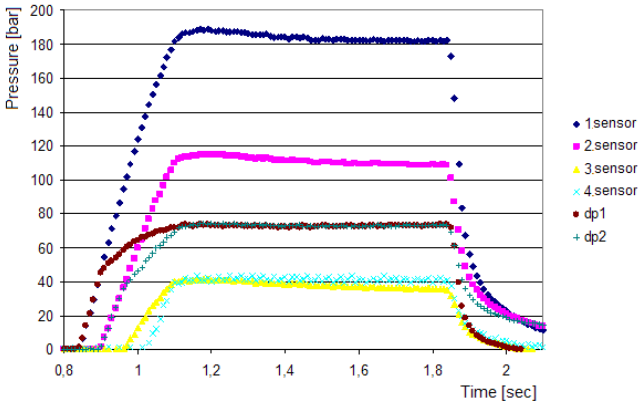

Fig. 4. Typical pressure curves

2.4. Calculations

The following formulas were used to calculate the viscosity of the polymers [7].

To define the shear rate, one has to know the geometry of the cavity and the flow rate (Eq.1), where b (Eq.2.) is the slope of $log\,\dot{\gamma}_f$ versus $log\,\tau_f$. It is necessary to know the pressure drop (ΔP), the height of the die (h) and the flow length (L) for the calculation of the shear stress (Eq.3). The flow curve is given by the power law (Eq.4).

$$\dot{\gamma}_f = \frac{2+b_2}{3}\left(\frac{6\cdot Q}{h^2\cdot w}\right) \qquad (1)$$

$$b_2 = \frac{d\,lg\,\dfrac{6\cdot Q}{h^2\cdot w}}{d\,lg\,\dfrac{h\cdot \Delta P}{2L}} \qquad (2)$$

$$\tau_f = \frac{h}{2}\cdot\frac{\Delta P}{L} \qquad (3)$$

$$\tau = k\cdot\dot{\gamma}^n \qquad (4)$$

where, $\dot{\gamma}$: deformation rate
Q: volume rate
h: height of the slit die
w: width of the slit die
ΔP: pressure drop
τ_f: shear stress at the wall
L: flow length
n: power law index
k: constant parameter called “consistency)

3. Results and discussion

Before the corrections (Bagley, Rabinowitsch) the calculated flow curves were basically different from the results of a standard method. The measurements were repeated with the same parameters but different die (L/h ratio were changed). The inlet pressure drop can be determined by using the extrapolations shown in Figure 5. The pressure in the case of L/h=0 is the inlet pressure drop.

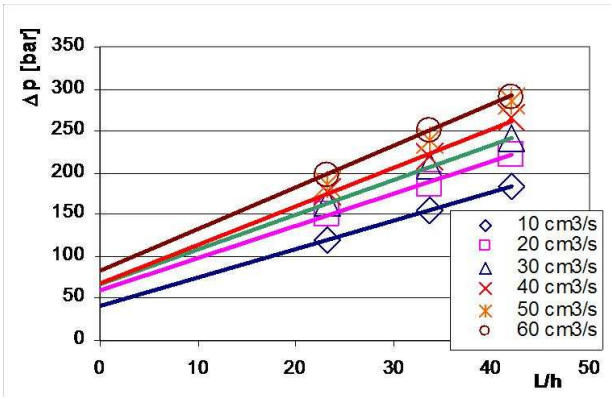

Fig. 5. Bagley Correction

Figure 6. shows the results of the new and the standard method. The triangles indicate the flow curve without corrections, the circles shows the flow curves applied data after the corrections. The squares show the results of measured by standard rheometer (HAAKE). It is clear from Fig. 6. that the apparent viscosity of the polymer melt (slope of the flow curve) decreases with increasing shear rate. The other important result that the flow curve measured by injection mould is the same, within the measuring error, as the curve measured by the HAAKE viscometer. It should be emphasised that the correction is essential otherwise the in- and outlet effects give misleading results.

The instrumented mould is suitable to determine the flow and viscosity curves of polymer materials.

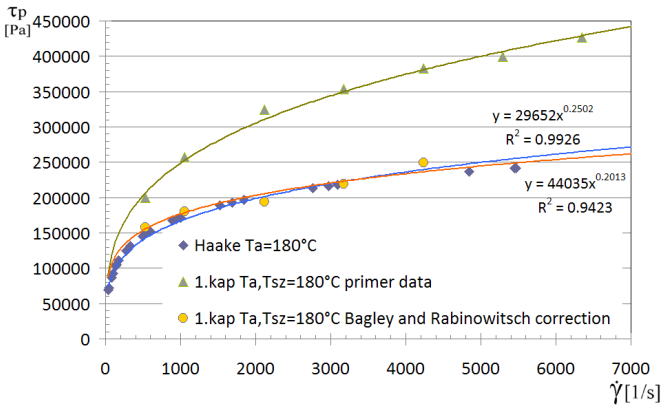

Fig. 6. Flow curves of the PE TIPOLEN FA2210

The calculated rheological parameters of PE are shown in Table 2. The value of the k decreases, while the n increases by the temperature. Both method shows the same tendency, but the value has some differences.

Table 2. The rheological parameters of the material.

Material constants (Fa2210)				
	HAAKE		New method	
T [°C]	k	n	k	n
180 °C	29652	0.2502	47202	0.2013
200 °C	27178	0,252		
220 °C	18547	0.29	29018	0.2284

The apparent viscosity (η_{app}) can be plotted as a function of 1/T (Figure 7.). Lines can be fit to the points at constant deformation rate. The apparent activation energy (E_f) can be determined from the slope of the lines (Eq.5).

$$E_f = 2{,}303 \cdot R \cdot tg\alpha \qquad (5)$$

Where, E_f: appearance activation energy
R: universal gas constant
tgα: slope of the lines

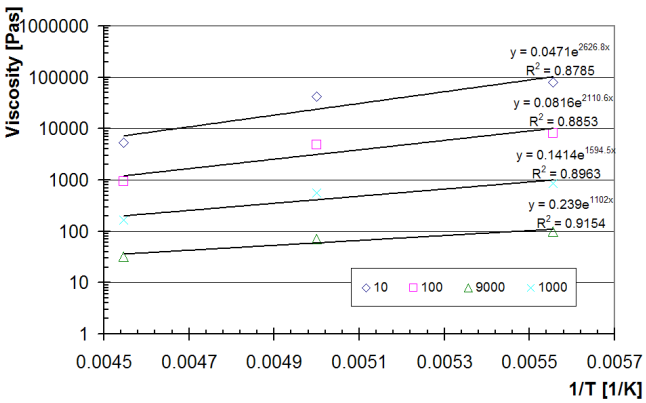

Fig. 7. Apparent viscosity-T^{-1}

Figure 8. shows the apparent activation energy of flow as function of deformation rate. The result is a straight line which shows the flow mechanism does not change in this rate region. The values of the activation energy of flow show good correlations with literature [10].

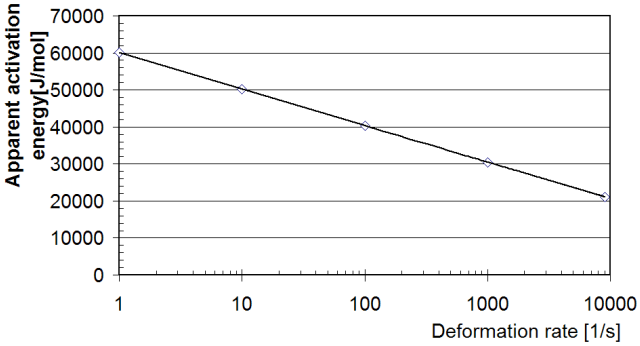

Fig. 8. Apparent activation energy vs. deformation rate

4. Conclusions

It was found that the developed measuring system is suitable for determining the rheological properties of polymers. The calculated flow curves correspond with the results of the standard curves. The apparent activation energies were determined as a function of deformation rate. It was found that the measured data correlate well to the data of the literature.

Acknowledgements

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Experiences in Implementation of Bologna Declaration

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Abstract

Agricultural higher education (AHE) in Croatia has undergone major changes due to the reform of studies according to Bologna Declaration. Until 2005/06 academic year three levels of study were introduced – bachelor, master and PhD study level. Structure of study programs changes from its roots and students and professor started with new concept of teaching process. Today, four years after, we can evaluate what are advantages and disadvantages of the new study process, where we made mistakes and what we should done in the future to improve teaching process. There are several issues connected with the existing problems – the lack of experience for new way of teaching, higher involvement of professor in teaching and work with students, higher student's involvement in teaching process, lack of adequate space for teaching, unprepared labour market for new diplomas, lack of mobility, undeveloped quality assurance system etc. Also, it is necessary for agricultural education to develop new programs and modules for lifelong learning education.

Keywords: agriculture higher education, bologna declaration, three levels study process

1. Introduction

Main role of higher education is to create new knowledge and to transfer it to the students and society. In other words faculties should educate new experts who can contribute to development of science, practice and community in a whole.

Agricultural higher education (AHE) in Croatia is very important for development of agricultural production and competitiveness of our agriculture on a larger scale. With our access to European Union on the horizon that is even more highlighted. AHE have crucial role in preparation of new agricultural experts who will be able to fulfil all future needs and who will help to create strong and modern agricultural production able to cope with all the challenges in the future. Those new agricultural experts should be educated in a flexible way so that can create own educational profile and specialize in area they are interested for. For achieving that goal it is very important to enable students to have elective courses and even more important is to enable them to gain some specific knowledge at the institution known to be experts in certain field.

Another very important role of AHE is scientific and research work in the field of life sciences. With this work AHE also contributes to the development of the agricultural production in Croatia, but it also contribute to agricultural science generally. This role is as important as educational role since best students stay at the Faculties and continues their research and teaching work. During study period students should develop critical way of thinking and desire to explore existing knowledge with the aim of creating new. Therefore study programs and learning process should be student-centred.

Another important issue for the AHE is organisation of lifelong learning education. It is essential to meet the needs of society and economy in which knowledge becomes rapidly out of date. Therefore constant training and relearning is needed.

With the signing of Bologna Declaration in 2001 Croatia has oblige to change higher education system according to the principles of the Declaration. Bologna declaration stress several aims:

- easy comparison of the diplomas
- development of two cycle system (bachelor/master)
- introduction of credit system (ECTS)
- encourage mobility in higher education
- development of quality assurance systems with comparable criteria and methodology
- encourage of European dimension in higher education – interuniversity's collaboration

Application of Bologna principles and Bologna process should improve academic quality and should prepare students for European labour market. Students should be preparing not just for the limited labour

market in there region of living or in their country, but they should gain whole spectre of skills that will enable them to adapt to the changes on economical and social plan. According to European University Association during development of

new curricula it should have in mind that the aim of education is not to satisfy short term demands of labour

market but to insure permanent and continuing employment.

Croatian Low of Scientific Work and Higher Education (NN123/2003) defined major directives for organisation of studies in higher education institutions: undergraduate (bachelor), graduate (master) and postgraduate (doctoral) study. Also, low introduced implementation of major Bologna tools: ECTS (European Credit Transfer System) and diploma supplement. According to the Low new studies were introduced from academic year 2005/2006.

2. Development of new study programs

Until introducing of Bologna process at Faculty of Agriculture in Osijek university studies lasts for nine semesters and students have same subject during winter and summer semester. Sometimes same subject lasts for three semesters. After finishing their study students get diploma - graduated engineer of agriculture. After that they can continue education for Master of Science that lasts for six semesters and after that they can continue in developing of doctor's thesis. Also, Faculty was offered professional studies that last for two years. From 2002 Faculty started with the reform of studies according to Bologna Declaration and in accordance with the study organisation in the leading agricultural universities in Europe. Faculty closely collaborated with Faculty of Agriculture from Zagreb and have a big help through the TEMPUS project 17108 "Reform of Agricultural Studies in Croatia". Undergone changes transformed organization and conducting of studies from their roots. Characteristics of new organization are:

- 3+2+3 structure – three years of bachelor studies, two years of master studies and three years of doctoral studies
- modular structure of the studies – modules replace subjects; modules consists of several units (in our case no more than 5) and in them several professors and assistants participate in lecturing; all modules lasts for one semester, on bachelor level lectures on one module are conducted during whole semester while on master level modules are conducted in block system for 3 weeks
- on bachelor and master level each academic year have 10 modules, modules have 75 lecturing hours and 6 ECTS
- on a bachelor level first year is the same for all students and they have ten compulsory modules; on second year they are listening 10 compulsory modules of the major they choose; on third year they have 5 compulsory modules, 4 elective modules and module of the final work; they can choose elective modules from the list offered by the Faculty or from other universities
- on a master level first year consists of 10 compulsory modules specialized for each major; on second year in winter semester students have five elective modules which they choose from the Faculty list or from other universities in Croatia or abroad
- with election of modules student create own educational profile depending on his affinities and working plans in the future; election of modules from other universities ensure students in gaining highly specialised knowledge from different areas of agricultural production
- implementation of ECTS system which includes: (a) ECTS points - measurement of student load including lecturing hours, learning hours, research work for seminars etc.; (b) information package; (c) diploma supplement; (d) learning agreement
- Doctoral study (PhD) also have ECTS points and compulsory and elective modules
- professional studies also have modular structure but they are more oriented to the practical work and they are preparing students for direct, practical work in agriculture

During development process for new curricula leading idea was that undergraduate study should give to the student's basic knowledge that will enable them to start with work after finishing their study or to enrol in graduate study. Graduate study should give students specific knowledge of the subject they are study. According to these idea modules on undergraduate studies has basic knowledge of the subject without deep and specific explanations. On graduate studies modules are specialized for certain field and they give to students special knowledge.

It should be stressed that the structure of the studies are same as the structure of studies at the Faculty of

Agriculture in Zagreb and as the structure of the studies in European universities. That will enable students to choose elective modules from other universities and to broaden their knowledge. Also that enables students after finishing undergraduate study to continue their studies on other universities.

3. New study programs

New study programs have been reviewed by domestic and international reviewers and with the approval of Ministry of Science, Education and Sport they started in academic year 2005/2006. According the Bologna Declaration and following documents reforms of study programs are process that last several year and that are not ending with the start of first academic year. At Faculty of Agriculture discussion about new programs continued after their implementation. In this discussion local community was also involved and their representatives stress the need for specialist in the field of vegetable and fruit growing. From that suggestion started work on a new study programs that are developed in a two years period and in collaboration with the Faculties of Agriculture from Maribor, Slovenia and Sarajevo, Bosnia and Herzegovina. Studies undergone reviewing process and get the approval from the Ministry of Science, Education and Sport and from the University J.J. Strossmayer from Osijek. Study programs offered at the university level are shown in (Table 1).

Faculty also offers undergraduate professional studies that also undergone changes according to Bologna Declaration and have same modular structure as university studies. These professional studies last for three years and are more oriented to practical work - one third of overall modules are practical one (Table 2.).

Table 1. University study programs at the Faculty of Agriculture in Osijek in academic year 2009/2010

Undergraduate study	Graduate study
1. Agroeconomics	1. Agroeconomics
2. Plant production	2. Plant production
3. Animal husbandry	Majors: Plant production
4. Mechanization	Plant nutrition and soil science
5. Horticulture	Plant breeding and seed production
	Plant protection
	3. Organic agriculture
	4. Mechanization
	5. Zootechnique
	Majors: Animal nutrition
	Hunting and beekeeping
	Special zootechnique
	6. Vegetable and flower production
	7. Fruit growing, viticulture and vine production
	Majors: Fruit growing
	Viticulture and vine production

Table 2. Undergraduate professional study programs at the Faculty of Agriculture in Osijek in academic year 2009/2010

Undergraduate professional studies
1. Agricultural entrepreneurship
2. Plant production
3. Animal husbandry
4. Agricultural machinery

4. Experiences after four academic years

By the end of academic year 2007/08 first "Bologna" generation of students finished their study. In 2008/09 firs graduate year started. Regardless the fact those studies were prepared for three years some problems occurred during first years of their realization. But, because of the scope of the reforms that could be expected. In a first and second year problems were connected with professors and with students. Professors especially emphasises problem of bigger involvement in teaching process and in consequence lack of time for research work. Also, they are used to the system oriented to professor not student-centred system. Even though Faculty published guide for the first year students with all necessary information's about new way of study students were unprepared. They were surprised with the new way of studying which require constant learning and partial examination and they often complain that it is like a secondary school. But after four years and many hours spend in discussion and adjustments and with fifth year of undergraduate students underway we can say that first problems are in most cases solved. Also from today's point of view several points can be stressed as challenges for the future of successful Bologna process:

1. Encouraging mobility - even though studies are organized in a way that students during last semester of undergraduate studies can choose modules from other universities that was not a case. They even did not choose modules from other faculties within the University. Several reasons exists for that – lack of advisory role from academic staff, possible problems with accepting points after returning, for mobility abroad lack of scholarships and low level of English knowledge. In our opinion Faculty and University should create positive atmosphere for mobility and they should be more active in explaining to the students why mobility is good for them and what advantages they will have. They should ensure conditions needed for ECTS recognitions. Also students should be educated about ways of finding scholarships through European funds.

2. Dialogue with employers – very important problem is unprepared labour market for new studying system. Lack of employers awareness of reforms is a key issue in this respect. Very often employers are not sure what bachelor diploma is and what they can expect from university bachelor graduate. Therefore open and constant dialogue with representatives of labour market is needed for successful employment of future graduates.

3. Continuation of studies after first cycle – on the basis of experience from 2008/09 academic year and beginning of graduate studies almost all students want to continue education on graduate level. This is in connection with point number 2. Students, parents and labour market are not sure what to do with bachelor degree and usual their opinion is that bachelor is condition for entering graduate studies and that only "real" degree is after the graduate study. This is in contradiction with the idea that bachelors should start working and then choose graduate study that is interesting for them and that is needed for their work. Also, connected with mobility students should finish undergraduate level at one university and graduate level in another, but that is not the case. Our opinion is that it will take time for shift in mentality and acceptance of new system. Faculty and University should actively present and explain new educational system and the role of bachelors through dialogue with students, employers and representatives of labour market, parents and government representatives.

4. Flexibility – is the key words for several issues. From the experience of enrolment of students in the first year of graduate studies rules for accepting student should be more flexible and should allow students to study certain major even they did not finished undergraduate studies in the same field. During learning process programs should be flexible and they should change – elective modules without interest from students should be replaced with more interested. Students should elect modules from other universities and flexibility in choosing should be encouraged etc.

5. Involvement of students in decisions process – students should be involved in process of quality control and improvement of teaching and learning. Their experience is very voluble for improvement process.

6. Lifelong learning – due to the development of knowledge and situation in which knowledge becomes rapidly out of date constant training and retraining is needed. Therefore it is very important to develop lifelong learning system in a forms of continuing professional development and training courses, courses for staff development etc.

7. Programs in English – for further development, encouraging of mobility, and what is especially important raising the number of student's studies on English language are required.

Comparison of relay and PLC control in pneumatics

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Abstract

In accordance with the needs of modern industry for pneumatic machine for stacking bottles in the beverage bottling plant was designed control. Work has demonstrated the process of designing outdated relay control and control with programmable logic controller. The advantages and disadvantages of one and the other control are given. For control purposes are made pneumatic and relay scheme of the machine and their functions are simulated in software package Festo Pneumatics Fluids. Using software Festo FST 4:10 programmed programmable logic controller (PLC). Designed control functionality was confirmed on didactic equipment. To display the mode of the machine in Autodesk Inventor software has made an animated 3D model of the machine.

Keywords: pneumatics, electro-pneumatics, automation, bottles stacking.

1. Introduction

Designed control is intended for a machine that stacking the bottles in carriers. The machine is of modular type and can be used in new or existing beverage bottler in which this part of the process isn't automated. In carriers that the machine is intended can stand twelve bottles, arranged in three or four rows.

Two different control are designed to perform the same function of machine. Control is designed for relay and PLC technique.

In Figure 1, shown is a 3D model of the machine with marked pneumatic cylinders (A-E) and sensors (S0-S7).

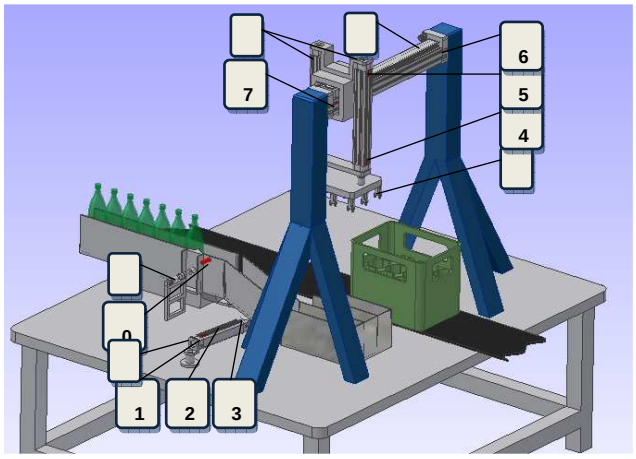

Fig. 1. Pneumatic machine for stacking bottles – 3D model

2. Mode of the machine

For the purposes of design management made position-step diagram showing the positions of the cylinder and the status of sensors and unambiguously defines the mode of the machine.

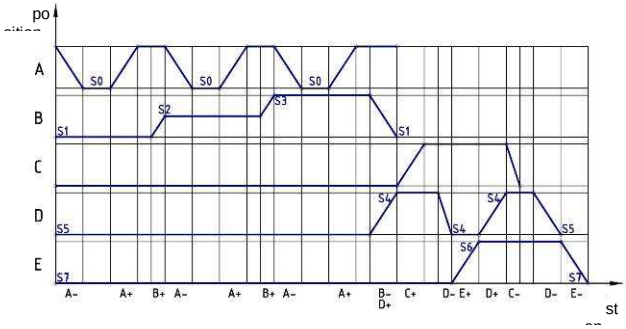

Fig. 2. Pneumatic machine for stacking bottles – position-step diagram

2.1. Pneumatic scheme of the machine

Figure 3 shows a pneumatic scheme of the machine for stacking bottles. For the machine required the following executive elements:

-12 grippers,
-2 double-acting cylinders,
-1 double-acting cylinder and

-1 linear drive.

-2 pneumatic valves 4/2 monostabile i
-2 pneumatic valves 3/2 monostabile.

Of pneumatic control elements is necessary:
-1 pneumatic valve 4/3 monostabile,

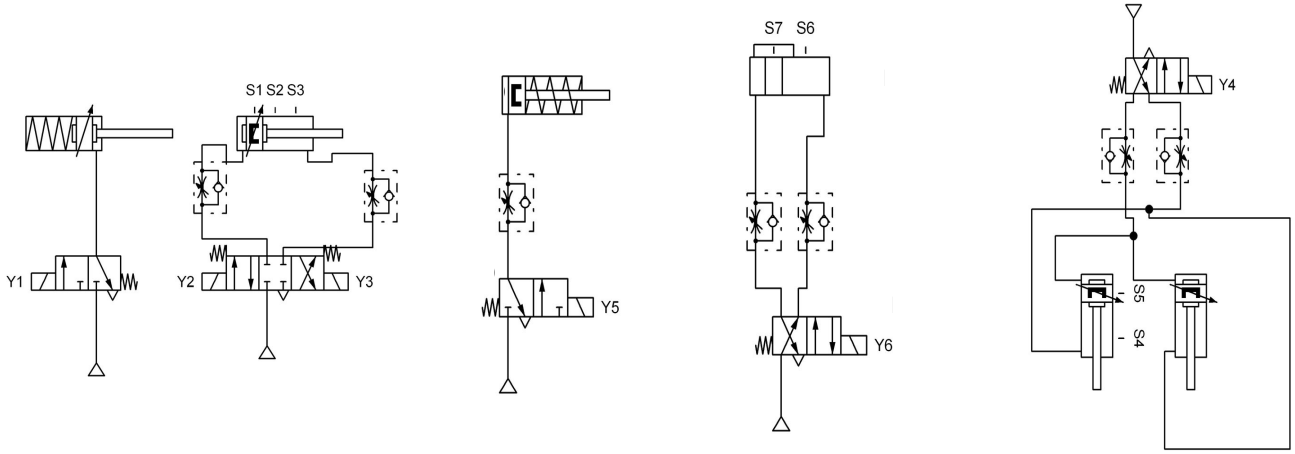

Fig. 3. Pneumatic scheme of the machine for stacking bottles

3. Relay control

For the purposes of relay control made the relay scheme of the machine (Figure 4). Simulation of the relay that would operate machine is made using software package Festo Pneumatics Fluids V4.2. So is verified correct relay schemes on which basis would be later programmed PLC.

From the relay scheme is seen to control the machine using the relay technique was necessary:

- 23 relay,
- 6 time delay relay,
- 3 counter with relay output,
- 1 optical sensor and
- 7 reed sensors.

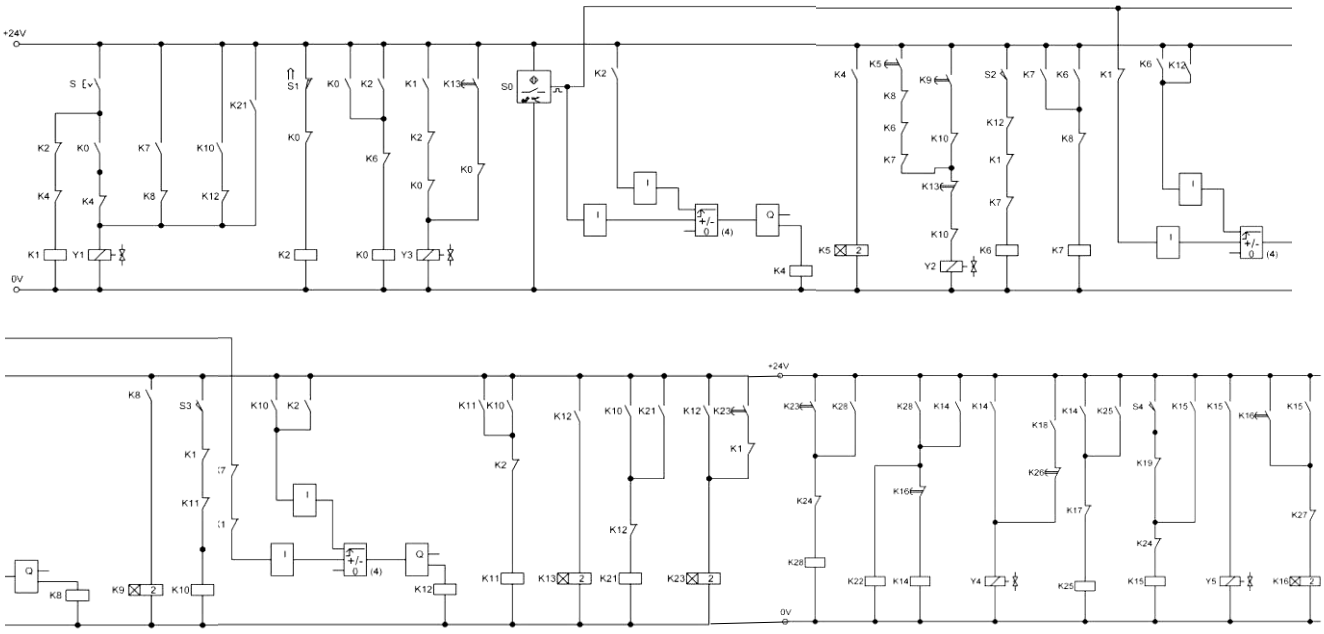

Fig. 4. Relay scheme of the machine

4. PLC control

Since the seventies of the last century trying to find an alternative replacement for the complex relay control systems. The new control system had to remove the biggest mistakes of relay control. As a result, the new control system asked the following requirements:

- simple programming,
- program changes without system intervention (without changing the wiring),
- smaller, cheaper and more reliable components of the relay control system,
- easy and inexpensive maintenance.

Development of production technology of electronic elements, especially in reducing their size, and thus the degree of integration, and continuous decline in their prices, has led to broad application of electronic control elements of the PLC's (*Programmable Logic Controller*). Except for relay control systems they replaced and classical pneumatic control systems [2].

Because of its low cost and its advantages PLC is often used in less demanding control circuits.

To control the machine for stacking bottles was chosen PLC FESTO FC-34. Figure 5 shows the PLC wiring diagram.

From the scheme can be seen that the machine control with PLC-om required:

- 1 optical sensor and
- 7 reed sensors.

4.1. Programming PLC

Program for the PLC that controls machine for stacking bottles is programmed in the software Festo FST 4.10. PLC. It is programmed in ladder diagram which is based on the previous relay scheme designed to control machine.

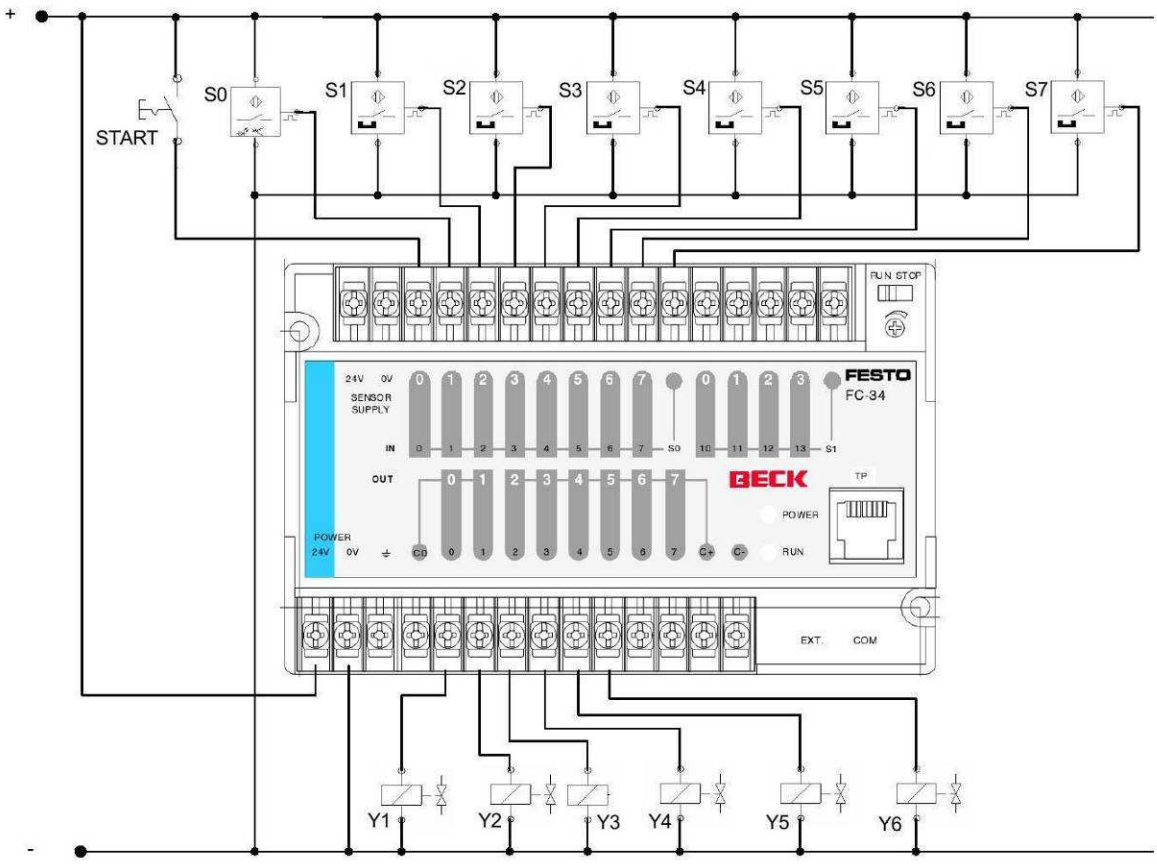

Fig. 5. PLC wiring diagram

Ladder diagram is one of the basic method of programming a PLC. The basic idea of ladder programming a PLC using commands, symbols, and logic taken from relay control, with the aim to facilitate adaptation of engineers and technicians to new environment.

Figure 6 shows part of a program through which PLC controlled machine.

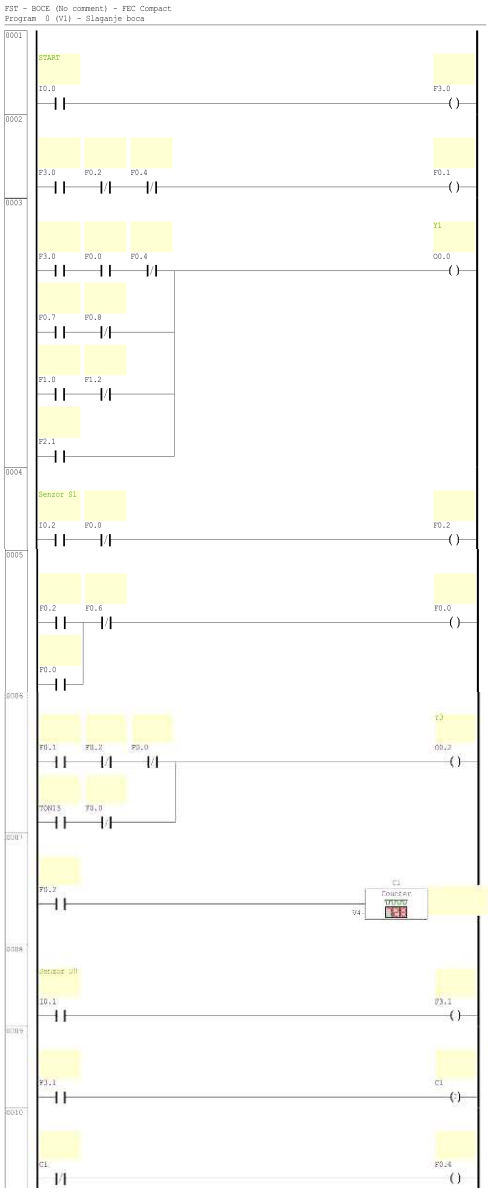

Fig. 6. PLC Program

5. Review of the machine on didactic equipment

On didactics equipment is connected electric and pneumatic part of the machine to display its principle of functional work. In Figure 7 is a presentation of didactic equipment connected to demonstrate the functions of the machine for stacking bottles.

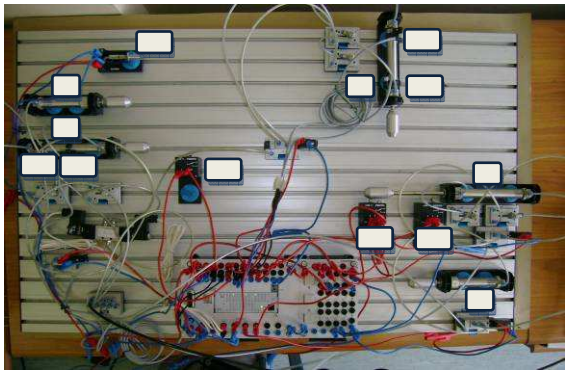

Fig. 7. Review of the machine on didactic equipment

6. Cost analysis

Table 1 shows the list of elements necessary for relay or PLC control and given are their approximate prices. In the table above are only elements that are different depending on type of control. This is only the comparison of elements necessary for cost analysis, the other elements, common to both control, are irrelevant to this calculation.

Table 1. Cost analysis.

ELEMENT	**PCS**	**PRICE** (relay control)	**PRICE** (PLC control)
Relay 24 VDC	23	3450,00 kn	-
Time delay relay 24 VDC	6	2400,00 kn	-
Counter with relay output	3	1800,00 kn	-
PLC Festo FC-34	1	-	4000,00 kn
TOTAL		**7650,00 kn**	**4000,00 kn**
DIFFERENCE		**3650,00 kn**	

From analysis is obvious that PLC control is lot economic and more acceptable with great cost savings.

7. Conclusions

The paper presents procedure and example of design modern electro-pneumatic system. For design example is chosen electro-pneumatic machine for stacking a bottles on which has demonstrated the whole process of design.

Designed control functionality was confirmed on didactic equipment.

From cost analysis of control elements (Table 1) can be concluded that is much better to chose PLC control.

In addition to the PLC significantly cheaper than the appropriate components necessary for relay control, PLC control has the following advantages:

- easier designing of PLC control,
- it is possible to simulate the operation on computer,
- components for PLC control are smaller and simpler,
- no mechanical failures in the PLC like in the relays,
- it is possible to make software changes without changing the wiring,
- easier and cheaper to maintain.

Use of PLC is often justified even when the price is slightly higher than the price of relay control.

In such cases when we are not sure of justification of PLC application first is necessary to set the criteria for determining justification for application of PLC. Some of these criteria are [4]:

- cost effectiveness,
- the complexity of control in design and development phase,
- need to alert on the distance,
- the need for supervision and control from the remote center,
- need to connect with other plants,
- ease of maintenance,
- expected need to expand in the future...

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Lot sizing of spare parts

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Abstract

Spare part demand could significantly vary over a time. Even though there are periods without demand. Commonly used lot sizing policies like Economic-Order-Quantity, Lot-For-Lot and Period Order Quantity do not take these effects into account. This research compares these policies with dynamic models, within which lot sizes are based on minimizing total inventory cost. Appropriate example is used to compare results within static and dynamic inventory models applied to spare parts. Results show that the dynamic inventory models give the lower total inventory cost.

Keywords: lot sizing, spare parts, dynamic models, static models

1. Introduction

Modern industry applications require the availability and reliability of machines, which ensures, among other things, the availability of spare parts and components at the time of their needs. As the intensity of wear of individual parts of the machine is very different and often unpredictable, it is necessary to stock a certain amount of spare parts. However, ordering[1] and inventory holding[2] costs are affecting performance. It is therefore necessary to find the optimal order size that will minimize total costs, while at the same time ensure availability of spare parts at the time of their needs.

To find the optimal ordering plan, there are different mathematical models, but the question is which of them give the best result in the issue of procurement of spare parts (HM. Wagner, 2004., R. Kleber, K. Inderfurth, 2009.).

In general, for solving this problem we can use static and dynamic programming inventory models.

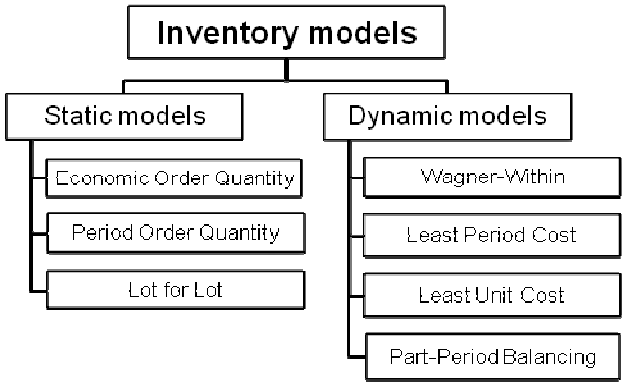

Figure 1. Inventory models

2. Static Lot-Sizing Models

2.1 Economic Order Quantity (EOQ)

The best known and the simplest model is the EOQ model, which was developed in 1915 by FW Harris. EOQ is based on the following assumptions[3]:

- Known and constant demand in time
- Known and constant lead time[4] over time
- Instantaneous receipt of spares
- No quantity discounts
- Constant ordering and holding costs over time
- No stock-outs are allowed.

[1] This is the sum of the fixed costs that are incurred each time a number of spare parts is ordered. These costs are not associated with the quantity ordered but primarily with the physical activities required to process the order. These activities are: specifying the order, selecting a supplier, issuing the order to the supplier, receiving the ordered goods, handling, checking, storing and payment. It is also called setup cost.

[2] Holding costs express the costs (direct or indirect) to keeping parts on stock in a warehouse (warehouse space, refrigeration, insurance, etc. usually not related to the unit cost).

[3] These assumptions do not hold all in the case of spare parts.

[4] The lead time is the time needed to get the spare part as indicated by the supplier. It starts from the moment the supplier is informed until he delivers the part on site.

It is necessary to know the following values for the optimization:

D - Annual demand in units of the spare part
C_n - Fixed cost per order
h - Holding cost per unit per year

Optimal lot size is determined by the equation:

$$Q^* = \sqrt{\frac{2DC_n}{h}} \quad (1)$$

2.2 Period Order Quantity (POQ)

The procedure of POQ model is following:

- Calculate EOQ using average demand
- Calculate time supply and round it to the nearest integer
- In each replenishment, order to cover that many periods' demand

Order interval is constant, but ordered quantities could be different.

2.3 Lot-For-Lot Model (LFL)

Spare parts are ordered precisely when needed. Each period is ordering a lot to satisfy only that period's demand. Lot-for-Lot is among the most popular with practitioners since it is simple and produces the least remnant work-in-process inventory. However, setup costs can be excessive if too many small lot sizes result.

3. Dynamic Lot-Sizing Models

Dynamic lot-sizing models are used within the demand which vary during a period of time. Furthermore, all of the models described in this chapter take assumptions:

- Demand during period t is P_t and can be anticipated.
- Planning orders is done for a specific timetable (planning horizons): $t=1, 2... T$
- No shortage is allowed.
- No limitations in warehouse nor in ordered quantity.
- The time necessary for the order realization is ignored (equals zero) or it is constant
- Warehouse expenses depend upon the level of supplies at the beginning of a period.
- The cost of ordering C_n, and holding costs h_t,
- Model objective is to determine the quantity of ordering x_t that minimize the inventory cost during T periods.

In addition, it is supposed that the following data is known:

P_t - Demand by periods
$C_{n(t)}$ - The ordering cost (usually $C_{n(t)}=const.=C_n$)
h_t - Inventory holding cost per unit (for unit that remain at the end of a period t)
T - Analyzed number of periods (usually it is 12 months ⇨ T=12, i.e. one year)

Mathematical definition of the problem:

TC_t^* - Cost of an optimal ordering plan for the first t periods
$Z_{m,t}$ - The cost of satisfying demands in periods m to t by ordering in period m for the periods up to t.
$Y_{m,t}$ - The cost of satisfying demands for periods 1 to t:

- By having in mind the optimal ordering plan in periods 1 to $m-1$
- Ordering in period m ($m \le t$) for periods m to t

$$Y_{m,t} = TC_{m-1}^* + Z_{m,t} \quad (2)$$

$$TC_t^* = \min(Y_{m,t}) \quad (1 \le m \le t) \quad (3)$$

Boundary conditions:

- Ordering is performed only when the inventory level is zero,
- Ordered quantity exactly corresponds to the demands in observed time periods,
- *State of supplies x ordered quantity = zero* The following means that is never optimal to order if there are any quantity on stock,
- If it is optimal to order in the period m to satisfy the demand for periods m to t, it is also optimal to order in the period m for the periods (m, m+1, …., t).

Horizon theorem:

If it is in solving t periods optimal to order in the period m to meet the demand in the period t, then in resolving w periods $(w>t)$ it is optimal to deliver order in the period m or later:

- If $z_t^*=1$ for the t period than $z_t^*=1$ for w periods $(w>t)$ and the ordering plan for the period t remains unchanged (frozen)
- If $z_t^*=0$ for t periods then $z_t^*=0$ or 1 for w periods $(w>t)$

where z_t^* is a binary variable (= 1 if the order is issued in period t, otherwise = 0)

3.1 Wagner-Within Model (W-W)

The goal of this model is to determine the replenishment plan so that the ordering and holding cost for certain period is minimal. Thus, the Wagner-Whitin model for $Z_{m,t}$ and $Y_{m,t}$ takes the total inventory cost.

The optimal ordering plan procedure is as follows:

a) Try to set inventory status demand to zero at the beginning and end of the period T , i.e. $I_1=0$ and $I_{T+1}=0$
b) Start with the first period i.e. $t=1$.
   All demand must be satisfied ⇨ $z^*= (1,-,-,\ldots,-)$.
   Calculate $TC_1^*=Y_{1,1}=Z_{1,1}=C_n$
c) Setup $t=t+1$. If $t > T$ End of procedure.
d) Calculate $Y_{m,t} = TC_{m-1}^* + Z_{m,t}$ for all m which correspond to unfrozen z_m
e) Calculate $TC_t^* = \min(Y_{m,t}), \quad m \le t,$ and try to determine $z^*=(z_1^*,\ldots,z_t^*)$
f) If $z_t^*=1$, frozen z^* for the period $(z_1^*,\ldots,z_t^*)$
g) Return to the item c)

Efficient computer implementation of the algorithm was presented in 1985 by James R. Evans.

3.2 Least Period Cost Model (LPC)

Whenever the demand is positive model find the order size that will cover the next "n" periods, where "n" is set to minimize the average cost per unit time. (E. Silver, H. Meal, 1973.)

The optimal ordering plan procedure is as follows:

a) Let the current period be $t=1$. For $t=1, 2,\ldots, T$ calculate average ordering and holding cost, if all items are ordered in the period t :

$$AC_t = \frac{1}{t}\left[C_n + \sum_{\tau=2}^{t} P_\tau \left(\sum_{u=2}^{\tau} h \right) \right] \quad (4)$$

where AC_t is the average setup and holding cost per time unit (monthly) and P_τ is the demand in period τ.

b) Select the period t in which t is $AC_t < AC_{t+1}$. That period should be noted as the period t^*.
c) Order in period 1 for the period t^*.
d) Subtract t^* from the T and repeat the process from the beginning

3.3 Least Unit Cost Model (LUC)

Whenever the demand is positive model find the order size that will cover the next "n" periods, where "n" is set to minimize the average ordering and holding cost per unit. The procedure for finding the optimal ordering plan in the period $t=1, 2,\ldots, T$ is as follows:

a) Let the current period be $t=1$. For $t=1,2,\ldots,T$ calculate the average ordering and holding cost per quantity unit, if all items are ordered in the period t:

$$UC_t = \frac{1}{\sum_{\tau}^{t} P_\tau}\left[C_n + \sum_{\tau=2}^{t} P_\tau \left(\sum_{u=2}^{\tau} h \right) \right] \quad (5)$$

Where:

UC_t - Average ordering and holding cost of inventory per quantity unit.
P_τ - The demand in period τ

b) Select the period in which t is $UC_t<UC_{t+1}$. Which we denote as period t^*.
c) Order the required quantity for the period 1 up to t^*.
d) Repeat the procedure for the period $t=t^*+1$, t^*+2, t^*+3, …,T

3.4 Part-Period Balancing Model (PPB)

The basic idea of this model is to equalize the holding cost in the period 1 to t with the cost of ordering during the period 1 (U. Wemmerlov, 1983.).

The optimal ordering plan procedure is as follows:

a) Let the current period be $t=1$. Then calculate holding cost for $t=1, 2,\ldots, T$ if ordering for periods 1 to t is done in period t:

$$PPC_t = \sum_{\tau=2}^{t} P_\tau \left(\sum_{u=2}^{\tau} h \right) \quad (6)$$

b) Select a value for t that is PPC_t closest to the value of the setup cost C_n. Denote this period t^*.
c) Order the required amount for the period 1 to t^*.
d) Repeat the procedure for the period $t=t^*+1$, t^*+2, t^*+3, …,T

4. Ordering plan calculation

4.1 The input data

Spare parts demand often tends to be "lumpy," that is, discontinuous and no uniform, with periods of zero

demand. According this assumption appropriate test data are used in evaluation of certain inventory models.

Table 1. The spare part demand

Period	1	2	3	4	5	6	7	8	9	10	11	12	Total
Demand	22	62	0	35	124	68	25	0	120	70	44	30	600

In this test ordering (setup) cost per order is 30,00 € and holding cost per unit and period is 0,2 €.

4.2 The test results

The figures 2. to 9. show the calculation results of the ordering plan for particular model. Calculation is done according to given procedures.

All values in the figures are given in Euros (€).

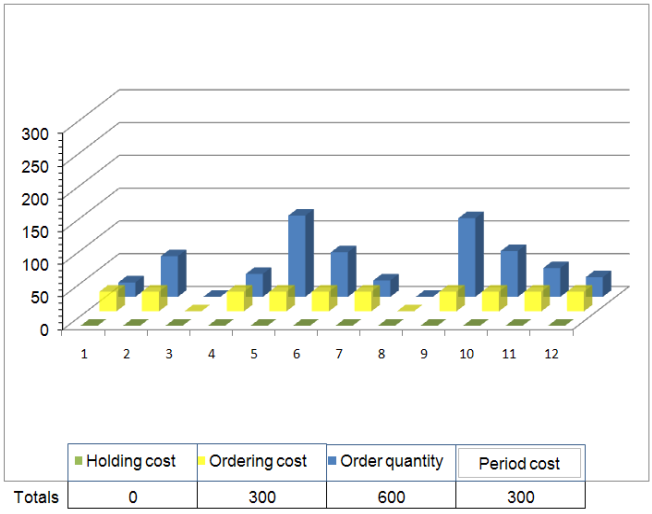

Figure 2. Lot-for-lot lot sizes

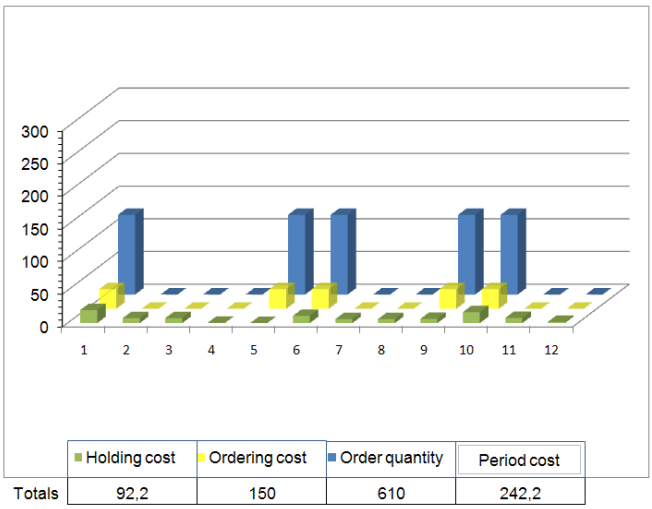

Figure 3. Economic Order Quantity lot sizes

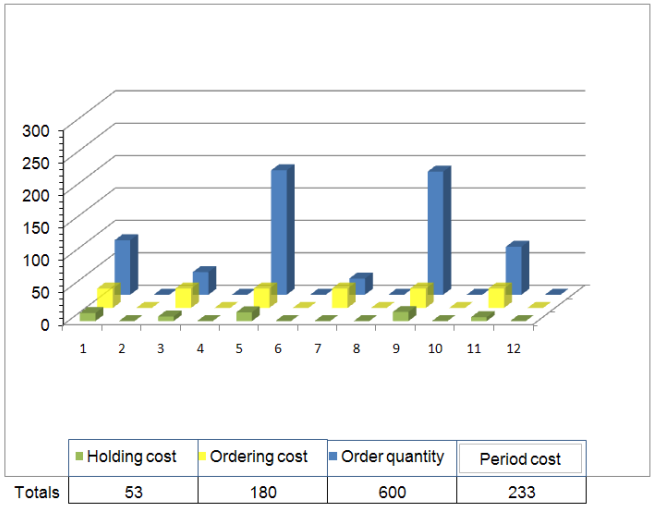

Figure 4. Period order quantity lot sizes

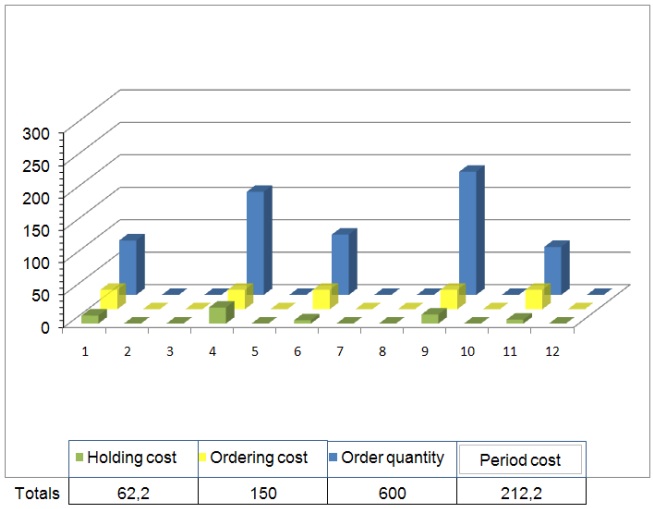

Figure 5. Least unit cost lot sizes

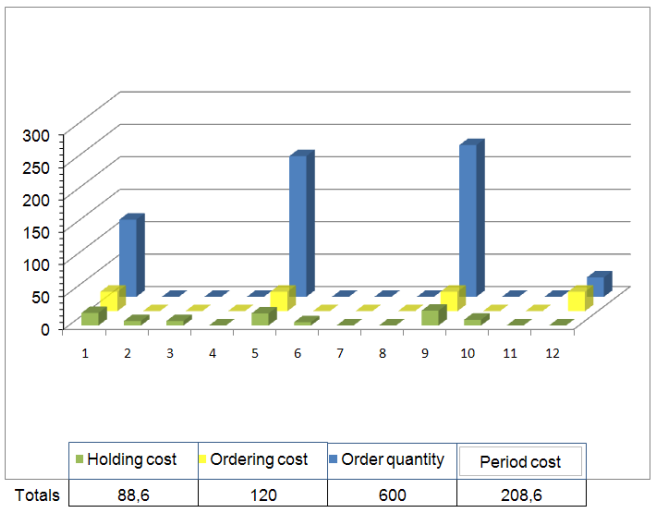

Figure 6. Part-period balancing lot sizes

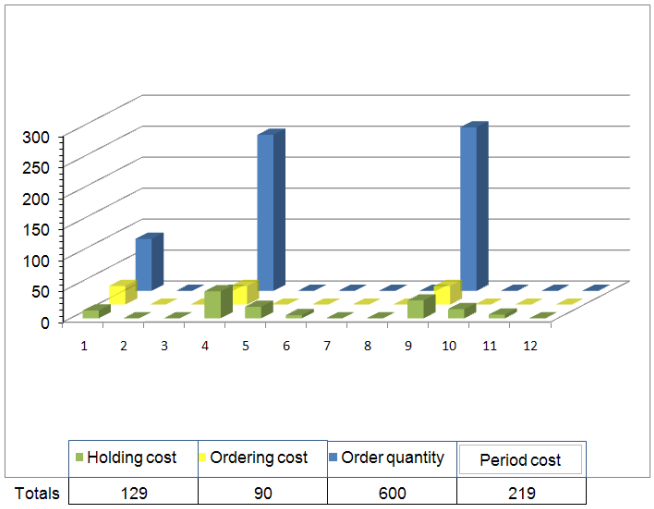

Figure 7. Least period cost lot sizes

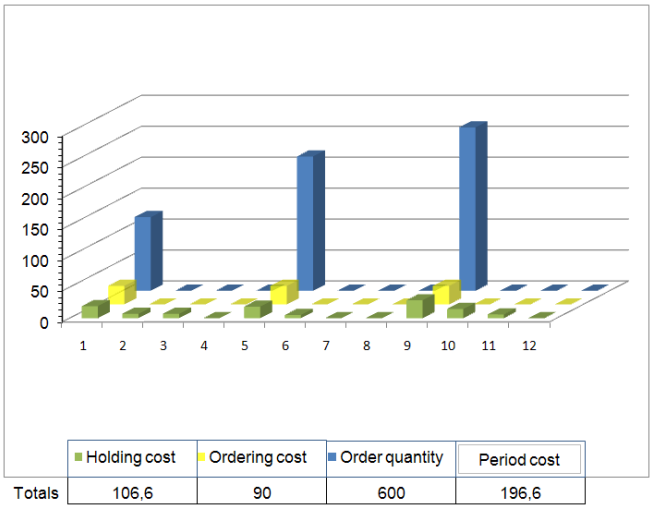

Figure 8. Wagner-Within lot sizes

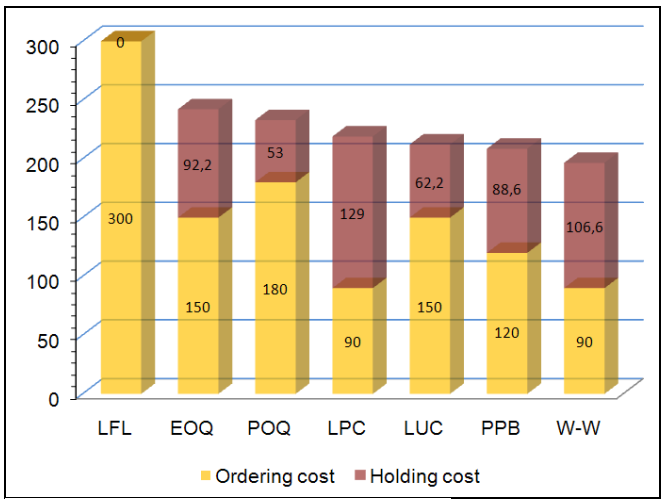

Figure 9. Comparison of the total cost

5. Conclusion

Spare parts demand tends to be "lumpy," that is, discontinuous and no uniform, with periods of zero demand.

In general, dynamic models give better result than static models for approximately 20%. The results of dynamic methods depend on the value and mutual respect of input data, and especially about the relationship between the ordering and holding cost. However, as it is evidently from the example and additional analysis, the best result in determining the optimal lot size of spare parts gives Wagner-Whitin method.

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Design of cylindrical pressure vessel with hemispherical heads due to fulfillment of membrane stress state condition

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Abstract

The main objective of this paper and performed research is to determine the most favorable constructional geometry type of joint between cylinder and hemispherical head of pressure vessel from the standpoint of fulfilling the condition of membrane stress state. By using known membrane shell theory, requirement for achieving membrane stress state in cylindrical pressure vessel with hemispherical heads was evaluated. Furthermore, the most favorable type of three possible constructional geometry of joint between cylinder and head of pressure vessel by using of software *ANSYS 12.0* based on finite element method, was ascertain. To this purpose, axisymmetrical finite element *PLANE-183* from the *ANSYS* finite element library was used.

Keywords: cylindrical pressure vessel, hemispherical head, membrane stress theory, finite element analysis.

1. Introduction

In this paper, the main intention is to realize the membrane stress state in thin-walled shell, in considered case in cylindrical pressure vessel with hemispherical heads. Reason for that is fact that shells in which the membrane stress state is applied, ratio of strength and stiffness to the weight of the shell is the most favorable [1], so the basic condition is that shell structures should be constructed on the they that membrane stress state is predominate in the most of structure. At ductile materials, which are the most metal materials, when the maximum strain in the shell reaches the boundary flow, does not come up to their overflow, but to redistribution of stress. It should also be noted that the consolidation of the shell must be such that allows the membrane displacements [1].

2. Geometry of considered pressure vessel

In this paper, cylindrical pressure vessel with hemispherical heads will be used for both, analytical calculation and numerical analysis with finite element method. Inner diameter of pressure vessel is D_i = 2000 mm, thickness of plate s = 25 mm, while the length of the cylindrical part of pressure vessel is L = 6000 mm. Pressure vessel is loaded by the internal working pressure of p = 1,8 MPa. Dimensions of such considered pressure vessel, with given loading are shown in Figure 1.

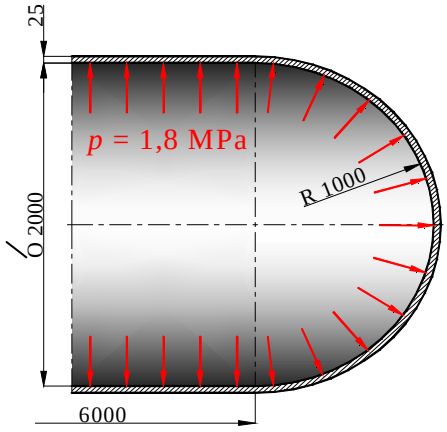


Fig. 1. Geometry and loading of considered cylindrical pressure vessel with hemispherical heads

3. Membrane shell theory

According to membrane shell theory, shells can be analyzed as thin-walled and thick-walled. Stress distribution per plate thickness is per hyperbolic state

for thick-walled shells, and for thin-walled shells, hyperbole can be approximated with linear state. Thin-walled shells are restricted with ratio of plate thickness (s) and inner (R_i) or outer (R_o) radius of shell, as shown in following equations [1]:

$$\frac{s}{R_i} \le \frac{1}{20} \text{ and } \frac{s}{R_o} \le \frac{1}{20} \quad (1)$$

Shells with larger value of ratio from equations (1) are thick-walled shells. In considered case, it is easy to conclude that it is thin-walled shell, so it is reasonable to use the membrane shell theory.

For calculating *Von Mises* equivalent stress, hoop and longitudinal stresses are needed, which have to be calculated from the hoop and longitudinal forces.

a) Membrane stresses in pressure vessel cylinder

The basic equations for internal forces and stresses could be found in References [2, 3]. Hoop force:

$$N_h = p \cdot R_m \quad (2)$$

- where p is inner pressure and R_m is average radius of curvature, which is calculated as (3):

$$R_m = R_i + \frac{s}{2} \quad (3)$$

Longitudinal force:

$$N_l = \frac{p \cdot R_m}{2} \quad (4)$$

Forces in hoop and longitudinal direction are calculated, now it is possible to calculate the stresses in the same directions:

Hoop stress:

$$\sigma_h = \frac{N_h}{s} \quad (5)$$

Longitudinal stress:

$$\sigma_l = \frac{N_l}{s} \quad (6)$$

After hoop and longitudinal stresses are calculated, it is possible to calculate maximum equivalent stress according to *HMH theory* (*Von Mises*):

$$\sigma_{eq} = \sqrt{\sigma_h^2 + \sigma_l^2 - \sigma_h \cdot \sigma_l} \quad (7)$$

b) Membrane stresses in hemispherical head of pressure vessel

In case of pressure vessel head, hoop and longitudinal force are the same, according to (8):

$$N_h = N_l = \frac{p \cdot R_m}{2} \quad (8)$$

Analogous with that, hoop and longitudinal stresses in same directions are the same too, according to (9):

$$\sigma_h = \sigma_l = \frac{N_h}{s} = \frac{N_l}{s} \quad (9)$$

Thus, stresses in the hoop and longitudinal direction are the same, maximum equivalent stress of hemispherical head is also same as the value of hoop stress, and respectively to longitudinal stress too:

$$\sigma_{eq} = \sigma_h = \sigma_l \quad (10)$$

c) Radial displacement of pressure vessel cylinder and head

Radial displacement of pressure vessel cylinder:

$$\Delta R_{cylinder} = \frac{p \cdot R_m^2}{2 \cdot E \cdot s_{cylinder}} \cdot (2 - \upsilon) \quad (11)$$

Radial displacement of pressure vessel head:

$$\Delta R_{head} = \frac{p \cdot R_m^2}{2 \cdot E \cdot s_{head}} \cdot (1 - \upsilon) \quad (12)$$

From the above relation for the radial displacement of cylindrical and hemispherical part of pressure vessels, it is obvious that they are not equal. However, in reality the ends of the cylindrical shell and hemispherical head are connected by welding, so radial displacement of cylinder and head are necessarily equal. These displacements are consisting of the membrane displacement and displacement that is arising due to local bending. Nevertheless, it is possible to design a pressure vessel so the membrane displacements of cylindrical shell and hemispherical

head are equal, by increasing the thickness of the cylindrical shell [4].

d) Condition for achievement the membrane stress state in pressure vessel

For acquiring a membrane stress state in cylindrical pressure vessel with hemispherical heads, plate thickness of cylinder must be greater than plate thickness of head. Adversely, on pressure vessel joint of cylinder and head, apart from membrane stresses, bending stress will appear too, so plate thickness of cylinder must be greater than plate thickness of head, according to equation (13):

$$s_{\text{cylinder}} = \frac{2-\upsilon}{1-\upsilon} \cdot s_{\text{head}} \quad (13)$$

3.1 Analytic calculation

For cylindrical pressure vessel considered in this paper, with geometry and load presented on Figure 1, and according to the relations for the membrane shell theory of thin-walled shells presented in Chapter 3 of this paper, analytical calculation is performed. Table 1 shows the results for radial displacements of cylindrical shell and hemispherical head, a condition for achieving the membrane stress state and maximum equivalent stress, but only in case of the cylindrical shell, because from membrane shell theory it is obvious that the maximum equivalent stress occurs exactly in cylinder of the pressure vessel.

Subsequent numerical analysis will show that the membrane stress state is not always possible to achieve, because pure membrane stress state does not exist, there are always appears a greater or lesser extent of bending.

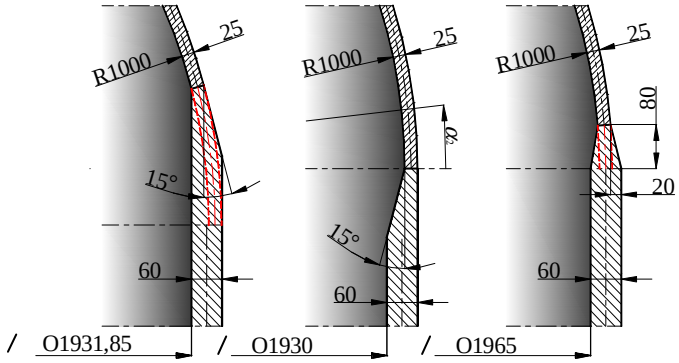
Table 1. Analytical results

Maximum equivalent stress of cylinder shell	$\sigma_{\text{eq}} = 63{,}13\,\text{MPa}$
Radial displacement of pressure vessel cylinder	$\Delta R_{\text{cylinder}} = 0{,}2988$ mm
Radial displacement of pressure vessel head	$\Delta R_{\text{head}} = 0{,}123\,\text{mm}$
Condition for achievement the membrane stress state	$s_{\text{cylinder}} = 60{,}72\,\text{mm}$

Thus, from obtained results it is obvious that for achieve membrane stress state in considered pressure vessel it is necessary to increase the thickness of cylinder plate from 25 mm to 60,72 mm, so for 35,72 mm. The numerical analysis will be performed for the thickness of the cylindrical shell as 60 mm, because that is the closest value to the standard thickness of sheet metal. However, the standard deviation allows a certain tolerance in the plus and minus, so in the production of pressure vessel, with thickness of plate as 60 mm, it is possible that sheet thickness is slightly thicker or thinner from 60 mm.

4. Joint geometry of cylinder and hemispherical head

As mentioned earlier, to achieve membrane stress state in the pressure vessel, plate thickness of cylindrical shell must be greater than the plate thickness of head. According to [5] and [6] construction of a transitional joint of hemispherical head and the cylinder can be derived in three ways, that the thickening of cylinder is inward of pressure vessel, outward of pressure vessel, and bilaterally, outward and inward, according to Figure 2. For hemispherical head without the cylindrical edge, as in case on Figure 2, a), the transition thickness from the cylindrical shell to hemispherical head must not exceed an angle of 15° [3]. In the case on Figure 2, b), condition is that sum of the angles $\alpha_1 + \alpha_2$ does not exceed a value of 15° [5]. Angle α_1 is the angle of 15° presented on Figure 2, b), and angle α_2 is in this case equal to zero, so condition is satisfied. Angle α_2 is angle from the center of curvature of hemispherical head to the reduced cylindrical part of head, according to Figure 2, b). In case on Figure 2, c), ratio length of lines at the transition from cylindrical shell to hemispherical head must not exceed the allowed ratio of ≅ 1:4 [6], so in considered case, ratio of mentioned lines is set up as 20:80, Figure 2, c).



a) b) c)

Fig. 2. Different construction geometry types of joint between cylinder shell and hemispherical head

5. Numerical analysis by finite element method

In the numerical analysis of pressure vessel considered in this paper, software *ANSYS 12.0* was used. Pressure vessel without changing the thickness of cylindrical shell, and three types of pressure vessel with the geometry of transition joint of cylindrical shell and hemispherical head was analyzed, according to Figure 2. The analysis is performed with axisymmetrical finite element *PLANE 183* from the *ANSYS* finite element library, Figure 3.

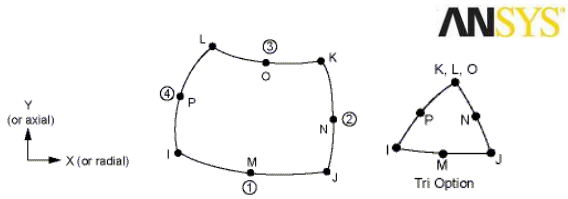


Fig. 3. Axisymmetrical finite element PLANE 183 [7]

PLANE 183 is defined by 8 nodes or 6 nodes having two degrees of freedom at each node: translations in the nodal *x* and *y* directions. The element may be used as a plane stress element, plane strain element or as an axisymmetric element. This element has plasticity, hyperelasticity, creep, stress stiffening, large deflection, and large strain capabilities. It is a higher order 2-D, 8-node or 6-node element. *PLANE 183* has quadratic displacement behavior and is well suited to modeling irregular shape [7].

Material is set as isotropic, linear elastic with Young's modulus of elasticity E = 210 000 MPa, and Poisson's ratio υ = 0,3.

Due to the complete symmetry of model, the geometry and loading, the problem is considered as axisymmetrical and axisymmetrical finite elements have been used. Therefore, numerical analysis is much more simplified and time to obtain solution is much shorter, because only the plane of axial symmetry of pressure vessels must bee discretizated.

In all mentioned cases for which numerical analysis are performed, the load is placed on the inner surface of pressure vessel (p = 1,8 MPa), on the vertex of hemispherical head, axial symmetry of model was placed, and on the section of cylindrical shell, constraint of axial displacement of pressure vessels was applied. In all cases, the finite element mesh is generated automatically with length of element edge of 7 mm, except on joint of cylinder and head, where mesh is set up with more density. In the case of pressure vessel with equal thickness of cylinder and head, mesh consists of approximately 3300 elements and 11000 nodes, while the other three cases when the cylinder plate thickness is larger, mesh consists of approximately 6000 elements and 19000 nodes.

a) Numerical results for pressure vessel with fixed plate thickness

Equivalent stress distribution according to the theory of *HMH* (*Von Mises*), for pressure vessel with constant plate thickness, is shown on Figure 4. As mentioned earlier, it is obvious that the maximum equivalent stress occurs in cylindrical shell of pressure vessel and it is almost completely coincides with the analytical solution obtained using the membrane shell theory of thin-walled shells, given in Table 1.

On Figure 4, it can be notice that in transition joint of cylindrical shell and hemispherical head of pressure vessel, bending is appearing too. The purpose and objective of achieving membrane stress state in pressure vessel is bending that occurs in joint reduce to a minimum, because it cannot be completely avoided.

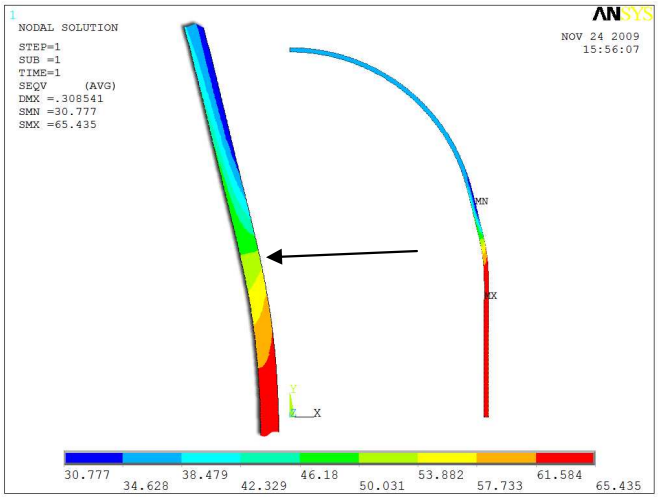


Fig. 4. Equivalent stress (*Von Mises*) distribution for case of constant plate thickness of pressure vessel, σ_{eq} [MPa]

Numerical results for radial displacement distribution are shown on Figure 5. Also, numerical results of radial displacement almost completely coincide with the analytical solutions using the membrane shell theory of thin-walled shells. As it is

presumed and obtained analytical, the maximum value of radial displacement is in the cylindrical shell, and going to the vertex of hemispherical head, radial displacement is approaching value zero, and just in the head vertex, value of radial displacement is zero. That is because radial displacements cannot occur on the axis of symmetry of pressure vessel.

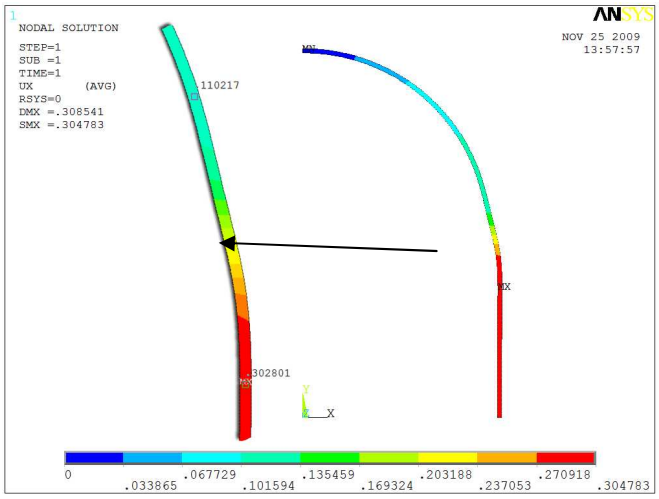


Fig. 5. Radial displacements distribution as a result of inner pressure of p = 1,8 MPa, ΔR [mm]

Hereafter, numerical results for different cases of transitional joint of cylindrical shell and hemispherical head of pressure vessel, and for fulfillment of membrane stress state condition are presented. Geometry of the pressure vessels are presented and modeled according to Figure 2.

b) Numerical results of pressure vessel for fulfillment of membrane stress state condition

Figure 6 shows the numerical results for equivalent stress distribution for pressure vessel with geometry according to Figure 2, a), on Figure 7 for the geometry of pressure vessels according to Figure 2, b), and on Figure 8 for the geometry of pressure vessels according to Figure 2, c).

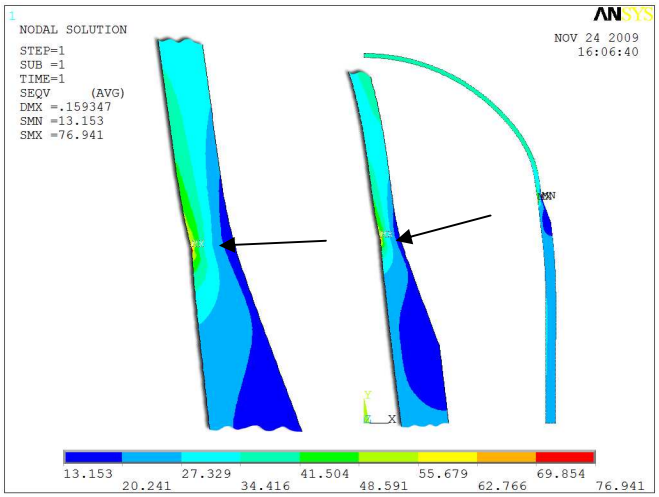


Fig. 6. Equivalent stress (*Von Mises*) distribution for case of outward thickening of pressure vessel cylinder, σ_{eq} [MPa]

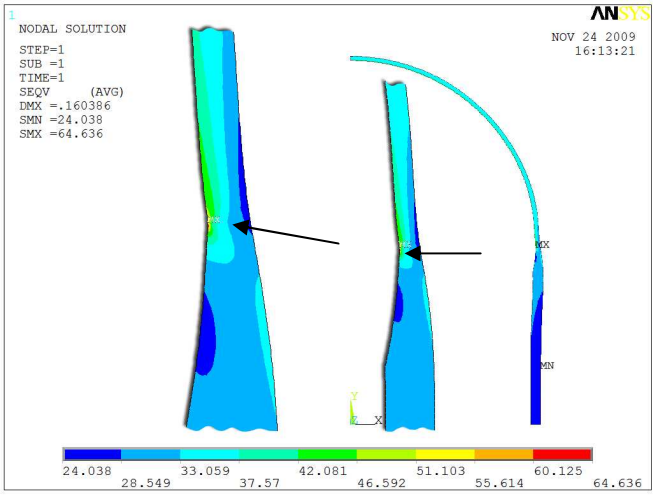


Fig. 7. Equivalent stress (*Von Mises*) distribution for case of inward thickening of pressure vessel cylinder, σ_{eq} [MPa]

From presented numerical results of equivalent stress distribution for different construction of a transitional joint of hemispherical head and cylinder of pressure vessel, it is apparent that in all three cases, the bending stress occurs, with a greater or lesser amount. Of course, intensity of the above mentioned bending stress is significantly lower than in the case of pressure vessel of the same thickness of cylinder and head plate.

The minimum intensity of the bending stress occurs in the case of the geometry of the transition joint according to the Figure 2, c), and numerical results for equivalent stresses distribution for the specified type of transition joint is shown on Figure 8. This is case of

thickening of the cylindrical shell bilaterally, outward and inward.

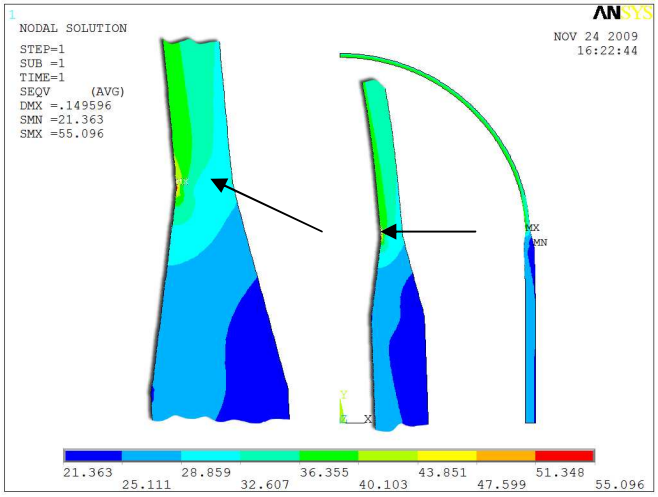
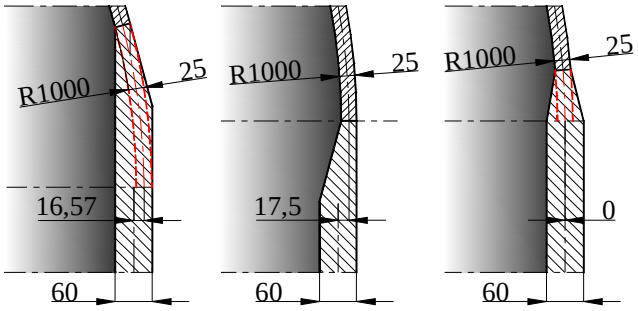


Fig. 8. Equivalent stress (*Von Mises*) distribution for case of bilaterally thickening of pressure vessel cylinder, outward and inward, σ_{eq} [MPa]

Assumption is confirmed, that exactly in that case will appear minimal bending stress because, misalignment of middle axes of symmetry of pressure vessel head and cylinder is equal to zero, Figure 9, c). While in the cases on Figure 9, a) and b) misalignment is much bigger, so that caused that intensity of the bending stresses is higher.



a) b) c)

Fig. 9. Misalignment of middle axes of symmetry of pressure vessel head and cylinder for cases of transition joint according to Figure 2

6. Results comparison for different joint types of cylinder and head

Comparison of numerical results for all three types of transition joint in terms of maximum equivalent stress is shown on Figure 10. Scale of results of equivalent stress distribution is divided into increments of 10 MPa and the stress fields in all three cases of the geometry of transition joint geometry are shown with the same colors.

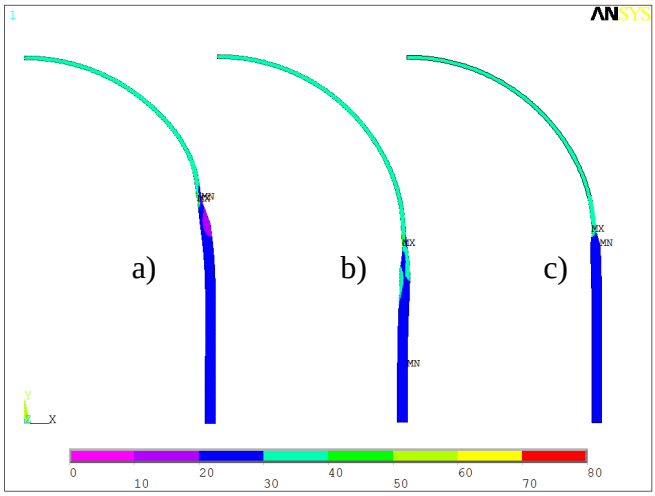


Fig. 10. Parallel view of equivalent stress distribution for three cases of structural solution of transition joint geometry, σ_{eq} [MPa]

It can be seen that in the aspect of equivalent stress all three construction solutions are acceptable, because the equivalent stresses in the hemispherical head and in the cylindrical shell are in the same range. In case of hemispherical head, stress range is within 30 to 40 MPa, and in case of the cylindrical shell within 20 to 30 MPa.

7. Conclusions

In this paper, the main objective was to determine which of three possible structural solutions of a transitional joint of hemispherical head and the cylinder shell is the best.

With analytical approach using the membrane shell theory of thin-walled shells and for geometry and loads for pressure vessel considered in this paper, radial displacements, the maximum equivalent stress and the condition to fulfillment of membrane stress state are calculated. The obtained results are verified by finite element method using the software *ANSYS 12.0*. Correctness of membrane shell theory was confirmed, because the deviation of numerical results from the analytical results is in the permitted 5%.

With further numerical analysis of three types geometry of the transition joint area, the best solution is ascertain, solution which on the greatest extent possible fulfillment the condition to achieve membrane stress state of pressure vessel. The best solution proved to be the solution shown in Figure 2, c), when the thickening

of cylinder is bilaterally, outward and inward, and thus, misalignment of middle axes of symmetry of pressure vessel head and cylinder is equal to zero, Figure 9, c). While in the two other cases on Figure 9, a) and b) misalignment is much bigger, so that caused that intensity of the bending stresses is higher.

From the point of maximum equivalent stresses, it was found that all three cases of the structural solution are acceptable, because the stresses that occur in the cylindrical shell or in hemispherical head in all three cases lie in the same range.

Also, in all three cases, stress concentration at the joint of cylindrical shell and hemispherical head are ascertained. Of course, exactly in that area of concentration the maximum value of equivalent stresses will appear. In this paper, it is not dedicate a big attend to a place of stress concentration, because it occurred in a very small area, and in all three cases appear on the inner surface of pressure vessel, where the quality of the weld cannot be improved later due to lack of access and processing. Thus, the area and the amount of the maximum equivalent stress mostly depend on the quality of welding, and the quality of the welded root.

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Fuzzy Control with Swarm Intelligence Scheduling Optimization

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Abstract

In this paper, fuzzy logic is analysed as enhancement tool for control scheduling optimization in combination with swarm intelligence. Fuzzy timing is one of possible solution for systems with need of dynamic scheduling at short and middle term time horizon. For proposed multi-objective optimization problem pseudo-goal fuzzy function is chosen because of its simplicity and flexibility. Pseudo-goal fuzzy function has shown some advantages compared to other multi-goal approaches. Novel non-parameter optimisation algorithm method called TRIBES is presented as possible solution in combination with fuzzy logic for optimisation of the presented scheduling problem.

Keywords: Fuzzy logic, Swarm intelligence, Scheduling, TRIBES

1. Introduction

Problems of scheduling and control are known problems and have been in attention of many researchers for last decades. Authors offer different problems formulations from unequal points of view. First, planning approach as top-down approach is focusing on scheduling from upper view where production order is launched with no feedback of actual status in lower levels of control: mechanical execution system, supervisory control and data acquisition and low level. Second, control approach as bottom-up approach is usually not sensitive to upper level requests, only in indirect way if such interconnection exists. Approaches used for solving scheduling optimization problems range from different type of exact mathematical models to usage of pure and combination of artificial intelligence methods. Solutions found in recent literature are mainly based on rapid growth of informatics technologies and methods like neural networks [1] and fuzzy logic [2-6], and variations of heuristic algorithms like tabu search [7], artificial immune systems [8], genetic algorithms [9-11], simulated annealing [12], and recently as the latest metaheuristic method: swarm intelligence (ant colony optimization [13] and particle swarm optimization [14] particularly). Most of these approaches are based on specific knowledge of problematic for which they were originally designed and can not be used in altered applications. Also, they propose that all the time all the parameters are accurately and punctually known, this is especially true for time parameters. Time parameter and its uncertainty nature are for the first time considered by P. Fortemps [13] and later by others with measurable success. In recent works authors used fuzzy processing time for single machine scheduling [2], two single machine scheduling [3], for batch production [2,4], and parallel machine scheduling [5].

Scheduling can be defined as process of determination of most appropriate time to perform every operation and task for started assignments e.g. launched production/work orders or process control tasks/jobs. Because of stated integrated approach is anticipated with focus on scheduling and control level with multi-objective optimization and usage of fuzzy logic for specific sub-functions (fuzzy processing times, pseudo-goal function determination and gain scheduling optimization). Our prime goal will be to evaluate this approach for no-wait scheduling problem for jobs which consists of more operations with predetermined order on devices/machines and continuous production with low level control. Additionally, each of devices or machines can do just one job at a time. Therefore, given problem is in scheduling given jobs while minimizing time difference between start and finish of a sequence of jobs/task or

total flow time over all jobs/tasks. Another objective is kipping production costs at lowest possible level within acceptable operational levels. All this stated makes optimization problem presented multi-objective with different objectives conflicting with each other.

2. Scheduling problem

The design platform that has been adopted in this research is illustrated in Figure 1. At the high level we have planning as governor and it is concerned with long term functions with large uncertainty degree and changes present on this level (new and changed customers orders; and changes in: final or partial quality goal, substitute products, total demand on production). In intermediate level – scheduling is performed with middle term of uncertainty degree and changes (new job/task; changes in: work orders/job/task priority, quantity or process requirements). And finally, at low level with shortest term of uncertainty degree, control system is connected to real physical production/process system. If case of automated flow and batch production systems gain scheduling is used for individual process controllers gain setup where gains are changed in predefine time or dependently on global/local variable changes or disturbances. Changes present on this level can be, adopted from [13]: materials varying arrival and quality parameters, operation delays, varying processing times, devices or machine not ready or in waiting to be served, utility supply failure, control system failures, breakdowns or other internal or external process disturbances. Every lower level has feedback connection to higher level.

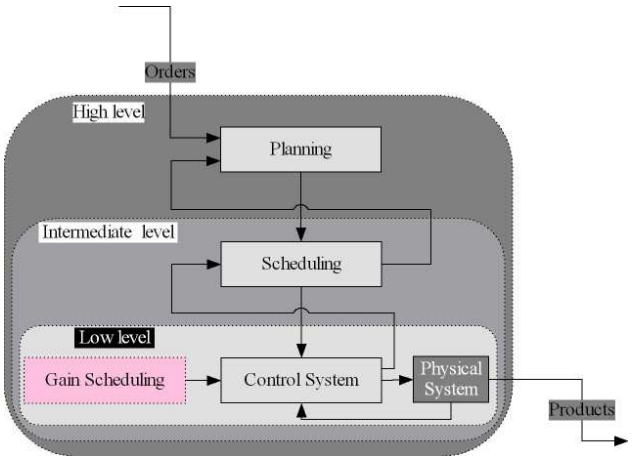

Fig. 1. General three level planning, scheduling and control schema

As case example, because of its simplicity, no-wait scheduling problem will be used adopted from [16]. This type of scheduling problem can be described as follows: with given processing times p (j, k) for given job (task) j and device (machine) k, each of defined n jobs (where j = 1, 2, …, n) will be sequenced through m devices (where k = 1, 2, …, m). Each of jobs (task) j can have a series of m operations (o_{j1}, o_{j2}, …, o_{jm}). Restriction of no-wait is defined in way that completion time of operation o_{jk} must be equal to the earliest time to start of the operation o_{jk+1} for k = 1, 2, …, m -1. That means that there can be no waiting time between the processing of any given consecutive operation of each and every of n jobs on any of devices/machines.

Let job permutation $\pi = (\pi_1, \pi_2, \ldots, \pi_n)$ stand for schedule of jobs in process and delay $d(\pi_{j-1}, \pi_j)$ is minimal delay on the first device (machine) between two following jobs. Then, according to [16] maximum completion time can be expressed as, with introduction of fuzzy processing time $\hat{p}$ for replacing standard processing time p:

$$C_{\max}(\pi) = \sum_{j=2}^{n} d(\pi_{j-1}, x_j) + \sum_{k=1}^{m} \tilde{p}(\pi_n, k)$$

Similarly, total flow time of n defined jobs can be expressed as:

$$TF(\pi) = \sum_{j=2}^{n} (n+1+\ldots+j) \cdot d(\pi_{j-1}, \pi_j) + \sum_{j=1}^{n} \sum_{k=1}^{m} \tilde{p}(j,k)$$

Finally, solution for total flow time goal is to find such permutation π in set of all possible permutations where total flow time is less or equal to maximal total flow time. In next step, we will define fuzzy processing time $\hat{p}$ and pseudo-goal function powered by means of fuzzy logic.

2.1. Fuzzy pseudo-goal function

As stated in introduction, we are faced with multi-objective optimization problem where objectives usually conflict each other. Generally, a common difficulty with multi-objective optimization is that it is impossible to find a feasible solution allowing simultaneous optimal solutions for all objectives [12].

One strait forward way of minimizing the objectives conflicting is an aggregation of more objectives into a single objective. Methods used to combine multi-objective functions into one overall objective function mainly include the objective weighting, distance functions, min-max formulation, Pareto-front [12, 13,

14]. Downfall for most of these methods is that each objective preserves conflict and sometimes makes final solution even less straightforward.

For solving of this downfall fuzzy logic can be used. Every output fuzzy decision is calculated as intersection of given fuzzy objectives and fuzzy constrains where we can have more objectives and more constraint functions defined. More precisely, we multiple inputs single output (MISO) fuzzy model. Every input variable must be fuzzified and described by means of membership functions. We scale every variable in interval [0, 1] of real numbers.

Fuzzy *if than* rules are defined in way that one combination of input variables has one output variable solution. Final fuzzy output variable is deffuzified and normalized in range of output variable values in this case fitness or goal functions range of values.

For membership functions triangular shaped fuzzy numbers are anticipated because of their simplicity in definition and implementations. Each of two objective functions has five fuzzy numbers defined for membership function while constraint functions have two and three fuzzy numbers defined.

Target single objective model is finally defined by maximizing the minimum degree of satisfaction among defined objectives in given range of defined constrain.

3. Swarm Intelligence

Swarm intelligence is metaheuristics method for optimization inspired from social interaction and communication of swarm of animals – bird flocks, fish schools, cattle herds, predators' packs, bees and ant colonies. At first introduced just as graphic representation of bird flock by C.V. Reynolds [14], latter elevated as powerful new optimization method by R. Eberhart and J. Kennedy [15].

In this section first standard particle swarm optimization algorithm will be presented, and later basics of TRIBES - new adaptive particle swarm optimization algorithm with its specifics.

3.1. Particle Swarm Optimization

In canonical form of particle swarm optimization (PSO) algorithm each particular solution is one particle. Every particle has its position and velocity and its fitness value can be calculated. Swarm of particles is flying through multi dimensional space of solutions with individual acceleration based on its own historical information, information from other particles in swarm (e.g. current best solution) and stochastic element of algorithm. This stochastic element is introduced for purpose of allowing the particle to individually search space of solutions and drag the whole swarm to direction with potentially better solution in randomise manner.

In case of PSO particles are "flown" through hyperspace in search of best solution (e.g. optimal or near-optimal solution) for target objective function. Each defined particle has adaptable velocity and memory of its previous position. Thus, particle remembers its own best position visited in hyperspace so far. In terms of PSO there are *pbest* (particles best) as particles best position so far and *gbest* (global best) as best position or fitness in population of all particles. Let search space of particles be *n*-demensional and *i*-th particle of the swarm can be defined as $X_i = (x_{i1}, x_{i2}, x_{i3}, \ldots, x_{id})$ and let velocity for *i*-th particle of swarm is given as $V_i = (v_{i1}, v_{i2}, v_{i3}, \ldots, v_{id})$. Also, let best previously visited particular position of *i*-th particle be defined as another *n*-dimensional vector $P_i = (p_{i1}, p_{i2}, p_{i3}, \ldots, p_{id})$ and let *g*-th particle be the best particle. Then swarm in search of best solution can be updated iteratively in following way updating its position *x* and velocity *v*:

$$x_{id}^{n+1} = x_{id}^{n} + v_{id}^{n+1}$$

$$v_{id}^{n+1} = \chi\left(\omega v_{id}^{n} + c_1 r_1^{n}\left(p_{id}^{n} - x_{id}^{n}\right) + c_2 r_2^{n}\left(p_{gd}^{n} - x_{id}^{n}\right)\right)$$

where,

χ – constriction factor of velocity update,

ω – inertia weight for previous velocity,

c_1 – cognitive acceleration parameter,

c_2 – social acceleration parameter,

r_1, r_2 – random numbers distributed in the range [0,1].

Setup of parameters of PSO algorithm is sometimes difficult and time consuming, for specific problems there are some guidelines and good modelling policies and can be found together with details of different topologies usage in search the hyperspace of solutions in Ref. [11, 15, 16].

3.2. TRIBES

TRIBES are adaptive particle optimization algorithm with two way auto-tuning capability: first is topology adoption according to current swarm behaviour and second is adoption of strategy of particles displacements based on particles current performance. This parameter free modification of PSO was introduced by M. Clerc [14, 15]. There are only few examples of TRIBES usage in this time, benchmarking testing [15], application for optimization of cutting parameters for nonlinear cutting model [16], in bio-informatics for molecular docking

simulations for protein and drugs structures exploration [17] and chaotic systems control by means of proportional-integral-derivative parameters optimization [18].

In TRIBES algorithm new concepts named *tribes* and *informers* are introduced. Each particle of swarm belongs to a single tribe. *Informer* for a given particle *P* is a particle *Q* that can give *P* some information, like best position found by *Q* so far and goal function value at that position. Concept of informer is same as concept of neighbour – someone who can influence state of current particle [15, 16, 17]. Set of informers of a particle, its *i*-group, holds, but is not limited to its own tribe. Adaption rules, similar to genetic algorithm, decide when a new particle is created or removed and when it becomes informer of another particle. Population of particles is separated in sub-populations called *tribes* where every tribe makes its own order and structure (topology). Successful tribes can benefit from by removing some of their weakest members (particles with worst score) and less successful tribes can benefit from adding some more members (to increase the chance of better score).

Pseudo-code for TRIBES algorithm is summarized in following steps [17, 19-23]:

1. Initialization: set iteration to 1. Initialize population of $i = 1, 2, \ldots, M$ with random values and initialize entire solution vector population in defined upper and lower limits of search space.
2. Evaluation: evaluate fitness value (objective function to be minimized) of each particle.
3. Move swarm: determine promising search areas with usage of hyper-spheres and position update.
4. Adoption schema: a particle that improves its performance is god, otherwise is bad.
5. Stopping criterion: set iteration to +1. Stop if maximum number of iterations or maximum number of evaluation of objective function is reached.

This is simplified pseudo-code for TRIBES algorithm, more details can be found in listed Ref. [17, 19-23].

4. Results

TRIBES as adaptive optimization algorithm in difference to other evolutionary methods including its origin PSO does not need any parameters except definition of problem needed to be solved. For purpose of this demonstration TRIBES algorithm was implemented using C programming language on Pentium IV PC platform with 512 MB of RAM. Maximum number of generations is set to 2000. Figure 2. shows convergence graph for F3 unimodal problem (Shifted Rotated High Conditioned Elliptic Function [24]) and Figure 3. shows graph for F7 multimodal problem (Griewank Function [24]) of results for TRIBES algorithm (adopted from [20]).

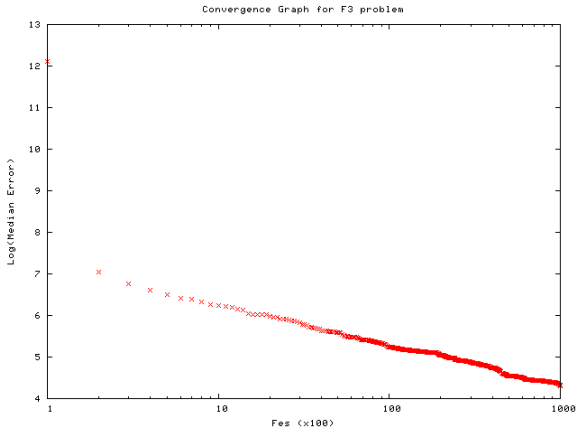

Fig. 2. Convergence of TRIBES algorithm for F3 standardized problem (with 1000 runs adopted from [20])

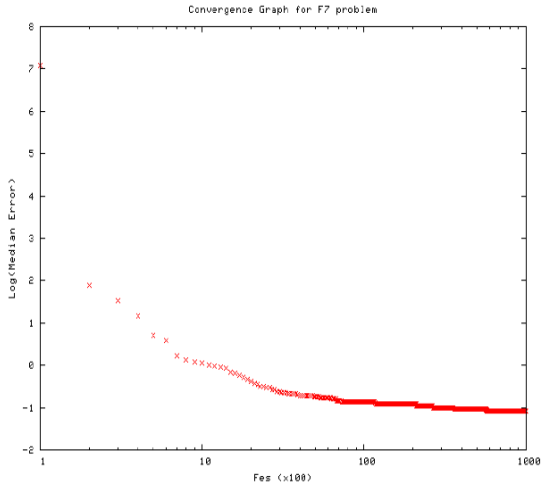

Fig. 2. Convergence of TRIBES algorithm for F7 standardized problem (with 1000 runs adopted from [20])

5. Conclusions

Flexibility of fuzzy logic has been demonstrated in two applications: for fuzzy time definition and pseudo-goal objective function evaluation. Sensitivity on quality of defined fuzzy set rules in rules database must be taken into further consideration. Next problem with traditional fuzzy engine if than rules schema require definition of many rules to cover the whole spectrum of possible solutions. The more input and an output variable with more complex membership functions means more rules and more calculation which is time and resources

consuming. For case of no-wait flow production problem maximum completion and total flow time are taken into consideration. Fuzzy processing time is introduced as mean of dealing with uncertainties. More work need to be done in implementation of proposed algorithm especially in fuzzy processing time area with extension to higher levels as well at lowest level of control. TRIBES algorithm has interesting characteristics and its adaptive nature is main advantage compared to standard PSO algorithm.

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Contribution of training center in raising regional competitiveness for mechanical engineering company

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Abstract

The paper analyzes the strategic settings in the development of entrepreneurship based on knowledge and technology transfer, training in new technologies and the impact of development on the assurance of sustainable regional development and improve competitiveness of the economy of the region.
In the first part of paper, the basic settings of regional development and regional policy as a regional approach to developing the entire national economy, were analysed.
The second part defines a "business-model innovation of support center Nova Gradiska", which was aimed at solving key development problems of the County, and a possible solution to start the technological development of Brod-Posavina County.
The paper sets out the activities and training center for new technologies as one of the centers of innovation within the business support center that is being developed in order to increase the competitiveness of the workforce as a prerequisite for the overall development of the region, the competitiveness of the above areas and new employment.

Keywords: production engineering, competitiveness, supporting center, new technologies, development

1. Introduction - Regional Development

Management of regional development is an extremely complex task. Systematic and integrated way to manage change and manage the optimum development of the society include the identification and implementation of key activities taking into account the strengths and weaknesses, and opportunities and threats that come from the external environment.

Management of regional development of Croatian under-developed areas should apply a combined approach to development "bottom-up", ie the local level, supported by a special promotion with national and regional levels. (combination of approaches "bottom-up" with the elements approach - "top-down").

There is no single model of local / regional development. Each local / regional initiatives defined by different objectives and priorities, because each community has to solve specific problems, and respected the different situations and environments. Each area has a range of resources that make up its development potential (material, human, cultural, institutional) and whose efficient use can contribute to more intensive local / regional development (Fig.1.)

Increased differences in regional development in Croatia are the result of a series of restrictions that inhibit the implementation of a systematic regional policy compatible with the regional policies of developed countries of the European Union.

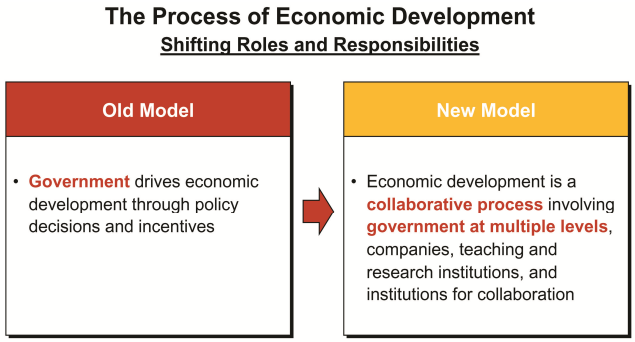

Fig. 1. Process of economic development - change role and responsibility [1]

The level of decentralization in Croatia is very low, currently ranging between 6-9% non-purpose funds of the budget, while at this stage of Croatian counties should be decentralized to the level of 20-25%, or finaly 50-70% in accordance with EU standards.

1.1. Analysis of basic economic indicators

Positive macroeconomic characteristics are manifested primarily in the continuation of high growth of total economic activity, exchange rate stability, low inflation, and further reducing the budget deficit. But at the same time the key problems of the Croatian economy in the form of high and growing balance of payments deficit (about 8% of GDP) and high foreign debt (about 86% of GDP) remain unresolved. High growth deficit foreign trade shows low level of competitiveness of the economy, and these trends are certainly not sustainable in the long term. Economic indicators also point to the conclusion that the increased dynamics of economic activity generated primarily personal growth and government consumption and investment.

Analysis and comparison of GDP growth in Croatia and selected countries in the environment and the EU in the period 2000-2007 (Fig. 2.) can be established that Croatia has recorded an average growth GDP 4.6% is classified into a group of countries with average growth.

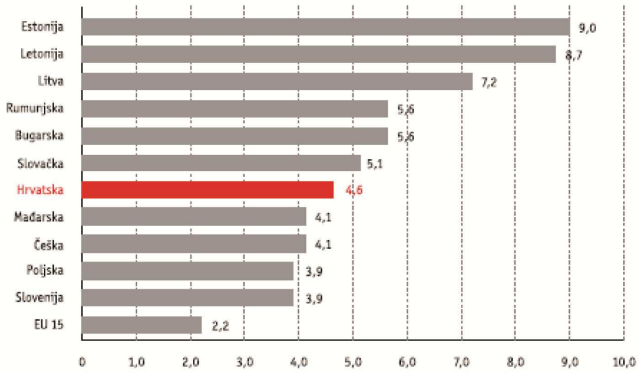

Fig. 2. Average annual growth rate of real GDP, 2000th-2007th,% [2]

Croatia is faced with huge regional differences in levels of development. Comparison of GDP per capita at the county level are visible the vast differences in development between the counties in Croatia. While the City of Zagreb produces nearly a third (31.8%) of GDP Croatian, Brod Posavina participate with only 2.3% of total GDP in Croatian. Comparing the GDP per capita between the counties in Croatia indicate that the most developed city of Zagreb has a 3.2 times higher GDP per capita of the least developed counties (Vukovarsko-srijemska i Brodsko Posavska County), which achieved only about 60% of the average Croatian.

If the GDP per capita is compared over the Croatian regions and the average European countries (EU-25) shows that the average Croatian GDP per capita, just under half the EU average, with a growth trend. While GDP per capita in Zagreb is 81% of GDP EU25, the same in Slavonski Brod-Posavina County is only 27% average in the EU25.

1.2. SWOT analysis

Based on previous analysis over the region, it was made SWOT analysis (Table 1.), as one of most used method at area of strategic management used for creation a conclusion towards better economic situation.

Strength and weakness cover Internal environment of Company and including exercise, expertise, organizational resources, comparative ability, advantages location, recognition, or distribution potential. Opportunities and threats come from external competitive environment. Purpose of this classification is ensurance of good relations interior material, technical, financial and management potential that provide more utilization opportunity with minimize risk with for community.

Table 1. SWOT analysis of Brod- Posavska County [3]

STRENGTH	**WEAKNESS**
Natural Resources *(high-quality agricultural land, plenty of water, significant forest resources)*	**The fall in industrial production, outdated technology and lack of investment** *(decrease in industrial production due to war, transition process, problematic privatization of state industrial enterprises)*
Strong industrial tradition and assets *(a strong industrial tradition in metal processing and wood processing sector, the concentration of industrial enterprises and the growth of crafts and small and medium enterprises)*	**High unemployment** *((characterized by a large share of unskilled labor)*
Excellent traffic position *(intersection of important European car roads and railway lines)*	**Unsatisfactory structure of the workforce** *(Adapted system education, poor computer literacy, knowledge management)*

OPPORTUNITIES	THREATS
Development of agricultural production *(development of organic production with a high share of new value added)* **Industrial Development** *(through the development of business and industrial zones, linking agriculture with manufacturing industries)* **Utilization of natural resources and the development of ecological tourism and ecological agriculture** *(based on the clean environment of the County)* **Improving cross-border cooperation**	**Increase in pollution** *(low level waste management and waste water and industrial pollution)* **Aboutdljev drain** *(emigration and depopulation)* **Inflexible bureaucracy** *(eg, unresolved property-legal relations, legal unadaptable conditions in the economy)* **Strong international competition and lack of investment**

As the problems that impede the development of the economy, and by their nature belong to the foreign (the responsibility of the public sector) are listed: the slowness of government bureaucracy, high taxes and welfare state, weak protection of creditor rights, late payments, limited market, banks lending nenaklonjenost small enterprises, Outdated Land Registry, the omnipresent unfair competition, insufficient or poor quality infrastructure, poor business support institutions, the relatively high cost of, weak purchasing power.

Internal problems that entrepreneurs have in the company are: lack of legal-customs procedures in Croatia and the EU, and EU programs that help the development of SMEs, the lack of quality workers, insufficient development and promotion of its own brands, high credit debt companies, outdated technology, lack of basic knowledge about our own work and specialized knowledge, inefficient organization of business that results in high production costs, high rent and construction costs.

The use of information technologies is limited although the offer of equipment (devices and applications)

sufficient quality. Small entrepreneurs do not use information technology as a base business decisions.

2. Effect of applying new Technologies to Competitiveness of the Economy of the Region

The stage of development "economy based on innovation factors " capability to produce innovative products and services to the global technological level, using advanced methods, is a key source of competitive advantage. With the aim of development of the Croatian economy to the "economy based on innovation factors" (Fig.3.), in which the factors of business sophistication become the main determinants of competitiveness it is necessary to resolve the problem overall business efficiency - the efficiency of investments and investments in technology and business processes and high-quality and professional work force.

The key is to systematically work on improving these critical factors to become a support company in improving the competitiveness of intensive investment in innovation and improvement of business sophistication.

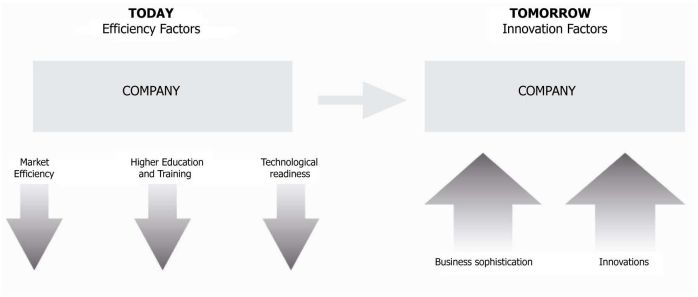

Fig. 3. Competitiveness - economic development based on innovation factors [2]

Analyzing the critical factors of competitiveness of companies in Croatia, it is evident that learning to work as part of lifelong learning is one of the most important internal factors of competitiveness, which is associated with similar factors that affect the environment - the educational system and labor market. Croatian company faced with the problem of finding qualified and motivated workforce that has skills and quick learning ability necessary for the acceptance of new technologies and efficiency of the investment process. If you are adding to this problem of inadequate regulation, lack of relevant support institutions and the developing specialized services to the business sector get a complete picture of factors that negatively affect the rapid and sustainable growth of the Croatian company.

3. Education and Competitiveness

The key of establishment of good quality education system is to ensure increase of competitiveness in economy and necessary quality of human capital as a main developing resources. The education directed to contribute productivity and increase of basic degree of education of population should be one of main priorities of Croatian.

The importance of education now gets in focus of growing need for educated and qualified workers with specialized knowledge, and is therefore one of the most important issues related to achieving high quality education of the whole population. According to research in the OECD determining the economic growth it was found that the quality of education is more important than quantity of education (Hanusek and Kimko).

It is also found that additional years of education of the population of individual country can increase production per capita for 4-7% (Bassani and Scarpetta, 2001), and an additional year of education leads to increased earnings from 5 to 15% (Psacharopoulos, 1994).

3.1. The structure of the workforce

Information on the education of employees, the unemployed and inactive suggest that education is the most important determinant of activity, income, personal development, and development and competitiveness of the country. Croatia has even 52% of the working age population in the inactive population. This social group is not employed nor looking for work and is very poorly educated, because more than half of the inactive have completed only primary or uncompleted primary school. Simultaneously, the share of uneducated people in the part of the active population (employed and unemployed) is about 20%.

In addition to the generally poor educational structure (Fig.4.), Croatia with 2.1% of adults involved in some form of lifelong learning at the European tail. At the same time, Croatia is located on the top in the European rank share of students who have completed secondary education aged between 20 and 24 (93.8%, just behind Norway.

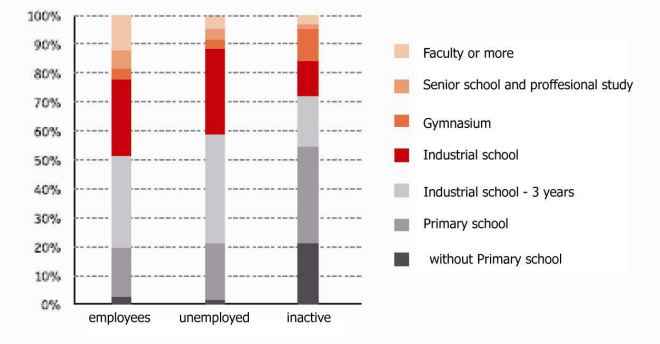

Fig. 4. Educational structure of labor force in 2006,% [2]

Significant additional efforts in education, it is necessary to significantly improve the educational structure in Croatia, and thus its potential for achieving a high level of global competitiveness, should change significantly. In line with stated lifelonglearning programs must become one of basic developer strategy and important function of business development.

3.2. Training and Education

Training and Education represent Central Policy Local/regional Developer Strategy, and Education population what is a key element in development and transition toward modern production and high added values. Although workforce is in Croatia relatively well educated and trained, missing modern knowledge and skills, and must be a key for executive adjustment of workforce, or to act at improvement of learning them, and adoption new knowledge and skills, in line with needs and requirements. In line with stated open the Issues forms new Training program (formally or informally Education) content (technical education, ICT, enterprising) and Cast and relations individual institutions in process.

And in the level of education in the Croatian population, there are significant differences. While the average highly educated 7.9% in Croatia, in Zagreb he is 16.8%, while Brod Posavina County is 4.2%.

4. Business Model - Innovation And Supporting Center Nova Gradiska

Supporting business innovation center in the industrial park of Nova Gradiska, is focused on key development issues Brod Posavina County: low competitiveness, low level of development potential and the lack of new investment, a small number of innovative, knowledge-based technologies and new

entrepreneurs, as well as inadequate knowledge and skills workforce, resulting in high unemployment and low personal income population of the Region.

Brod Posavina is one of the least developed counties in Croatia (GDP per capita in 2006. Euro 3950, which represents a 58.2% average in Croatian, or 27% of EU average 25), faced with high unemployment (29.6%) and low Personal income level (about 70% of the average Croatian).

Active measures include employment training programs for new technologies and skills in accordance with the needs and demands of the market, ensuring the availability of a quality workforce for the business sector and thus contribute to the competitiveness, adaptability and flexibility of labor markets and business sectors. The project includes new training methods and management. Application of "best practices" with the EU technical assistance experts partner networking in relevant networks, training of staff BISC's.

4.1. The planned project results

Implementation of the Project establishes a system for integrated services and entrepreneurship development and vocational education programs (VET) for targeted workforce training in new technologies.

It is realistic to expect that students training program, successfully ending a targeted specialist training program, acquire advanced specialist knowledge and skills that will enhance their competitiveness and employability, and with the support of relevant institutions to ensure their employment in existing companies and new investments will be realized in industrial park.

It is realistic to expect that the implementation of the Project to support capacity building of VET institutions to implement targeted training programs for new technology and business in accordance with market needs.(Fig.5.)

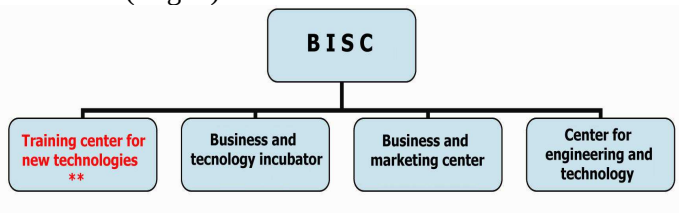

Fig. 5. Project Components Business Innovation Center supporting Nova Gradiska

5. Training Center for new Technologies

It was planned that training center for new technologies implemented training in CNC metal processing technology, training in quality control (measurement techniques), IT training and training in entrepreneurship.

The goal is to create highly differentiated products in accordance with the specific needs of the business sector in the Region.

Components of business innovation support center are:

Training in CNC METAL

Basic training program - Is intended for final year students of industrial and technical schools, and the unemployed metal processing and related disciplines in the Region. Program includes: Basic Techniques of CAD and CNC techniques, CNC turning and milling - the basics of programming, practical work on CNC lathes and milling machines, final exam and certification. It is planned that the training lasts for 80 hours.

Advanced training program - Training is based on the application of CAD / CAM software solutions for 3D modeling. Includes virtual modeling and practical production of parts on modern CNC machines. Training includes: basics of 3D modeling and CAM applications in manufacturing, visualization / simulation process, DNC communication computer / machine, producing parts, exercise. It is planned that the training lasts for 80 hours.

TRAINING IN QUALITY CONTROL AND TECHNICS OF MEASUREMENTS

Basic training program - Training is for unemployed workers and metal-processing of the profession in order to acquire basic technical knowledge of measuring techniques. Standard practice in measurement techniques include: an introduction to measurement techniques, external and internal workpiece measurement, control surface roughness and hardness of the material. It is planned that the training takes 20 hours.

Advanced training program -- The training is intended for unemployed workers and metal-working professional who possess basic technical knowledge of measuring techniques. Advanced training in measurement techniques include: Introduction to 3D measuring equipment, 3D measurement techniques, the control software in 3D measurement, contact and nekontaktno measurement obradaka. It is planned that the training lasts for 40 hours.

6. Conclusions

Modern regional policy aims to balance the overall economic efficiency and balanced regional (spatial) development, and attaches strategic importance of industrial restructuring and other structural adjustments in the underdeveloped regions to raise their economic and technological competitiveness.

While a significant lag in research sector and development for Croatian EU competition observed the rate of employment in knowledge-based service sector is intended, the rate of employment in high and medium technology manufacturing sector, investment in research and development of the share of GDP, investment ratio public and private sectors in research and development, it is necessary to make investments in research and development of market-oriented, intensive development ties and relations between research and higher education institutions and the economy, and to develop new higher education and research institutions and smaller centers, which will positively affect the balanced development and competitiveness of the wider area.

With a lack of incentives for investment in research and development and education in Croatia, especially when it comes to encouraging the supply of educational and scientific research services in the private sector, it becomes apparent that science and education have not yet received adequate and satisfactory role.

Taking into account the facts established during the creation of the Regional Operational Program of Slavonski Brod and Posavina County Strategic Development Program of Nova Gradiska, in relation to regional development, competitiveness, the level of implementation of innovations, knowledge and new technologies in the economy of the county, and the unsatisfactory state of human resources in the City and County, joined the implementation of the project supporting business innovation center in the industrial park of Nova Gradiska, as one of the priorities of county development projects.

When defining the business model innovation support center Nova Gradiska used the so-called. best practice in relation to the application of the concept of "regional clusters", and "research driven clusters " in the field of regional development and improving competitiveness. Application of the above concept is the basis which enables the development of innovation for the competitiveness of enterprises and industries, an effective instrument for the concentration of resources and funding, creating value for their territory and to promote interregional cooperation and networking, and improving the degree of integration between industry and science, and the ability to develop and manage innovation. Development of new business infrastructure, integration, networking and internationalization, and improving knowledge and skills of entrepreneurs and the workforce in the region will enable the specialization, focus on products and services with high added value, the application of international standards and thereby improving the competitiveness of the region.

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Designing virtual model product by means of information technology (IT)

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Abstract

This paper deals with developing ways to enlighten designing and constructing of one mechanical product – gearbox. It is done by fully automating complex calculation using Visual Basic for Applications programming language. Data was stored in form of tables and graphs and was retrieved by using API functions of software holding accompanying data. Virtual model of product was built in 3D CAE software and linked to output results of calculation, visually manifesting design variations. Main goal was to move focus from tedious and time consuming task of manual calculations subject to errors to more freedom in design itself and investigating of what various combinations of input parameters yield. Although a system was used for particular product of gearbox, it is meant to indicate the power and practical use of information technology in helping engineers design products with more freedom in general.

Keywords: parameter modelling, product virtual model, VBA, API, CAE

1. Introduction

The base for this work was [1] – "Manual for construction practice", which is used in teaching the course *Elements of construction II* on Faculty of Mechanical Engineering. It includes detailed calculation of gearbox with one degree transmission and single helical gears in parallel configuration.

There are 16 input parameters ranging from power to transmit, speed of input shaft, type of main drive, to materials of shaft and gears and geometric characteristics of gears. Calculations itself consists of two main parts: calculation of gears and calculation of shafts holding the gears. Manual [1] holds formulas, instruction for sketches, tabular data, and graphs needed for successful accomplishing of design and calculation process.

Because of its complexity, it may take some time for whole process to finish manually, risking the possibility for errors to show up along the way. That's where idea was born to automate whole calculation process.

Although there are already automated calculations of various types of gears available either for free or to pay for, it is assumed that this particular calculation cannot be fully analytically described avoiding the need to lookup data from tables and, as it will show, more importantly, from graphs, thus presenting model for any other calculation where such or similar manual actions are needed.

Extending the Manual [1], 3D fully parametric model of gearbox was built using CAE modelling software, for visual representation of calculation and definitive confirmation of results.

2. Application development

Following software was used in building the program: Microsoft Office Excel, Autodesk AutoCAD, and Autodesk Inventor. Programming was done in Visual Basic for Applications (or VBA), using Excel as base for it.

2.1. Preparation

Whole process consists of several phases. Tabular data presented in 30 tables was stored in *.XLS Excel file in one worksheet. Tables include both data related directly to gear calculation, and data containing sizes of standardized elements used in gearbox assembly (screws, nuts, gaskets, bearings ...). Of course this could also be done by using databases, but for this

example that wasn't necessary, and the way it was done was completely sufficient.

Calculation includes 18 graphs of different complexity. Some of them are probably analytically describable, but for most of them it would very hard to do so. They were all redrawn in AutoCAD and stored in one *.DWG file.

Autodesk Inventor was used for building virtual model of gearbox. Model is fully parameterised, using multiple levels of parameterisation. Calculation results are stored in three separate *.XLS files, containing data for gears and housing, bearings, and shafts. Inventor model is linked to these three files. Values from them are used both in sketches of features of individual parts, and in constraints used to position the parts in assembly. Furthermore, many parameters used in model itself are derived from, and depend on, sometimes multiple values taken from input files.

Inventor has feature called "Design accelerator" which includes many types of mechanical design elements (bolted connections, clevis pins, shafts, bearings, V-belts, springs ...), but most interesting was possibility to design gears. This was used in modelling gear parts – they weren't modelled from scratch, but parameters were forwarded to parts built with Design accelerator. Similar approach was used for all standard parts in assembly, with the difference that for them data vas retrieved from tables, and gears used data from calculation.

2.2. VBA

Programming language used was Visual Basic for Applications (further in text: VBA). It is an implementation of Microsoft's event-driven programming language Visual Basic 6, and associated integrated development environment (IDE). By embedding the VBA IDE into their applications, developers can build custom solutions using Microsoft Visual Basic. It is built into Microsoft Office, other Microsoft applications such as Microsoft MapPoint and Microsoft Visio; as well as being at least partially implemented in some other applications such as AutoCAD, WordPerfect, Inventor, CATIA ...

As its name suggests, VBA is closely related to Visual Basic and uses the Visual Basic Runtime, but can normally only run code within a host application rather than as a standalone application. It can, however, be used to control one application from another using OLE Automation. For example, it is used to automatically create a Word report from Excel data, in turn automatically collected by Excel from polled observation sensors.

VBA is functionally rich and extremely flexible but it does have some important limitations, including limited support for function pointers which are used as call-back functions in the Windows API. It has the ability to use (but not create) (ActiveX/COM) DLLs, and later versions add support for class modules.

Interaction with the host application uses OLE Automation. Typically, the host application provides a type library and API documentation which document how VBA programs can interact with the application. Multiple applications can be automated from the one host by creating Application objects within the VBA code. References to the different libraries must be created within the VBA client before any of the methods, objects, etc. become available to use in the application [2].

All programming was done in Excel, using it as a host applications for VBA, and creating Application object toward AutoCAD for reading graphs situated inside *.DWG file. To fulfil task, opposite method could be used – with AutoCAD being the host application for VBA, and Application object toward Excel created for reading tables inside *.XLS file.

Yet another approach is possible: since it's compatible with Visual Basic, front-end for developed application could be done in Visual Basic, where also all programming could take place, and Application objects toward both Excel and AutoCAD created. Doing so could eventually eliminate Excel from being used: filling the data can be done in *OpenOffice*, and some independent components for accessing data within *.XLS files can be used (like *Gembox Spreadsheet*). Since some of those components even outperform Excel's own automation libraries; that could be approach used where larger amounts of data is processed and need for performance is required.

3. Programming

Front-end for this application was simply Excel worksheet with cells on it used both as input fields and mean for representing calculation results (Fig. 1.).

Tabular data was stored in the same *.XLS file, only in another worksheet (Fig. 2.).

For easier management, code is divided into several modules, containing functions and subroutines (Fig. 4.).

Input data			
	Mark	Unit	
Required power of input machine	P_{RS}	kW	**28**
Electrical motor speed	n_{EM}	s^{-1}	**24**
Standardised gear ratio	u	-	**4,25**
Working machine mass moment	GD^2_{KS}	$N \cdot m^2$	**65**
Electrical motor starting time	t_u	s	**0,75**
Torsion load	-	-	**J**
Type of drive	-	-	**Working without a uniform shoc**
Durability of drive			**T**
Drive gear teeth number	z_1	-	**19**
Drive gear material	-	-	**15 Cr Ni 8 (Č5421)**
Material state	-	-	**PK**
Angle of action	α_n	°	**20**
Helix angle	β	°	**7**
Gears quality	-	-	**8**
Driven shaft material	-	-	**Č0745**
Shaft security factor	S_{potr}	-	**1,5**
Module class (1 - 2 - 3)			**1**
Module - manual input			**1,5**

CALCULATE

View the table of materials

View the table of materials

Fig. 1. Input screen

Table TR010 - Axis distance bounday values

Nominal values of axis distance		Quality of axis distance											
		1		2		3		4		5		6	
		Quality of gears											
		1	2	3	4	5	6	7	8	9	10	11	12
6	10	2	2	5	5	8	8	11	11	18	18	45	45
10	18	3	3	6	6	9	9	14	14	22	22	55	55
18	30	3	3	7	7	11	11	17	17	26	26	65	65
30	50	4	4	8	8	13	13	20	20	31	31	80	80
50	80	4	4	10	10	15	15	23	23	37	37	95	95
80	120	5	5	11	11	18	18	27	27	44	44	110	110
120	180	6	6	13	13	20	20	32	32	50	50	125	125
180	250	7	7	15	15	23	23	36	36	58	58	145	145
250	315	8	8	16	16	26	26	41	41	65	65	160	160
315	400	9	9	18	18	29	29	45	45	70	70	180	180
400	500	10	10	20	20	32	32	49	49	78	78	200	200

Fig. 2. Tabular data

General flow of the program is as follows: it first connects with *.DWG file containing graphs, followed by separate calculations for gears, shafts, and finally filling out three *.XLS files with values for generation of 3D model (and some extra data evaluation is done there, preparing it for 3D model) (Fig. 3.). Upon entering first module, program fills its variables from input cells and starts the calculation. Choice of materials used is accomplished by using drop-down menu object *Combobox*, which is very suitable for this purpose, since its content can be written somewhere on worksheet and easily prepared and manipulated (and that is used in this case, by simply connecting it to table rewritten from Manual [1]).

Process of calculation consists of steps where every step ends in some result carried on further. And that result must comply with limitations imposed to it. So, wherever there is such demand, program verifies current result and notifies user if it is unsatisfying.

After that it stops, and it's needed to start it again after changing the input values.

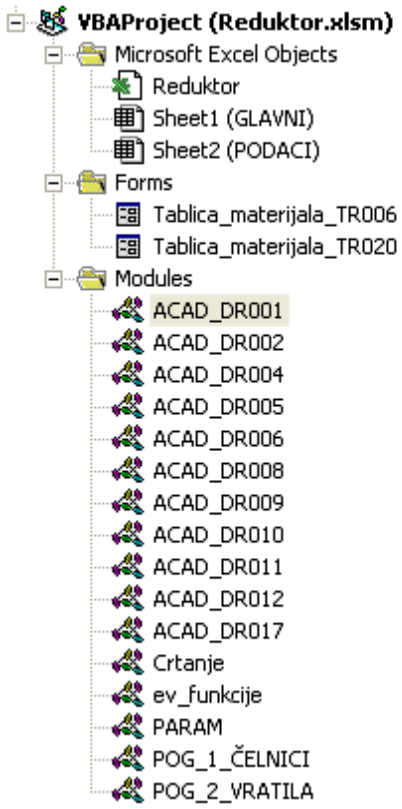

Fig. 4. Code organization

Since graphs were available in printed form (Manual [1]), it was needed to transfer them in digital vector form. It was done by scanning them and literary drawing over them in AutoCAD. Three types of objects were used for that: *lines*, *polylines*, and *splines*, depending on type of geometry in graphs. Much care was taken in doing this, since any deviation from originals leads to inaccurate results in calculation. Every graph is put in its boundary rectangle, which is

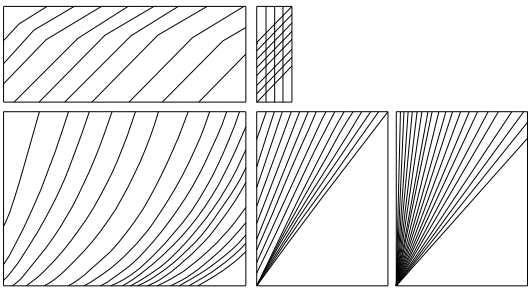

Fig. 5. Graphs digitalized (sample)

Besides finding the way to read graphs, there were also two more significant features elaborated along the way.

One is when it is necessary to carry out control of stress regarded to side face of tooth. For that it is necessary to need some factors, two of which can be determined by manually sketching gears geometry, and then reading the values from sketch. For automation to overcome this, AutoCAD was used once more, only this time complete geometry (sketch) was drawn and results read using code with AutoCAD functions.

important because one corner of rectangle is then origin point for reading data from that graph, and its coordinates are written in code (Fig. 5.). Every graph is unique to operate with, and each one has its own subroutine for retrieving data from it.

The way data is read from graph was very important step in elaboration of program, because if that wasn't possible, there wouldn't be much use from the rest of software. It is done by using AutoCAD function *IntersectWith.* It gets coordinated of section of two curves (objects). For that it is necessary to draw line at either *x* or *y* axis (from code), intersect it with desired line existing in graph, collect intersection coordinates, and use it for further process. For some graphs there are several steps in doing so, and it can get somewhat complicated.

One of challenges was to determine best way to find out how to access the existing line on graph to intersect with. At the end it was done by using property of objects in AutoCAD called *handle*. It is unique parameter property for each object on drawing, and that way it was possible to access precisely specified object. Only thing is that it was necessary to manually access each line in drawing, read its *handle*, and write it in code (Fig. 6.).

The way program prepares graphs for reading is that it loads into memory all lines for that graph and then operates with them, but each time when loading subroutine for a graph, it queries through all objects on drawing (around 400), and loading only those required. That process hugely slows down performance of program. It is surely possible to come up with some other faster way of doing this, but purpose of this work was to present interoperability of different software solutions, and possible improvements are left open.

Another tricky part was determining border

```
DR001_ish(0) = 1470.4594
DR001_ish(1) = 821.8231
faktorY = 87.903 / 1.5
nula = DR001_ish(1) + 0.5 * faktorY
zn12pol = (z_n_1 + z_n_2) / 2

  For Each elem In MSpace
       Select Case elem.Handle
        Case "1E6": Set DR001_L(1) = elem       'L1
        Case "1E8": Set DR001_L(2) = elem       'L2
        Case "1E9": Set DR001_L(3) = elem       'L3
        Case "1EA": Set DR001_L(4) = elem       'L4
        Case "1DD": Set DR001_L(5) = elem       'L5
        Case "1DC": Set DR001_L(6) = elem       'L6
        Case "1DB": Set DR001_L(7) = elem       'L7
        Case "1DA": Set DR001_L(8) = elem       'L8
        Case "1D9": Set DR001_L(9) = elem       'L9
        Case "1D8": Set DR001_L(10) = elem      'L10
        Case "1D7": Set DR001_L(11) = elem      'L11
        Case "1D6": Set DR001_L(12) = elem      'L12
        Case "1D5": Set DR001_L(13) = elem      'L13
        Case "1D4": Set DR001_L(14) = elem      'L14
        Case "1D3": Set DR001_L(15) = elem      'L15
        Case "1D2": Set DR001_L(16) = elem      'L16
        Case "1D1": Set DR001_L(17) = elem      'L17
       End Select
  Next elem
```

Fig. 6. Portion of code for graph reading

Gearbox virtual model consists of 10 custom made parts, plus standardized parts (bearings, bolts, gaskets ...). Manual [1] suggests two types of housing: moulded or welded. For this work only moulded housing was modelled, following template from [3], Fig. 372.1.

Although most of parameter values are read from calculation output files, many of them are defined in Inventor itself; distance of axis and diameter and thickness of gears being most important ones which practically defines whole housing.

At first sight, parts don't look much hard to model, but since they are completely driven and change in

size, thickness, number of holes ... biggest time was spent not on modelling itself, but determining what rules to set so that that model doesn't fail when regenerating, and that changes are properly carried out through whole assembly.

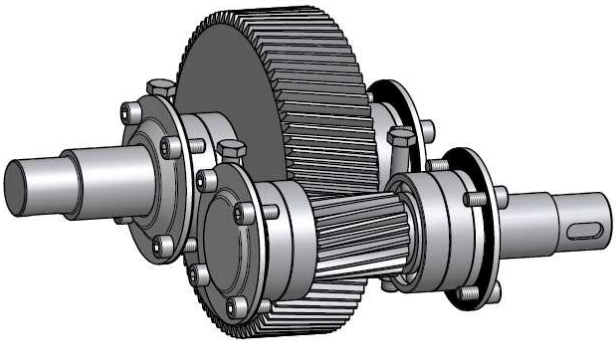

Fig. 8. Gearbox virtual model without housing

deviations of measure over several teeth. In manual calculation, up to that point some values are known and it is necessary to find out most suitable combination of standardized deviations from tables based on those values. This involves many steps of iteration with different pairs of chosen values, and finally determining what set suites best. To automate it, algorithm was developed which understands from what position in table it should start reading data so that calculation is done quicker, and it dynamically determines range of values from that starting point.

4. Virtual model

When calculation in Excel finishes successfully, and with assembly open in Inventor, it is only necessary to hit *Update* button and it will update itself completely reading data from files. Then visual examination can be carried out, confirming or declining calculation results and redoing it by changing input values.

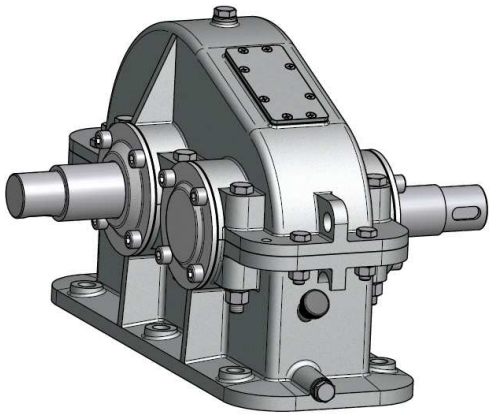

Fig. 7. Gearbox virtual model

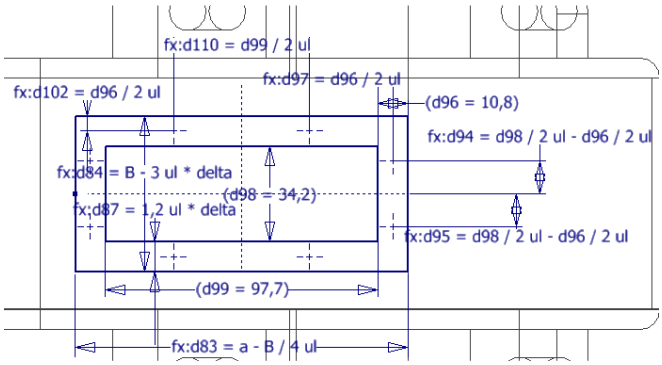

Fig. 9. Example of a sketch used for creating lid

5. Conclusions

Main task of this work was to cooperate with multiple software solutions in cause of simplifying and quickening one engineering calculation. Task was successful, and obtained software solution deals with all elements of calculation automatically. Result of that is huge amount of time saved on manual work, which can then be more purposefully used on changing input values and observing what effect and in what degree they have on outcome. With that engineers can better understand what they're dealing with and predict behaviour of the model, all of that leading to more quality design.

Although very thorough, software has some space for improvement. First of all is the speed of reading the graphs, which if done some other way could fasten calculation significantly. Second, and more complex to do, is the idea to make program 'smarter' in a way that it changes the input values by itself and learns significance of particular values. What could be done with that is the ability of software to determine what set of input values would lead to desired characteristics, but that would include some more complex programming. This project was realized using relatively simple programming (only it was somewhat comprehensive – there are around 2.000 lines of code used), with very much basic programming functions and loops. Only deviation from that was using of specific functions and methods related to Excel and AutoCAD. For detailed elaboration of work see [5].

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Bending in two stages

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Abstract

In manufacturing of working parts by metal forming there are various methods that cause different procedures and ways of bending process. Elastic part of deformation causes springback of sheet metal plate which affects form and accuracy of bended sheet metal plate. The important criterion in validation of bended parts is angle of springback of sheet metal plate. As a measure for angle accuracy, it can be taken into account a relative error of bending angle. For the improvement of accuracy model that compensates mechanical springback is used. The influence of mechanical springback on bending angle can be eliminated with, bending sheet metal plates with smaller angle than one desired so after the springback sheet metal plate takes desired bending angle. The following elements influence on the bending process: force of bending/calibration, die configuration, work piece geometry, product properties and friction. Bending process of steel sheet metal plate St1403 was simulated with FEM method.

Keywords: sheet metal plate, bending, V-die, finite element model.

1. Introduction

The important criterion in evaluation of bent components is the bending angle. The relative bending angle error may represent the measure of angle accuracy of the bent parts.

$$O_a = \frac{\alpha_2 - \alpha_{wz}}{\alpha_{wz}} \quad (1)$$

where:

α_2 - bending angle after withdrawal of pressure,

α_{wz} - die angle.

There are three types of die bending operations: a)opened, b) half-opened, c) closed, see Fig. 1.

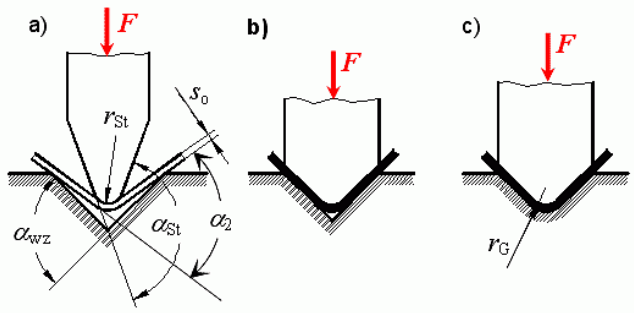

Fig. 1. Three types of dies. [1]

If the effect of elastic springback is neutralised, close tolerances and dimensions of bended part can be obtained, which is shown in Fig. 2.

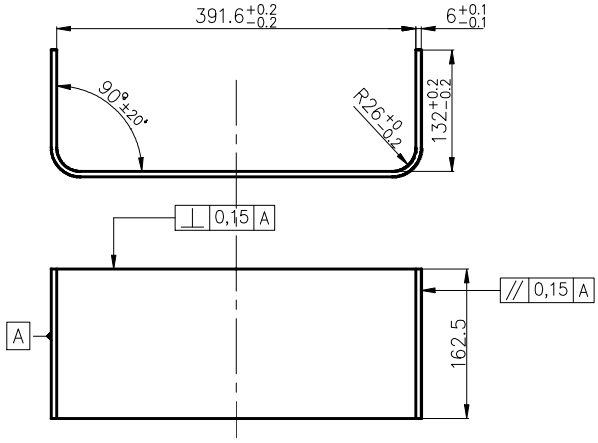

Fig. 2. Bended part with close tolerances required. [2]

In bending of metal plates there is phenomenon of elastic spring-back. Springback can be reduced in two ways. First is determination of springback return angle for some material, and than this part is over bended for the amount of springback angle, so when it is released from die the part takes desired bend angle. For example if angle of springback is 1° and desired bend angle is

90°, then part is bended to 89° and after unloading it takes angle of 90°.

The other way is calibration in V-die in one or two phase bending processes, where length of arc is plastically formed according to punch radius. The interdependence of relative bend angle error O_α, and the specific maximal force F_{max}/b for different die radii is shown in Fig.3. In case of positive errors there are differences, which are greater with the increase of the force. One can see that the increase of O_α is accompanied by decrease of punch radius r_{st}.

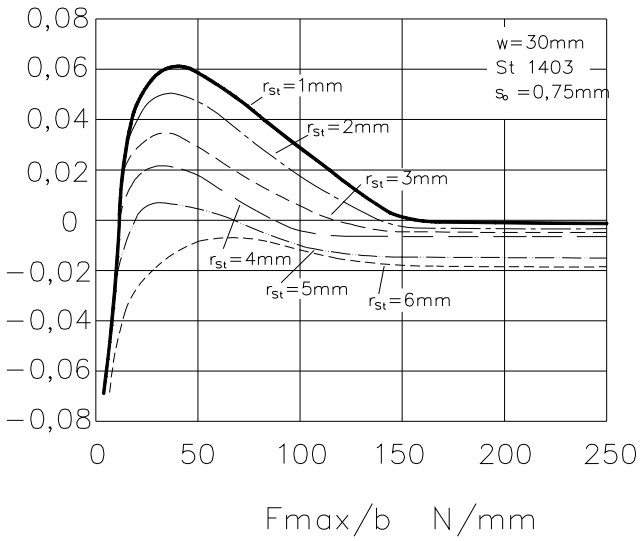

Fig. 3. Relative bend angle error and specific maximal force for various die radii in bending in half opened 90^0 V-dies. [3]

The precise bending in two phases is presented on the Fig. 4.

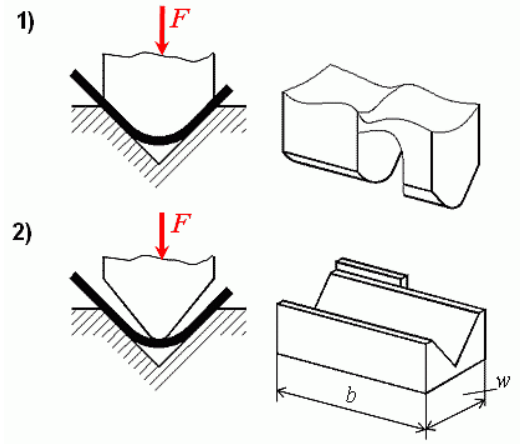

Fig. 4. The precise bending in two stages. [4]

In the first stage the work piece has greater radius then it is needed (early stage of bending), but after that, the work piece is bended with demanded radius (final stage of bending).

Although the cost of bending in two stage is greater then the one in the one bending stage, this has advantage in economical sense by small and medium series, because there is no supplementary finishing of the tool. In the first stage of bending the width of the punch is equal to the width of the work piece. In second stage of bending the workpiece is placed underneath the punch for final bending. In the following phases both stages are performed simultaneously (one work piece on the early stage of bending, while on the other the final bending). In this way the time for the production of one part is reduced almost as in one-stage bending. Fig. 4.

If one wishes to emphasise the accuracy of realising the angle according to DIN 7151, then it is demanded to determine the length of that angle. On the Fig. 5, the dependence between aberration of length and aberration of angle is presented.

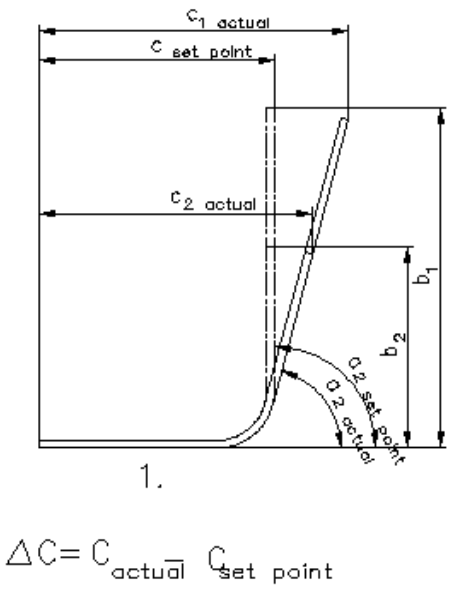

Fig. 5. Dependance between length and angle of the bended sheet metal plate. [5]

2. Methods and materials used for research

For the numerical Finite Element Method simulation of the half opened V-die bending steel sheet metal plate from St1403 material was used. Steel St1403 is German DIN designation, European norm BS EN 10130:1999 is old designation for the same material. New EU norm is EN DC04 (1.0338) [6].

This material has the following mechanical properties [7]:

- yield stress R_{p02} = 157 MPa
- ultimate tensile stress R_m = 309,2 MPa
- n value n = 0,242

Flow curve is approximated with expression:

$$k_f = 556(0,0058+\varphi)^{0,246}, \text{MPa} \qquad (2)$$

where φ is true strain. [7]

Bending process was simulated in MSC.MARC, so the strain hardening curve is supposed to be entered in the form of plastic portion of true strain/true stress. These calculations are done by expression:

$\varphi_p = \varphi - \frac{k_f}{E}$, where E represents Young's modulus of elasticity. For steel sheet metal plate St1403 Young's modulus of elasticity is E = 210 GPa. Flow curve for St1403 material is shown in Fig. 6.

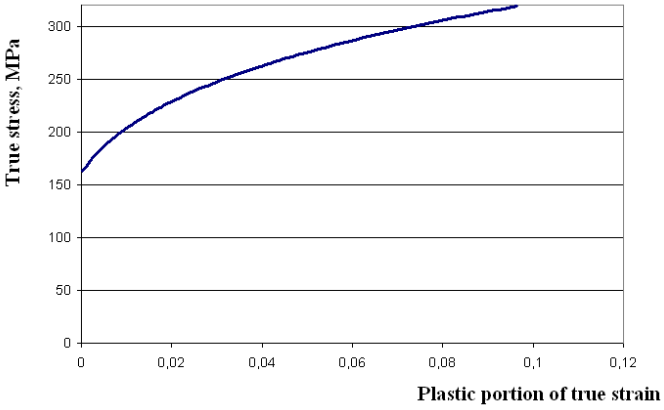

Fig. 6. Flow curve for St1403.

Poisson's ratio ν = 0,3 was used in simulation. Material was described numerically as isotropic elastic-plastic material with isotropic hardening rule and piece wise linear strain rate method. Yield surface was calculated according to vonMises.

Problem was simulated with contact bodies, of which one was punch with angle 90° and tip radius of 4 mm, lower tool was also with angle 90° and in two versions. One was half-opened tool, and other was closed tool with radius of 4,75 mm. Sheet metal plate was simulated with dimension of 27 mm length and 0,75 mm height (shown if Fig. 7). Problem was modelled as plane strain so thickness is by default set as 1. Upper tool (punch) was controlled by path of -8,1 mm at the end of the stroke, as a function of time. In the time t=0, punch path was also set as 0 mm. All points between were extrapolated during simulation. At desired values of punch path, the upper tool (punch) was stopped, and reversed in other direction, so sheet plate could elastically return. Values of angle between sheet plate ends were measured in each time increment before, and after the unloading.

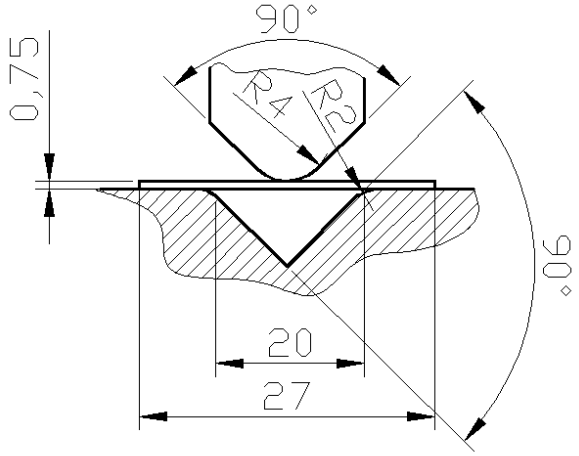

Fig. 7. Model with dimension used in FEM simulation.

Fig. 8. shows punch position as a function of time. Punch motion is set in negative position of y axis which is shown on a FEM model in Fig. 9.

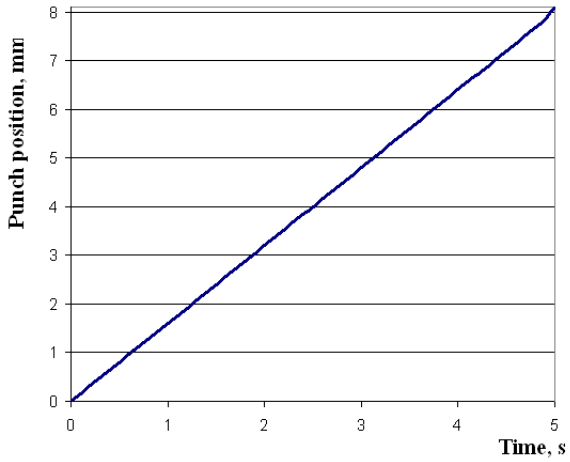

Fig. 8. Punch motion as a function of time.

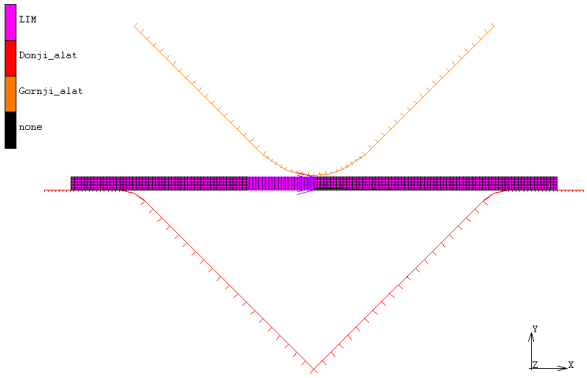

Fig. 9. FEM model of half opened V-die

3. Results and achievements

Results were observed as angle between free sheet plate ends. In some chosen time increments punch tool motion was stopped, and punch tool was reversed in direction, allowing elements to unload and approximate elastic springback. These angles before and after the elastic springback (Fig. 10.) were used to calculate relative bending angle error according to expression (1).

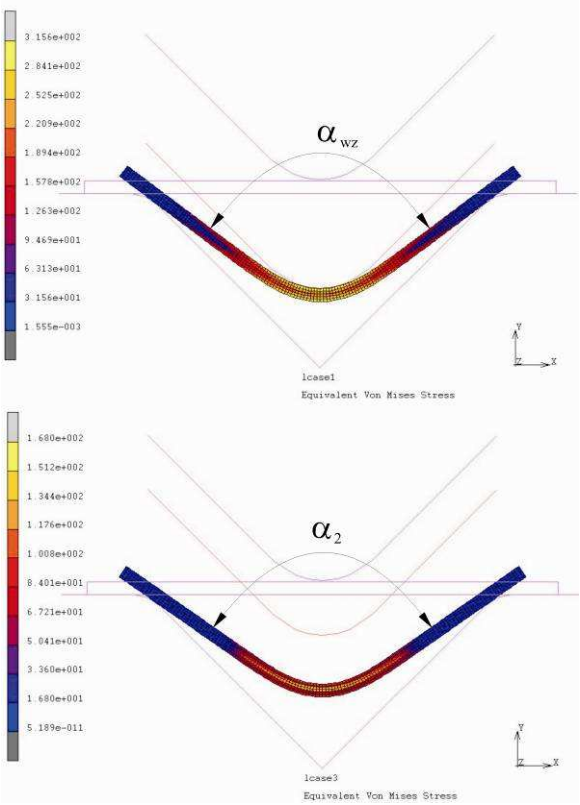

Fig. 10. Angles before and after release.

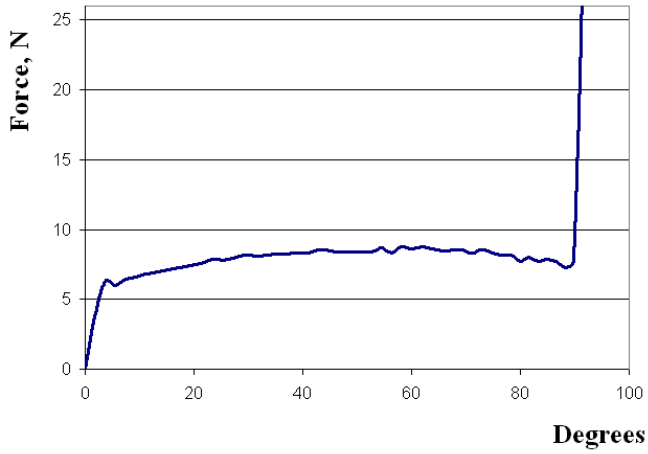

Fig 11. Calculated bending force as a function of bend angle.

Fig. 11. shows calculated force of bending of sheet plate as a function of degree of bending. One can see great increase of bending force at angle of 90°. This is because of material is strength hardening in the area around punch radius. Depending on a magnitude of forming force *F* stresses can be large enough so this complete area hardens enough so that there is almost no elastic springback. This high force is called calibrating force. Sometimes it is not economically to use high forming forces, so the only way of precision V-die bending is to over-bend some part for the amount of elastic springback, so when the part is unloaded and springback takes place – the part takes desired shape. This means that tool with smaller tip angle should be used.

Fig. 12. shows relative bending angle error as a function of punch travel. In numerical simulation, tool (punch) motion was stopped and reversed at desired time increments, and angles were measured before and after unloading, which is shown in Fig. 10. Based on the calculated angles, relative bending angle error is calculated and plotted as a function of punch travel.

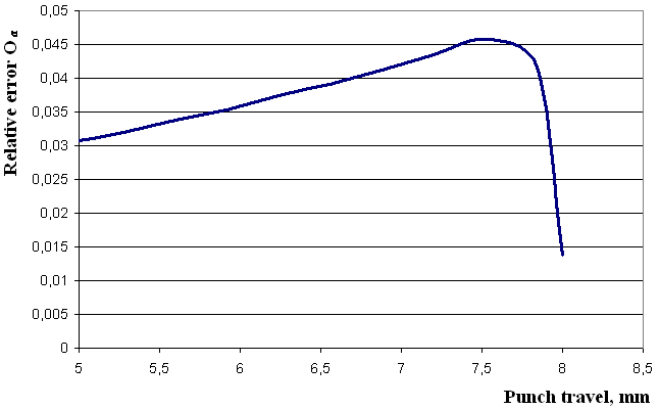

Fig. 12. Diagram of relative bending error as a function of punch travel.

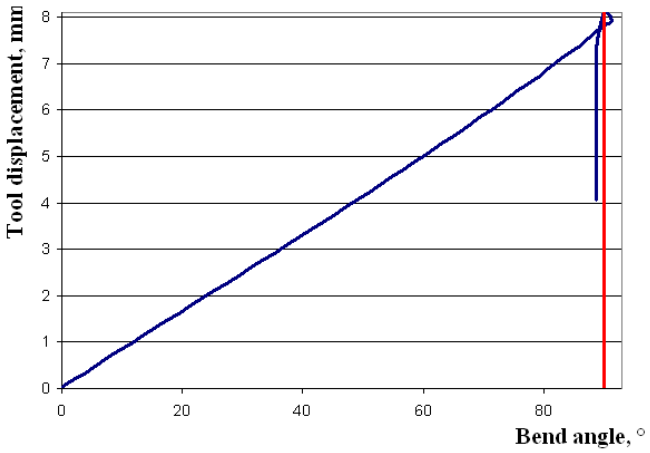

Fig. 13. Tool (punch) displacement as a function of bend angle

Fig. 13. shows tool (punch) displacement as a function of time. It is interesting to see that before the final punch motion of 8,1 mm the bend angle is lower than V-die angle which is set as 90°. This effect is more expressed with the use of smaller punch tip radius, and many experimental tests have shown this phenomenon.

4. Conclusions

In this paper, the process of sheet metal plate is investigated. With the use of finite element method, the process of sheet metal forming was simulated. Simulation was done with St1403 material. Since the effect of elastic springback is present in almost every bended sheet metal plate, it is necessary to take into account this effect. Today because of energy crisis automobile and other manufacturers tends to reduce energy consumption by the use of light weight constructions and composite materials. Especially in automobile industry, the use of high strength sheet metal plates is present because these materials offer same strength and less weigh than conventional ones. Also because of strength hardening, these materials have more expressed effect of elastic springback. Based on the results obtained by FEM, bending process should be investigated with high strength steels, and various bending parameters as V-die length *w*, punch angle, punch tip radius, V-die radius, coefficients of friction, force of bending etc.

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Evaluation design parameters of heat exchanger hanging on steam boiler – horizontal pass type

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Abstract

During the design of almost every part of mechanical engineering, there is several variant of structural solutions. Sometimes it is not easy to decide which structural solution to choose from, and often it is necessary to use different models of assessment and evaluation of structural solutions with the application of the theory of decision making. In this paper, decision making of a structural solution on example of hanging type of heat exchanger used in the steam generator with a horizontal flue gas passage, is presented. Between two variants of structural solution, and on basic of evaluation with the theory of decision making, optimal solution is decided in considering the advantage and disadvantage of individual constructional solutions.

Keywords: decision theory, models of evaluation, decisions, potential method, heat exchanger, hanging.

1. Introduction

Decision making is a problem that occurs in each activity. Decision problem is usually a problem in which the main intention is to appropriate for one of the alternatives, taking into consideration all relevant factors or criteria.

Because the criteria are usually conflicting, the selection of decision maker will not be the optimal solution in the traditional sense, but it will be the satisfactory solution of which in a given situation there is no better. Evaluation of the possible decisions is subject to the subjective impression of decision maker and depends on amount, or importance of criteria [1].

Logical decision making is an important part of all science-based professions, where experts apply their knowledge in some area of decision making. For example, decision making in medicine often involves making a diagnosis and selecting appropriate treatment. Some researches, using naturalistic methods, shows that in situations with lack of time, with more parameters, or with more ambiguities, experts are using intuitive decision making rather than structured approach, following the basic approach to decision making with a series of indicators and expert experience, and immediately comes to the satisfactory result and with no alternative comparison.

Mentioned decision making include integrated uncertainty. However, the theory of decision making identifies and involves uncertainty with structured and rational justified ways of decision since its conception 1964th [2].

Make a decision means to choose one of multiple choices. So, the decision maker, designer in this case, must to do the following [3]:

- understand how the mind makes judgments, where such processes are positioned, and how to proceed from where he is,
- by knowing how others made decisions, understand the overall picture of applicable technology and clarify its relation with the designer's own judgments
- Grasp the overall picture of the design process, that is the sequence of determining matters including what the goal (functional requirement) and conditions (constraints) are, so that he can apply them to his own activities (design).

2. Decision in Design

Depending on the level of the designer with his mind deep in the process of designing, a number of questions arise including the following [3]:

- Does designing mean just following samples that are already available?
- Can we follow manuals (written procedures) to design? Or if we carefully search standards, can we find the answer?
- Where do we start when we design?
- What is the procedure for making a design?
- How do we set the design goal? What are the free-to-set variables? Dependent variables? Constraints?
- (When we look at a drawing,) how was each item designed?
- (When we look at a product based on a design,) how were its shape and structure determined?

Questions come up one after another. Many of these relate directly to technology or science but most of them are questions about the act of design itself. When a student mimics design, he has a “sample” to follow. Modifying an existing design starts from a “former design.” A design with an established method proceeds following a “design manual (procedure).” In these cases, it is easy to know where to start and how to complete the design. In creating something new, however, there is no sample, no former design, no manual.

The designer has to produce everything for himself. In this situation, the most important thing to know is how decisions are made in design.

There are many constraints, as Figure 1 shows, on designs. The figure shows these constraints in the order that they come to the designer’s mind. Purely technical constraints are on the left side, starting from function/mechanism in the lower left-hand corner. As the design progresses, those on the right start to weigh more. The most significant ones for the overall design project are cost, turnaround, and method of manufacture.

Figure 1 shows the constraints about design in the narrow sense. As technology and industry advance, and the results of the design affect our lives or society, constraints shift from the early technical or economic limitations to social, environmental, or ethical constraints, as Figure 2 shows.

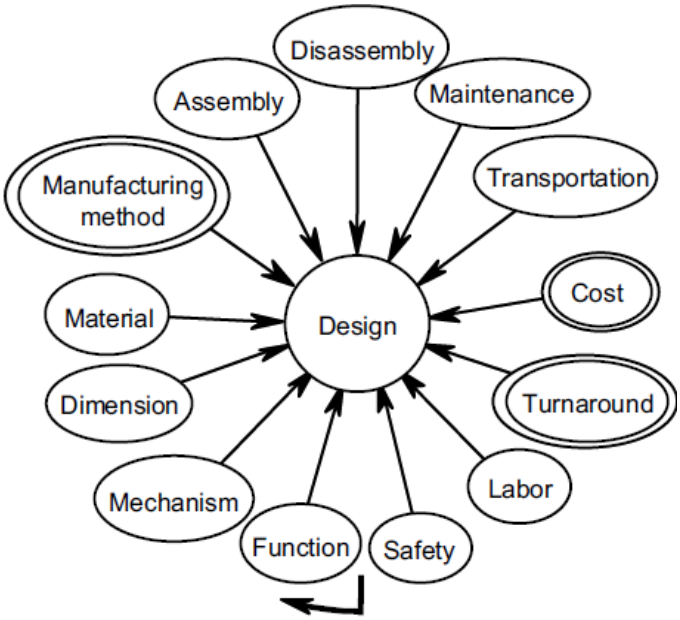

Fig. 1 Constraints associated with design [3]

The designer must bear this deeply in mind, or social aspects of the design will even result in the evaluation that “Designing is evil” [3].

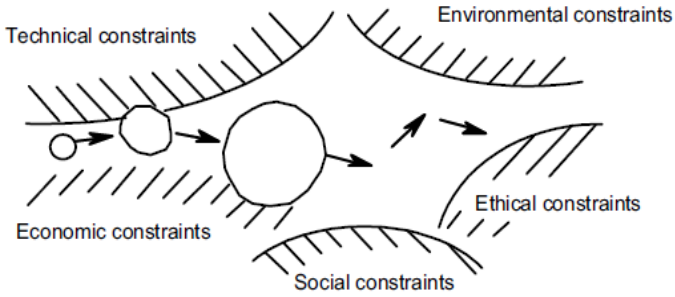

Fig. 2 Transition of constraints with advancements in technology or the industry [3]

By most decision making definitions, common is that it is a choice between more than one version. It is important that it is a process that lasts a shorter or longer time, in which it is made a choice between two or more features, and to solve the problem because of we decided for decision making.

Decision is necessary to define as a result of the selection process among several possibilities of solving the problem. That decision could effectively solve the problem, it must be, first of all, unambiguous, precise, realistic and clear, and above all, it must be made on time.

Decision making is not an easy job. It is very difficult and sometimes almost impossible to make a decision which will have only positive effects as a result. Namely, decision making always dismissed any conflict and in fact there is no decision without positive and negative aspects.

Therefore, ambition is to make a decision that will have far more positive than negative consequences. In decision making, great help are methods and models for it, with common name as valuation models.

3. Potential method

In the past twenty years, the number of methods for multiobjective decision making is growing rapidly. Each has its advantages and disadvantages and more or less are oriented to decision-making in the context of economic planning, designing, selection of script.

Potential method, developed by L. Čaklović, arise from efforts to reconcile the two approaches: the rational, based on the works of von Neumann and Morgenstern, and the pragmatic, strongly criticized by the rationalists, which promotes Saaty-s method of characteristic vector. Both access misfire, if the relation of preferences is not complete, with fact that the rationalists 'appreciate' only transitive relations.

Potential method has accept the idea from rationalists, known as 'trade-off' idea, between the exchanges, and the possibility of measuring of 'inconsistency' of input data from Saaty-s method. This method opens new possibilities for the analysis of social networks, with particular emphasis on the duality and calculating the asymptotic state system with feedback connections [4].

3.1. Full graph potential

The full graph potential is actually a kind of potential and ranking methods. If there is a finite set of alternatives and decision maker is identifying it with n points in the plane (or in space), for each pair of alternative, decision maker is giving the preference to one of them or declared it as same preferred.

The arrow indicates a preference that is direct from less to the more preferred alternative. If preference satisfy, then the next step is determining the value function according to the equation (1) which define the ordinal scale on a set of alternatives.

Let the "$\succeq$" is relation of poor preference on set S. Then there are a function $V : S \to \Re$ which is consistent with the relation [4]:

$$x \geq y \Leftrightarrow V(x) \geq V(y) \tag{1}$$

In the method of potentials, for each preference (arrow) in the graph, a number that expresses the strength or amount of preference is added. This number represents the ratio of importance between two criteria. The aim of decision maker is to include the preferences and their strength in the decisions. Figure 3 shows the example of preferences with its amounts.

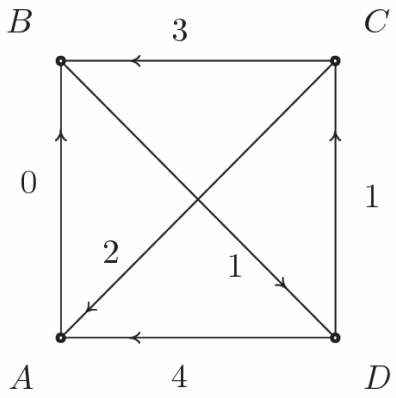

Fig. 3 Preference with its amount [4]

4. Design of heat exchanger

In power plants, overheated steam is produced by steam generator (steam boiler), which basic elements are recovering heat exchanger. These heat exchangers according to their function can work as economizer, evaporators and steam over heater. This paper is analyzing the economizer which is using the heat from flue gases to heat the water. It is antidirectional tubular heat exchanger shown in Figure 4

Figure 4 shows that this is a large heat exchanger (dimensions 2400x6200x7400 mm and total mass, m = 96000 kg), which is not strong enough to bear itself. Therefore, the additional construction for supporting the exchanger is essential.

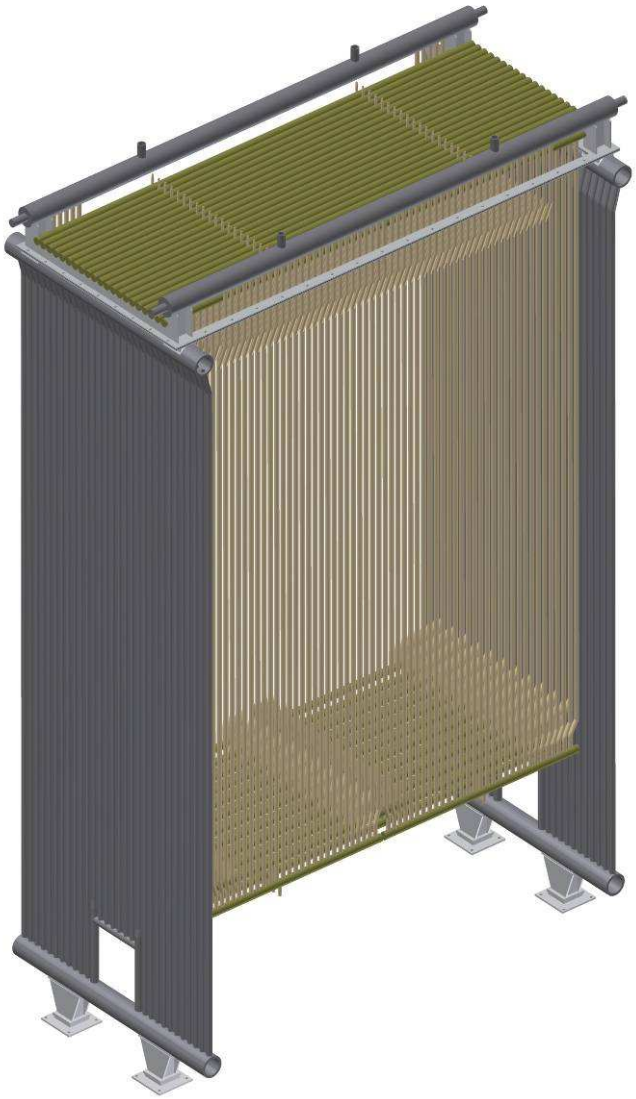

Fig. 4 Isometric view of the heat exchanger

5. Application of potential method for decision making of hanging the heat exchanger

As there are more solutions of hanging the pack of heat exchanger, it is necessary to decide which one to use in practice. There are two basic solutions, and also that is two variants in which this paper is based. The first variant consists of support and steel profiles, which also represent an independent construction, Figure 5.

Variant two is related to the strengthening of bearing chambers of heat exchanger with steel bar, so the exchanger is carrying itself, as shown in Figure 6.

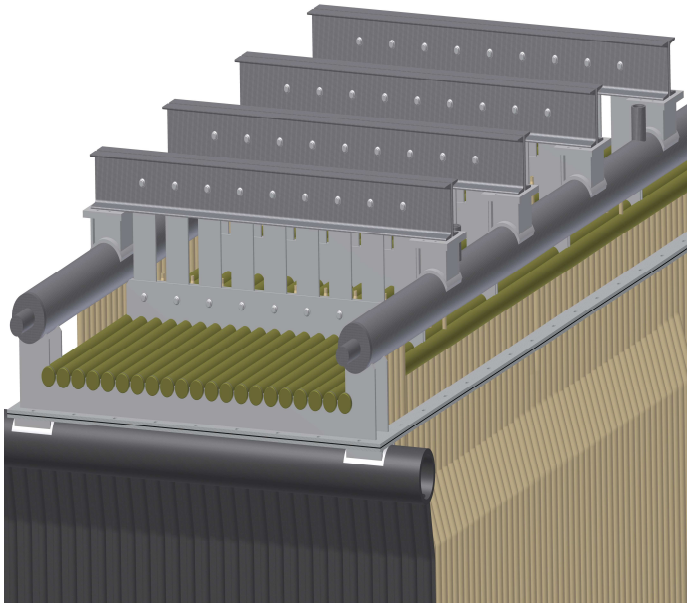

Fig. 5 Hanging variant of the heat exchanger structure by carrying construction

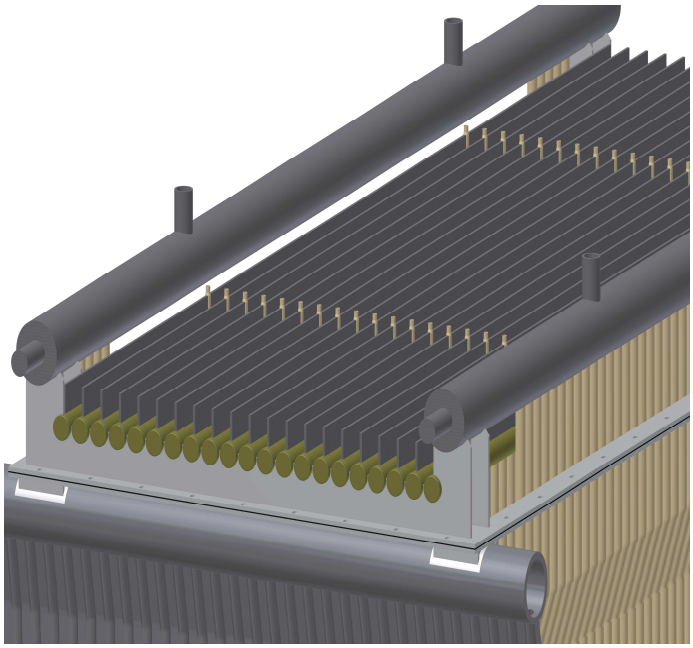

Fig. 6 Hanging variant of the heat exchanger structure by strengthening of bearing chamber

The problem with the first variant is the manufacturing of a new steel construction, while the biggest disadvantage of second variant is large amount of welding on the pressure part, which can cause errors in production.

To perform the evaluation, it is necessary to get as many possible advantages and disadvantages of each variant. There are several criteria for evaluation, namely: finance, transport, mounting, dismantling and maintenance, material, etc.

To perform the evaluating with the potential method, it is need to include relations or ratios between the values of two criteria. To choose a variant, computer software for calculate by potential method was used.

Following criteria are used (in brackets are the names used in the hierarchy):

1. price of labor (production)
2. mounting, dismantling (mounting)
3. the complexity of the welding process (welding)
4. maintenance (maintenance)
5. errors possibility (errors)
6. transport (transport)
7. price of materials (material)
8. load of steel construction (weight).

The first, third and seventh criterion is directly related to finance during mounting and production, while the first and third criteria is relating to the availability of production capacity.

The second and fourth criteria is relating to the accessibility and the ability to the facilitate mounting and dismantling at the field, and maintenance which greatly affects on the respect of terms of work.

The fifth criterion relates to reliability, a sixth criterion indicates the possibility of transport to the place of mounting, and the eighth criterion presents the technical characteristics of beams. Table 1 presents the relations between certain criteria:

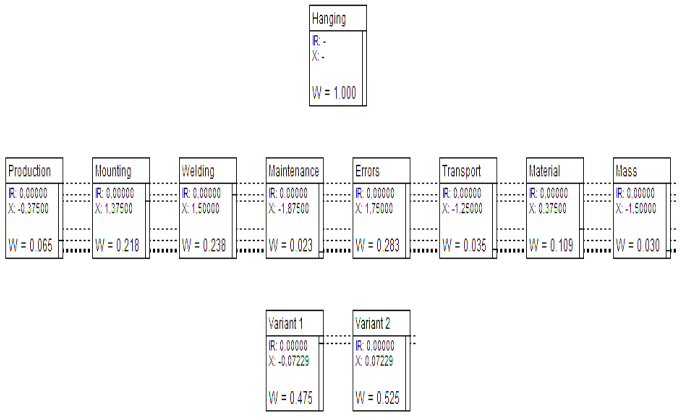

Fig. 7 Hierarchy after ranking

Table 1. Relations between certain criteria

Relation in regards to aim: Hanging			
Criteria	Assessment	Criteria	Assessment
PR:MO	1:2	WE:ER	-
PR: WE	1:2	WE:TR	3:1
PR: MI	2:1	WE:MA	2:1
PR:ER	1:3	WE:MS	4:1
PR:TR	2:1	MI:ER	1:4
PR:MA	1:2	MI:TR	-
PR:MS	2:1	MI:MA	1:3
MO: WE	2:1	MI:MS	-
MO: MI	3:1	ER:TR	3:1
MO:ER	-	ER:MA	2:1
MO:TR	2:1	ER:MS	2:1
MO:MA	-	TR:MA	1:2
MO:MS	2:1	TR:MS	2:1
WE: MI	3:1	MA:MS	-
PR – production, MO – mounting, WE – welding, MI – maintenance, ER – errors, TR – transport, MA – material, MS – mass.			

Using relations from Table 1 in the program for calculating with potential method, values for each criterion was obtained. After calculating all the criteria of the hierarchy (Figure 7) it is obvious that the strongest criterion is the possibility of error with value of 0,283. Figure 8 shows the relationships among the entered criteria. Table 2 presents the ratios between the variations for each specific criterion.

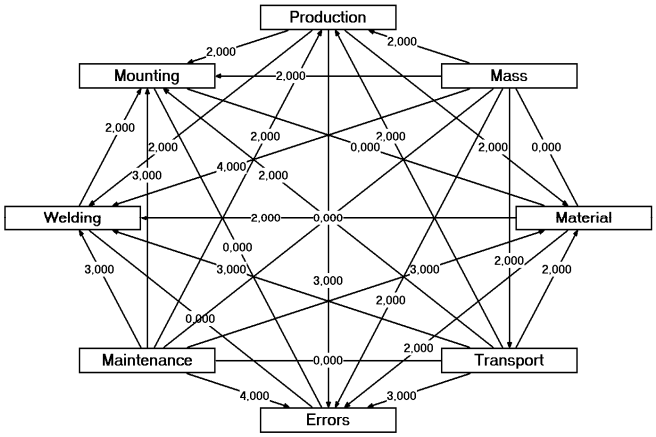

Fig. 8 Relationships among all criteria

The first variant of hanging is better in only two criteria, and these are welding and the possibility of error. But these two criteria have the highest value, so they are the most important.

Table 2. Relationships among variants for all criteria

Criteria	Assessment
In relation to first criterion: Production	
V1:V2	1:3
In relation to second criterion: Mounting	
V1:V2	1:3
In relation to third criterion: Welding	
V1:V2	2:1
In relation to fourth criterion: Maintenance	
V1:V2	1:1
In relation to fifth criterion: Errors	
V1:V2	3:1
In relation to sixth criterion: Transport	
V1:V2	1:3
In relation to seventh criterion: Material	
V1:V2	1:3
In relation to eighth criterion: Mass	
V1:V2	1:4

Solution showed that the variant 2 is in advantage regarding to the first, and it is decided that variant 2 will be used in practice.

6. Conclusions

Valuation models commonly used to confirm a decision that is already assumed. From Figures 5 and 6 it is visible that variant 2 is in advantage in regard to variant 1, because of its dimensions and the number of used parts. On the basis of set criteria, and the advantages and disadvantages of each variant, the best solution was defined. Figure 9 shows the values of each criteria which are obtained based on the ratio between each of them. It is expected to be the most important criterion is montage, welding and the possibility of errors, which was shown whit this method too.

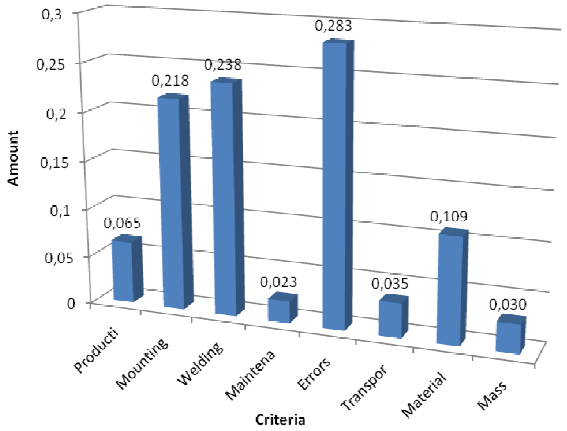

Fig. 9 Amounts of all criteria

Based on the ratios from Table 2 and using them in the program for calculating, the final decision was obtained. As it was expected, the results showed that variant 2 is better than the first, although the first variant was much better at the two most important criteria. So, it was decided to use variant 2 (Figure 10).

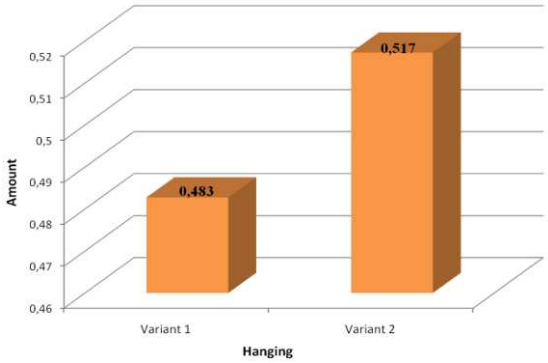

Fig. 10 On the basis on set criterias, variant 2 is chosen

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Dependence of the surface roughness profile parameters and vibration parameters in awj cutting

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Abstract

The paper deals with relationship between the parameters of the roughness profile (*Ra*, *Rq*, *Rz*) and vibration parameters (velocity, acceleration). Experiments were conducted by measuring vibration and ultrasonic emissions during cutting aluminium at different traverse speeds cutting head. Surface roughness parameters were measured by an optical non-destructive method. This document aims to highlight the relationship between surface roughness and vibration.

Keywords: hydroabrasive cutting, vibrating analysis, surface topography

1. Introduction

The abrasive waterjet (AWJ) is a non-traditional machining method that was developed in 1980s. Its main principle is that the high speed jet si formed by means of a transformation of hydrostatic energy and material is removed by micro-cutting of abrasive particle, erosion and impact effect of AWJ. With unique machining method, lesser cutting force and no thermal influence on target material, the AWJ has a wide range of machinable materials. AWJ has been widely used in machining materials such as titanium, steels, brass, aluminium and that technology is widely employed in industry.

AWJ has still some limitation such as bigger specific energy consumption. To improve machining cabability and utilization, many investigations on machining mechanism were developed over the past decades, such as erosion model of AWJ and impacting erosion model of brittle materials. Based on these investigations, several novel and effective techniques of AWJ were developed, such as titled nozzle and nozzle oscillation techniques. Until today the action mechanism between AWJ and target material still has not been obtained and explained.

Therefore, we studied the process of abrasive waterjet cutting starting to examine ways of using mechanical vibrations. Abrasive waterjet cutting of materials causes the mechanical oscillations and vibrations. In addition to the adverse effects of vibration in the cutting material they bear important information to study the cutting mechanism, where the immediate state of the technological process can be monitored. Taking into account that the material is subjected to high-speed erosion power, the use of vibration analysis for the application and monitoring abrasive waterjet cutting is accurate. It should be noted that the vibrations record the waves that are generated by local deformation of the stress on materials [6]. Several efforts vibration analysis applications, or acoustic emissions have been processed in the works [2], [3] for on-line management and monitoring of the immediate stat of surface morphology created by the AWJ in the works [1], [4], [5].

2. Related and previous work

In that field of the research with the aim to improve the abrasive waterjet cutting performance was made a huge research work. But in any scientific database as, Web of Knowledge, Scopus, Science Direct or Scirus, there is not any scientific report that deals with relationship between vibration parameters, AWJ factors and finally surface profile parameters *Ra*, *Rq* and *Rz*. Some partial research under supervision of Kovacevic [9], Momber [8] and Mohan [11] has been done. In

their research reports we can find the using of Acoustic emission (AE) models of AWJ where the monitoring of AWJ dissipated energy has been studied by Mohan [11]. Kovacevic used the AE in order to monitoring of AWJ drilling depth of cut [4], [9], [10]. Identification of different removal mechanisms by AE has been studied by Momber. And finally Mohan used AE for monitoring of AWJ depth of cut. Kovacevic in 1995 reported the research work, where the vertical force of AWJ has been measured [4]. The aim of the experimental work was to apply for on-line monitoring of surface roughness. But they great deal to the research field is now impractical to the erosive nature of the AWJ [12], [13], [14]. Hence the first part of our study is to bring a results dealing with finding of the relationship between parameters of vibration (acceleration and velocity) and AWJ factors.

3. Sample preparation

The experiment had been carried out within the framework of academic cooperation between the Department of Production Management, Faculty of Manufacturing Technologies Technical University of Kosice, with a seat in Presov, and the Institute of Physics, HGF, VŠB - TU Ostrava in cooperation with Slovak firms DRC, Ltd., Presov (Mr. Mikita), and the company Technical Diagnostics, Ltd., Presov (Dr. Adamčík, Ing. Bartoš), supported by the Scientific Grant Agency in the frame-work of the project VEGA 1/4157/07 where the main goal is to develop on-line technology of the management of materials cutting by abrasive waterjet (Fig. 1). The diagnostic measurements of vibrations in the evaluation of the impact of focusing tube wear during abrasive waterjet cutting of aluminum has been used to the precise cutting table from PTV company, designed for surface application of the AWJ technology. The water pressure was generat-ed by the pump FLOW 9xD55 with V = 4.7 l.min^{-1} with a power p = 60 HP. An Ingersoll Rand cutting head has been used at the experiment. All samples have been produced with a constant setting of input factors (Table 1). Vibration measurement (data collection) was provided during abrasive waterjet cutting of aluminum. Vibration sensors were mounted on the workpiece and the focusing tube (Fig. 1).

To fix their position, the sensors had been attached to the adapter by a threaded screw M6. The absolute vibration had been recorded - the surface vibration sensors had been installed on site. The analysis was transferred from the time (TIME) records and FFT spectra. Measurements of vibration had been repeatedly recorded during the abrasive waterjet cutting.

Table 1. Experimental set up

Technological conditions		
Factors	Unit and dimension	Value
Pressure	p [MPa]	350
Orifice diameter	d_0 [mm]	0,14 (inch)
Focusing tube diameter (Roctec)	d_f [mm]	[0,8 – 1]
Stand off distance	z [mm]	2
Abrasive (Barton Garnet)	*MESH*	80
Material thickness (aluminum)	b [mm]	40
Abrasive mass flow rate	m_a [g.min^{-1}]	400
Feed rate	v [mm.min^{-1}]	20, 140
Environmental conditions		
Factors	Unit and dimension	Value
Temperature	C [°]	20
Pressure	p [hPa]	1007
Altitude	[m]	280
Geographical location	-	49°00′00″N 21°14′00″E

Figure.1 Diagnostic measuring vibration during cutting aluminium

The vibrations at abrasive water jet cutting running with a new focusing tube (Roctec 100) and worn focusing tube (after 60 hours of operation) were compared. Data collection was carried by NI PXI by

measurement system (a type of measurement card PXI 4472B, 8-channel simultaneous collection, 24 bit A / D converter, sampling frequency of 102 kHz, the dynamic range of 110 dB) and frequency analyzer microlog GX-S. Data analysis was transferred by Lab View Professional Development System, including Sound and Vibration Toolset and Order Analysis Toolset, and Aptitude Analyst SKF Condition Monitoring. As sensors, accelerometers were used PCB IMI type 607A11 with integrated cable (sensitivity of 100 mV / g, frequency range up to 10 kHz). Control - calibration - measurements have been transferred through the spectrum analyzer (data collectors) SKF microlog GX-S, the analysis of measured data was transferred via software SKF Aptitude Analyst.

4. Results and discussion

The hydroabrasive cutting of the material is provided by the tool AWJ – abrasive waterjet. The AWJ tool formation is a complex process in which it is necessary to take into account several effects. Formed tool consist of dynamically changing elements such water, air and abrasives. Current shape and energy profile of AWJ depends on hydrodynamic factors such pressure, diameter of water orifice, abrasive mass flow rate, diameter of focusing tube, focusing tube length etc. Acting by AWJ is formed a new surface topography which quality we can numerically express by surface roughness profile parameters *Ra*, *Rq* and *Rz* [□m]. Accompanied feature at AWJ cutting of material (creations of surface topography) is generation of noise (*Laeq* [dB]) and vibration parameters (v [m.s^{-1}] and a [m.s^{-2}]). Both that is considered to be as a „negative feature of the technology“ are carrier of the information about the processing of the material in real-time. In order to find a relationship between the surface quality and vibration the measurement of surface profile parameters *Ra*, *Rq* and *Rz* and vibration parameters of the experimentally made cuts have been provided. On following figures 2, 3 are graphically displayed plots of real topographic function obtained by non-contact optical measurement Microprof FRT with cooperation with assoc. prof. Ing. Miloslav Ohlidal, PhD in VUT Brno.

Profile roughness parameters *Ra*, *Rq* and *Rz* [□m] were measured in 41 depth lines. Observed values *Ra*, *Rq* and *Rz* [□m] for the traverse speed are interpreted in Figure 2 and 3. Figure 2a shows the plot of surface profile parameters *Ra*, *Rq* and *Rz* obtained after cutting with traverse speed of v = 20 mm.min^{-1}. On the chart graphs are seen that the parameter values are higher profile in the initial zone (depth 4 mm) than in the smooth zone. Consequently, their numerical values increase depth after the depth line situated in 4 mm.

Figure 3 graphically interprets the plot of numerical values in the profile roughness parameter values for traverse speed of abrasive cutting head at v = 140 mm.min^{-1}. During AWJ cutting of material on which were fixed sensors on experimentally cut materials (Fig. 1) detect the mechanical oscillations. Figure 2 and 5 shows a comparison of the velocity signal in the range of traverse rate v = 20 mm.min^{-1} (Fig. 2) and v = 140 mm.min^{-1} (Fig. 3). At traverse speed of cutting head v = 20 mm.min^{-1} is evidently seen the high values of velocity than on figure (Fig. 3). It can be caused by impacting of the abrasive particles per time unit. Hence we may assume that there is a diret connection between abrasive mass flow rate and velocity.

5. Conclusion

The experimental study deals with a closer understanding of the surface topography created by abrasive waterjet. How to split the sample material was used aluminum, which was divided by the diferent treverse speeds. This paper compares the results obtained by cutting the traverse speed 20 and 140 mm.min^{-1}. The results show a correlation with the roughness of vibration that are generated by contact hydroabrasive flow with material. In hydroabrasive cutting vibrations have the same origin as the parameters of roughness profile.

Based on experimental measurements of surface parameters and vibration when cutting aluminium we can conclude:

- the existence of dependency between the profile roughness parameters *Ra*, *Rq*, *Rz*, and traverse speed is confirmed,
- the existence of dependency between the profile roughness parameters *Ra*, *Rq*, *Rz* and and mass flow of abrasives confirmed,
- measured signals have a non-periodical character.

This is a first step towards closely understanding of cutting mechanism of material and improving of cutting performance of abrasive waterjet technology.

In the future it is necessary to focus on the decomposition of FFT and continue measurements at different speeds depending on confirmation of the displacement parameters *Ra*, *Rq*, *Rz* to vibration.

Acknowledgements

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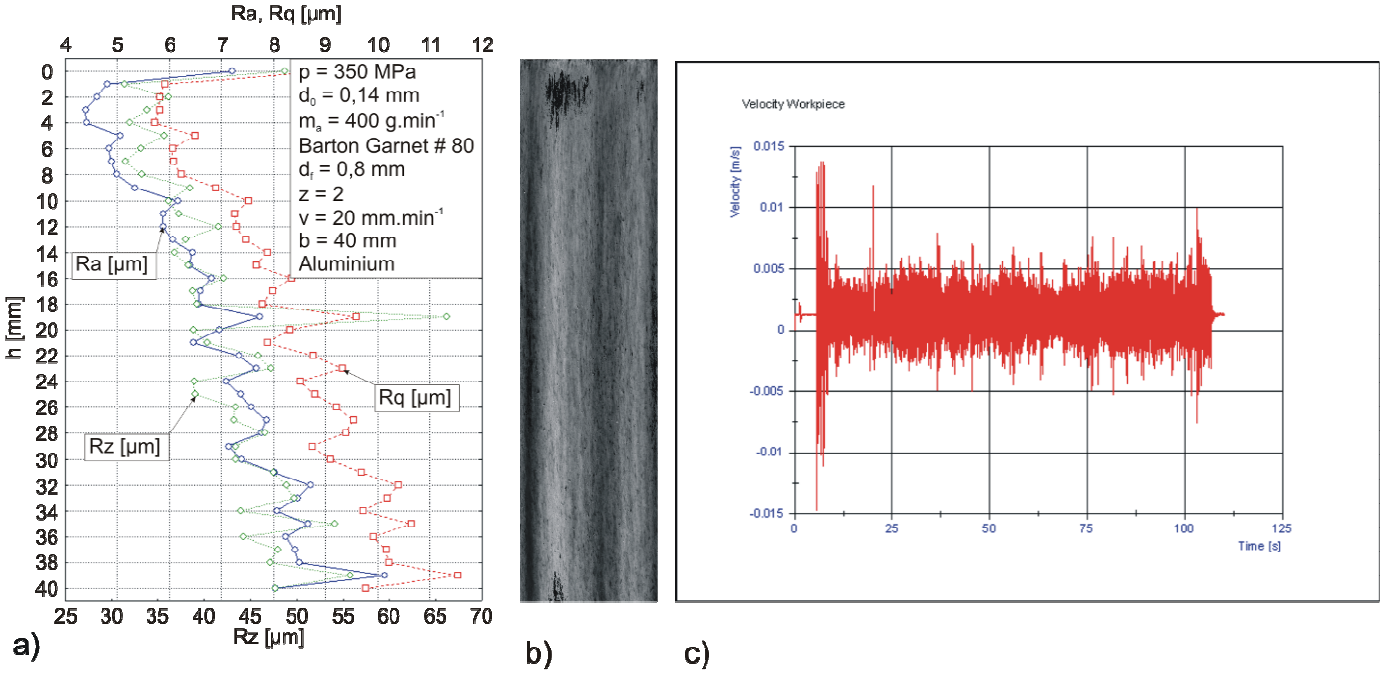

Figure.2 Behaviour of the surface profile parameters *Ra*, *Rq* and *Rz* generated under defined conditions and signal of velocity obtained from sensor placed on workpiece at traverse speed v = 20 mm.min^{-1}

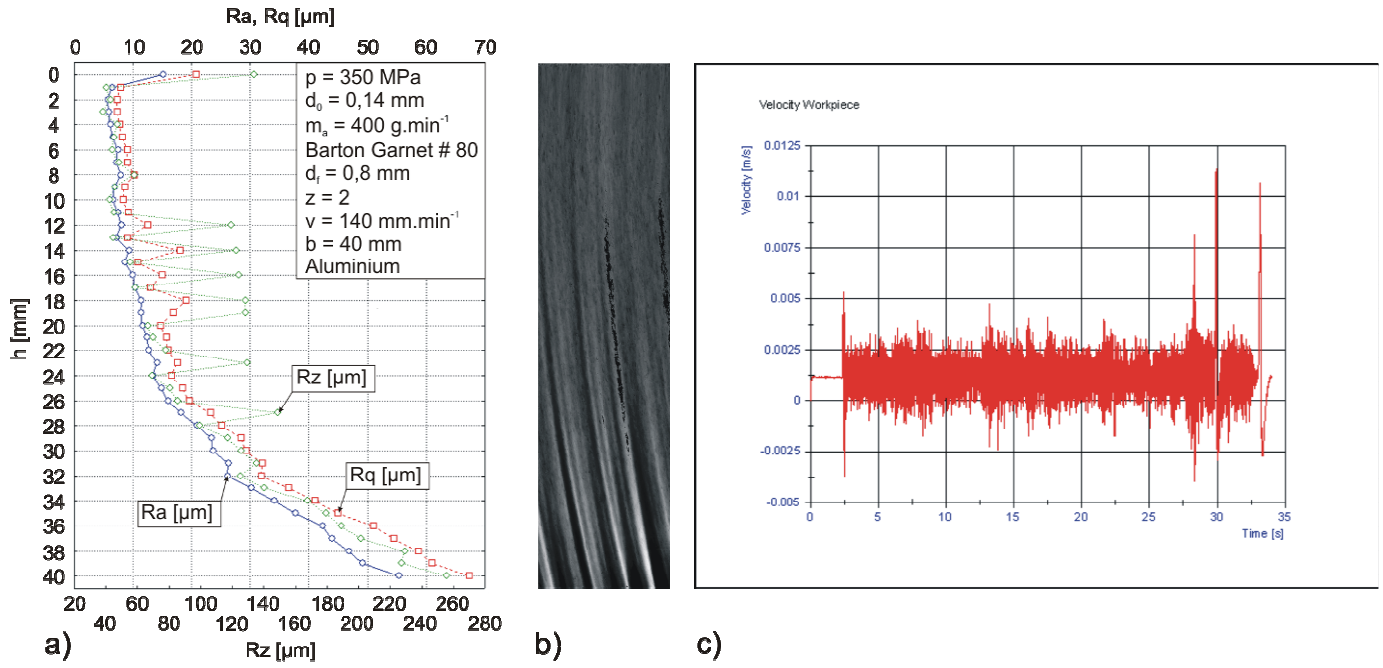

Figure.3 Behaviour of the surface profile parameters *Ra*, *Rq* and *Rz* generated under defined conditions and signal of velocity obtained at traverse speed v = 140 mm.min^{-1}

Development and marketing of new products in company Chromos-Svjetlost d.o.o.

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Abstract

Production companies meet with the business decision of development of a new product as a great financial venture. . In order for the product to realize the long-term financial plan of the production company, it has to do some additional research of the market. The complete process of development of the new product, which is the result of the market research, is a demanding and gradient road whose final goal is to realize the desires and needs of the utmost users, but also his financial gain of the company itself. The article analyses the role of marketing in the development of the new product on the principle of the production company Chromos Svjetlost d.o.o., with a special overview on the development of the new product based on water "Aqualux".

Keywords: New product, development and the processes of the development of the product, marketing, strategy and promotion

1. Introduction

Each production company that engages into the process of the development of a new product must be ready for great financial investments in the market research. Some of the inevitable issues in a production company are: to find a product that is favorable for development, why produce it, how to produce it, how good is that project for the company, what its losses are, and what the gain of the new product is. A big issue is why do the companies produce new products and expose themselves to a huge financial investment and risk, when they can live of the present products that have already achieved their reputation and position in the market? The answer to that is really simple- competition. The competition wants to occupy a better position than their rivals and by placing the new product it wants to launch a competitive product and occupy the leading position. That is the main reason why the companies go into financial risk and develop a new product.

2. New product

2.1. Meaning

It is constantly pointed out that the relationship between the new and the old products (innovation rate) is in a permanent increase during the last decade, and that in the future, only companies that will be able to develop new products and import them into the market, can count on survival [1]. Also, of all forms of development of products, the development of new products is the most responsible, the most complex, but also the most efficient area of product policy in the business policy of economic organization. [2] A great advantage of each production company is a direct and intimate relationship with its customers, so that they could react in due time and answer to the market, i.e. to offer their customers the right product. As the customers are crucial in the life of the existent products, they are also crucial in the beginning of the life of a new product.

2.2. Advantages

How can the company be sure that it developed a new product, which will bring a large financial gain? It is a question that all production companies make, and in order not to come to that question, i.e. the companies to be sure in their investment, they have to go through great steps before the launching of the new product in the market. The first advantage that the manufacturers can have is the understanding of the market on which they are present, and the knowledge of the needs of their customers. On the basis of listening to the wishes of the customers and researching of the ground on which they are present and also the one on which they are not, appears an idea for the development of a new product. The main advantage that a company can have to its competitors is the primacy of placing the new product on the

market accompanied by additional marketing advertising as an announcement and accompaniment of the placement on the market.

2.3. Disadvantages

According to various researches [3], it has been established that new products are sinking to a troublesome rate where the rate of failure of new products for packaged goods (which are mostly made of expanded present line) is around 80%.

Factors that can be responsible for that are:

- Highly influential manager in a company can boost the idea despite negative discoveries gained on the basis of market research
- The idea is good, but the size of the market is overrated
- The actual product is not well designed
- The new product is not regularly positioned on the market, it is not efficiently advertised or is too expensive
- The costs of development are higher than expected
- The competitors strike back stronger than expected

The first and basic disadvantage that can be found as a barrier in the development of a new product is insufficient knowledge about the product itself, and rough competition that is already on the market with the same product, and therefore you need to fight for the parts of the market with a risk of reduced selling and reduced gains from the product. Each new product requires great financial investments in machines, raw material, development technologies and various marketing investments for advertising the new product. Only particular production companies can withstand such investments because some of them simply do not have enough capital to bear investment into the development of a new product.

3. The development and the process of development of a new product

Each production company has to include all the processes that accompany the planning of the development of the new product before the development itself, so that it could come to a quality product on a legitimate and rational way, in accordance to customers, and on the benefit for its company. What has to be considered is that "a process, even if it is ideal for one company, is not so good for another" [4]. No production company, not even the analyzed Chromos-Svjetlost has such prestige or the financial background so that it could allow the development of a new product without the prior process of planning and narrowing the choice of ideas of what and how to fabricate. Chromos-Svjetlost Company is guided by basic processes that are essential in the act of realization of the new product, and those are:

- **Generation and selection of the idea**

How to go for the right idea and how to recognize it in a large number of offered ideas, is an important question and a big decision.

Each company, as well as the analyzed one, which deals with production, has a team that is responsible and takes part in the final decision making for developing a new product. The idea of a product to be fabricated can come primarily from the market, and the utmost consumers, commission agents, and the employees themselves. Ideas that come into a company must be audited, because if all ideas would pass and tried to be realized, it would come to the firm's bankruptcy, due to the fact that it simply could not bear it financially.

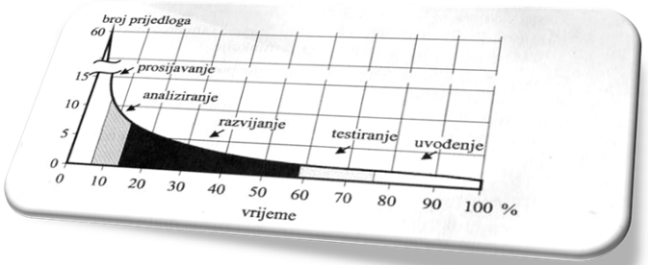

Fig. 1. Selection of ideas

- **Concept of the new product**

After the company has made the decision about which idea should be taken as final for manufacturing a new product, the next step in realizing the idea through a complete product is the data about what wants to be manufactured? According to the amicable idea, we already know what the final product could offer and what can be expected from it, but there are numerous other questions that need to be answered. The next thing we are interested in as product manufacturers is for whom is the product manufactured? Who is going to use it? Children, adults or older people? Which age group, and when? There has to be a ready answer to all those questions,

so that the placement of the product on the market would pass using as little effort as possible and accomplishing its goals.

- **Marketing strategy**

By testing the concept of the new product, we come to cognition about which products to go to realization with. Also, it requires preparing a marketing strategy for the new product. As it is important to make a concept of the new product, it is also equally important to make a marketing strategy for the new product.

According to Kotler, [3], a marketing strategy plan consists of 3 parts:

1. Perceive the size, structure and behavior of the target market; plan the positioning of the product and the selling, realization of a portion in the market_and profit during the first years.
2. Plan the price of the product, distribution strategy and the budget for the marketing in the first year.
3. A plan of long-term selling and profit goals, as well as the marketing mix during that time.

- **Business analyses**

For each new product, the company must estimate the positioning on the market; identify the target group of customers and possible gains through market placement. Besides that, the company must include the costs of all company departments and in that way have a clear vision of the possible business with the new product.

- **The development of the new product**

When the results of the business analyses of the new product meet the requirements of the company management, then the realization of the new product development can begin. During the initiation of the new product development, true costs are realized, where the company brings the initial idea of the product into a technically deductible and commercially pay out product. When the technical development of the product is finished and all the parameters for the quality of the new product are tested, the company invests additional financial assets into the marketing of the new product.

- **Market testing**

Companies think of various ways of market analyses with the intention to set up some general tendencies, requirements, wishes and market needs for a company's new product. The tested company invests financial assets into presenting the product to target groups of consumers (for example construction builders) from whom it gets timely information of the new product, competitors as well as suggestions for the product improvement. That way the financial assets are more focused towards the improvement of the product and it can be influenced on the blocking of a bad product on time.

4. New product marketing

Each production company must ensure factors of manufacturing quantitatively and qualitatively prepare the distribution channels, make a network schedule of promotion activities and start up a product commercialization process for the refund of the invested financial assets. For the act of putting the product on the market, it is necessary to look at the market situation, name the product, protect the name, set a price, market placement, corresponding packaging and to make a strategy of market appearance. I am giving examples of the new product marketing on the basis of the product "Aqualux" in the company Chromos Svjetlost.

a. Product name

Name of the product is a very important and difficult decision of each production company because choosing a wrong name can make the breakthrough of the product almost impossible, as well as it can create a large financial loss. The above-mentioned product of the tested company is closely related to the concept of water that is added to it, and it also involved the word water in it. Table 1.shows the suggestions of the marketing department for the new product.

Rb	KROVNO IME
1.	HADVAO
2.	H2OL
3.	AQUABLIC
4.	PRIMAGUA
5.	AGUAS
6.	AQUALOOK
7.	AQUALUX
8.	AQUALINE
9.	AQUASET
10.	AQUASHINE
11.	AQUARELL

Table 1. The suggestion for the product name

b. Strategy and prices program planning

Thanks to a good market position of the tested company and its good accessibility to each part of the market, in the domicile as well as in the foreign market, the strategic plan of the new product's coming out on the market is partly made easier. Due to good business and partnership relations with the consumers, the new product can be very easily found on store shelves. The goal of the plan is a complete supply of each store with new products and promotion materials so that everything could be offered to customers at once (table 2.)

Rb	STRATEGIJSKI PLAN	PREDNOST
1.	Formiranje cijena	Poznavanje cijena konkurencije
2.	Izrada dizajna novog proizvoda	Poznavanje dizajna konkurencije
3.	Organiziranje distribucije	Postojeća distributivna mreža
4.	Dostava uzoraka kupcima (izvođačima radova)	Dobivanje brze povratne informacije
5.	Opskrba strateških trgovina s novim proizvodom	Posjedovanje prodajnog prostora u trgovinama
6.	Opskrba strateških trgovina promotivnim materijalima	Informacija kupcima na licu mjesta
7.	Organiziranje prezentacija novih proizvoda po strateškim gradovima	Direktno upoznavanje izvođača sa kvalitetom i primjenom proizvoda
8.	Postepeno uvođenje novog proizvoda u manjim trgovinama	
9.	Uvođenje strojnog nijansiranja novog proizvoda	Posjedovanje strojeva na domaćem i inozemnom tržištu
10.	Uvođenje dodatnih nijansi iz tonkarte u trgovine, ovisno o potrebama tržišta	Opskrba nijansama prije konkurencije
11.	Uvođenje novih proizvoda na inozemna tržišta (plan strategije prema planu strategije na domaćem tržištu)	Isto kao ina domaćem tržištu

Table 2. Strategic plan of the placement of the new product on the market

According to a made strategic plan for the placement of the new product on the market, the next step is the price forming for the new product (table 3.). The decision about forming of the prices has been made easier insofar as the competitor's prices are known, but special attention should be added to the fact that each market, regardless of the goods that is sold there, knows the escalation of the prices, transfer prices, dumping prices and the black market.

Rb	NAZIV PROIZVODA	PAK.	PROIZVOĐAČI (TVORNIČKE CIJENE) Kn/kom					
	TEMELJI		BELINKA	BIFIX	JUB	SITOLOR	HELIOS	COLOR
1.	AQUA EMAJL TEMELJ ZA DRVO	0,50L	28,76					
2.	EMAJL PRIMER ZA DRVO	0,75L			31,90			
	METAL PRIMER	0,75L			37,90			
3.	DURALIN AQUA	0,75L				28,35		
		2,5L				85,75		
4.	TESSAROL AKRIL (bijeli, crni)	0,75L					46,61	
	TESSAROL AKRIL (boje)	0,75L					74,59	
5.	COLOMIN AQUA temelj metal	0,75L						44,00
6.	COLOMIN AQUA temelj drvo	0,75L						37,10

Table 3. Compared prices of the competitive products

Product prices are guided according to the prices and quality of the competitive products, but with the awareness that this is a new product that yet has to be accepted on the market.

c. Promotion

In order to completely organize the promotion of the new product, a plan for the promotion needs to be made.

The plan consists of:

- Idea for the arrangement of the new product
- Advertising material
- Presentation
- Radio-campaign
- Billboard campaign
- Survey

d. Distribution organization

Quality organized distribution channels make possible for the company to decrease overall costs, to boost competitiveness of the assortment and to qualitatively and quantitatively approach a much larger market, which is in the terms of a strong competitiveness very significant. It is of great importance for the company that the product be made available to the customers as soon as possible, which is achieved by choosing the right distribution channels (picture 1 and 2), which will ensure that the product is available, visible to the customers, i.e. in the right time, on the right place, with minimal costs, and the customer's satisfaction.

Fig. 2. Goods movement through the direct distribution channels

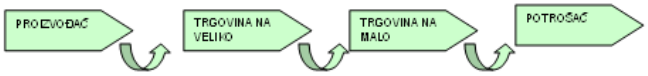

Fig. 3. Goods movement through the indirect distribution channels

The core presumption for the decrease of the distribution costs is to realize an optimal number of arbiters in the exchange, and namely those arbiters who will do the arbitrary activities as efficient as possible and with lower costs with regard to other arbiters.

5. Conclusion

Today appears a much larger number of products that are adjusted to the requirements of the over populous and over demanding market. But, with the exception of that, we are facing the fact that the life expectancy of the product is becoming shorter, and the need for new kinds and varieties of the product is increasing. As a reaction to that, the production companies must invest into the development and marketing of the new products and in the shortest possible time offer the market what it needs. As consumers are those who dictate the market demands, the companies must be constantly present on the market and move along with their competitors or better to say, go a few steps ahead of them.

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Vibrational diagnostic of steam turbine blade breakage

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Abstract

Failures of turbine blades are identified as the leading causes of unplanned outages for steam turbine. For the safety and economic reasons it is very important to detect the blade failure in its early phase. Namely, turbine operation with rotor blade failure can lead to catastrophic turbine damage and also can cause serious injury or death to anyone unfortunate enough to be standing near the turbine at the moment of failure. Obviously, blade failure detection is a very serious matter, and machines that are suspected of having a blade failure must be treated with the utmost respect. This article presents a case history of diagnosis of steam turbine rotor blade breakage using continuously collected vibration data.

Keywords: Vibrational diagnostic, Steam turbine, Blade breakage, Machinery management system, Maintenance

1. Introduction

It is well known that catastrophic failure of a vital machine, large or small, can cause serious injury or death, result in the total loss of the machine, shut down the plant for an extended period, and be a public relations nightmare. For these reasons, it is not acceptable to wait until a machine fails before fixing a problem; the maintenance engineer must take a proactive stance. Namely, the maintenance engineer should have the sufficient knowledge to detect machine problems before they caused economic losses associated with decreased plant efficiency, unplanned downtime, damage, or serious loss of production. [1]

Failures of turbine rotor blades are identified as the leading causes of unplanned outages for steam turbine. For the safety and economic reasons it is very important to detect the blade failure in its early phase. Vibration monitoring system as a part of condition-based maintenance programs assists in achieving this aim.

There are only a few articles which document the diagnosis of turbine rotor blade breakage based on vibration data. [2], [3], [4] All of them describe diagnosis of this malfunction as a noted step change of amplitude and phase rotor unbalance vector. The unbalance is the most common rotor system malfunction. It is treated in all books which cover fundamentals of rotor-dynamics. [5], [6]

This case history presents an example of diagnosis of steam turbine rotor blade breakage analyzing continuously collected vibration data. The steam turbine drives a process air compressor which is a vital part of ammonia plant in fertilizer company Petrokemija d.d., Kutina, Croatia. This machine train represents such large business risks including economic, safety, government compliance, or production interruption that significant mechanical failures cannot be tolerated. For this reason machines of this train are monitored by Bently Nevada's 3500 series machinery protection system, which provides continuous, on-line monitoring suitable for machinery protection applications. Also there is Bently Nevada's Data Manager 2000 (DM 2000), a computerized machinery management system which continuously collects and stores data from all machinery protection system inputs during transient operation, steady state operation and when protection system alarms. This data

are used to evaluate the machine's condition and diagnosis current machine malfunction.

2. Analysis of collected vibration data

2.1. Machine train diagram

Summarized in Figure 1, the train consists of the steam turbine as a prime mover, driving low-pressure (LP) compressor. This compressor is coupled to a speed-increasing gearbox to drive a high-pressure (HP) compressor. Machinery shafts are coupled by gear couplings. All journal bearings of the machine train are equipped with XY proximity probes for measurements of relative shaft vibrations. Keyphasor transducers are installed on both the high and low speed rotors, to provide phase locked speed and phase references. The train is monitored via Bently Nevada 3500 series machinery protection system. This protection system transmits the data to Bently Nevada Data Manager 2000 software which provides continuous machinery condition monitoring and diagnostic capabilities.

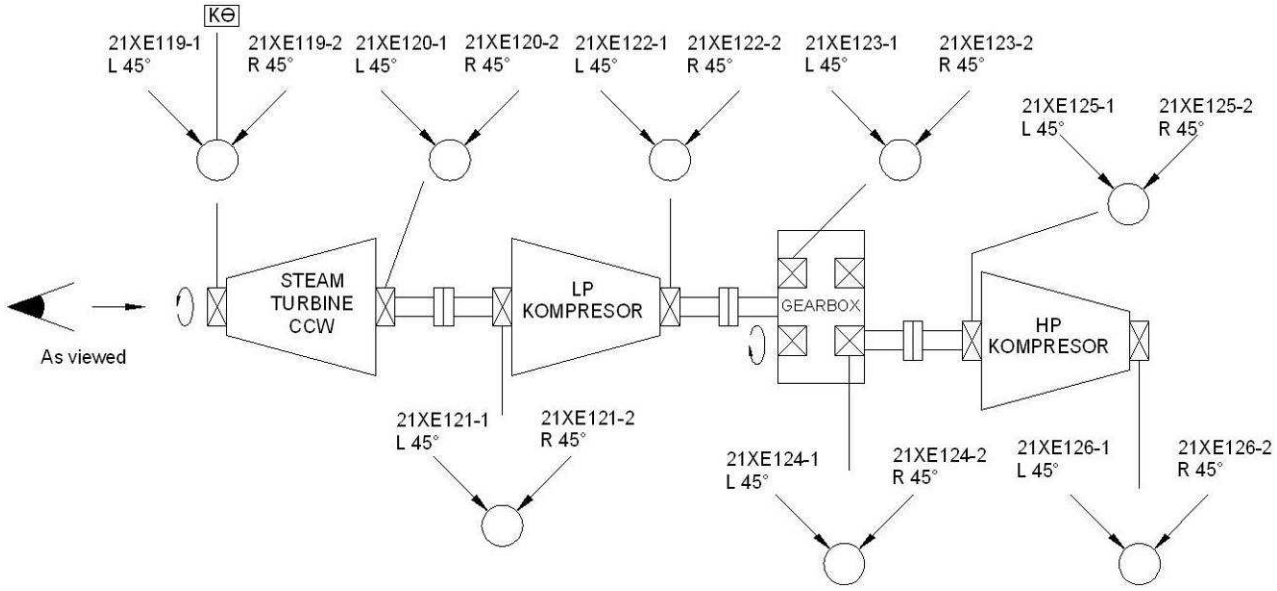

Fig. 1. Machine train diagram

2.2. Steam turbine technical data

The turbine cross-sectional drawing can be seen on Figure 2.

This turbine is a typical design of a single-cylinder condensing turbine for industrial application. It has 7 steam expansion impulse stages. Each stage is a combination of a stationary nozzle cascade with nozzles fastened in nozzle chest or diaphragms and a moving blade cascade mounted on the next rotor disc. The first stage is usually called the governing (the control) stage. The turbine rotor is a flexible type (the 1st critical speed is below nominal running speed). It contains 7 discs which are forged integral with the rotor shaft (there are not any shrink fit disk). The turbine moving blades are mounted in the grooves of the relevant rotor disk. These blades are tied at the ends into packs by means of strip banding (shroud). The turbine stator has a casing with conventional horizontal flanged joint and additionally one vertical joint which divide it into the front portion and exhaust end. The front end of the casing is cast while the exhaust end is of welded design. The turbine stator has inside the housings of end sealing glands, diaphragms and their sealing glands. All sealing glands are the labyrinth type. The housings of turbine bearings also belong to stationary parts of the turbine. The front housing contains the journal and thrust bearing and rear one, only the journal bearing. Type of both journal bearings is tilting pads. Also the thrust bearing is tilting pads type. The rear-end bearing housing of the turbine carries the shaft-turning gear intended for slow turning of the rotor at start up and shut down of the turbine. The turbine has automatic governing system which contains four valves for controlling steam admission to

the turbine, a distributing valve lever driven by a rack from a piston-type servomotor and the Woodward speed governor. The turbine has also the steam quick stop valve for cutting of steam admission to the turbine by the command of any turbine protection device (for instance overspeed protection).

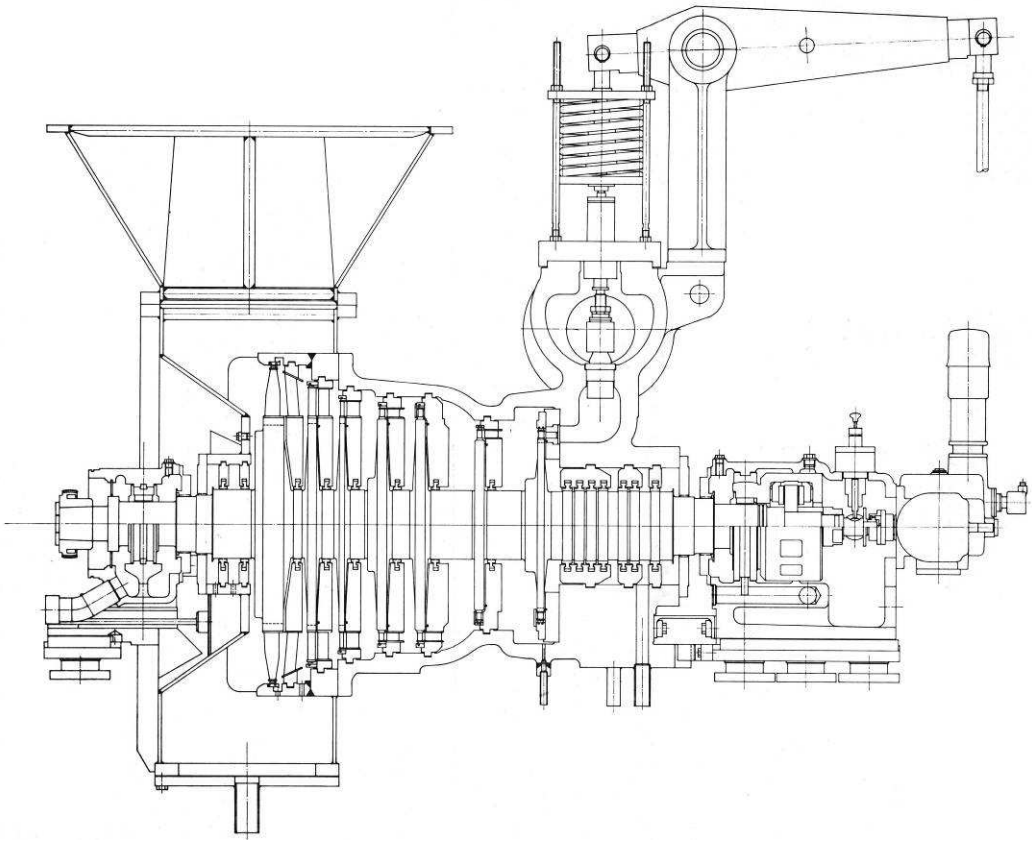

Fig. 2. Turbine cross-sectional drawing

The main technical data of the steam turbine are showed in Table 1:

Table 1. Technical data [7]

No.	Name	Data
1.	Type	Axial, impulse, condensing turbine
2.	Rotation direction	CCW
3.	Number of stages	7
4.	The 1st critical speed	3300 rpm
5.	The 2nd critical speed	9750 rpm
6.	Inlet steam condition	
	- Pressure	39,7 bar abs
	- Temperature	395 °C
	- Flow	46,12 t/h
7.	Exhaust steam pressure	0,14 bar abs
8.	Outlet power	9895 kW
9.	Operating speed range	
	- Nominal	6190 rpm
	- Maximum	6500 rpm
	- Minimum	5260 rpm
10.	Rotor	Integral disk type
11.	Type of journal bearings	Tilting pads
12.	Type of thrust bearing	Tilting pads

2.3. Short chronology of vibration incident

Until 16 July 2009 the turbine was running rather smoothly with pretty low shaft vibration levels on both journal bearings of the turbine (about 15 μm pp). On 16 July 2009 about 8 o'clock am the turbine was suddenly tripped due to some process reason. While the rotor running speed was gradually decreasing the turbine operator was trying to return the turbine in normal operation in order to continue the production process. The rotor running speed had dropped at 1120 rpm. At that time the operator realized necessary conditions to speed up the turbine rotor. When the rotor speed reached 6335 rpm the vibration level on the exhaust end of the turbine sharply increased on approximately 100 μm pp. It can be seen on Figure 3. Also in the same moment the vibration level on the front end of the turbine increased on approximately 40 μm pp. DM 2000 automatically collected the data during these events. In order to identify source of vibration problem an analysis of the collected data was done.

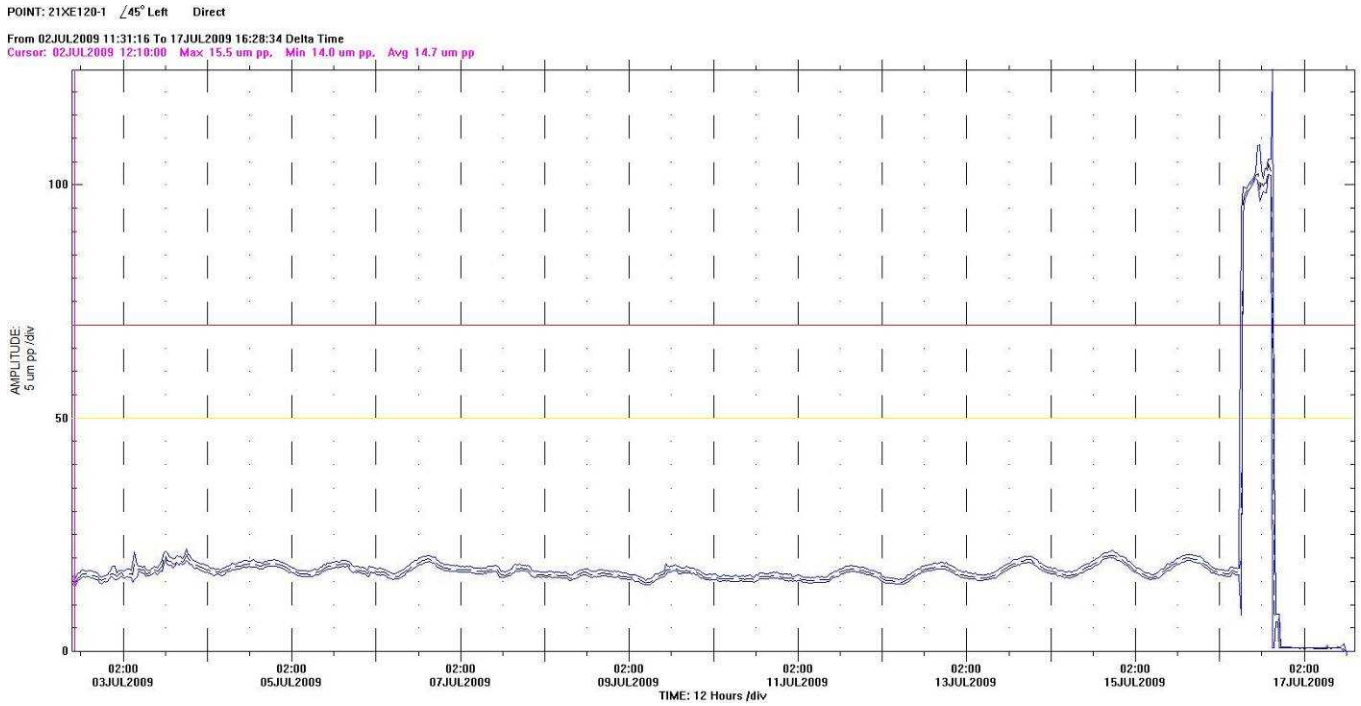

Fig. 3. Vibration trend plot

2.4. Data analysis

First, vibration data collected before the increased vibration level was reviewed. As it was already explained the overall shaft vibration levels on both journal bearings of the turbine were pretty low and within allowed tolerance (the 1st alarm of vibration level was 50 μm pp). Using a full spectrum plots (Figure 4) the predominant frequency component was synchronous with rotor running speed (1X). Also its level was very low (below 10 μm pp).

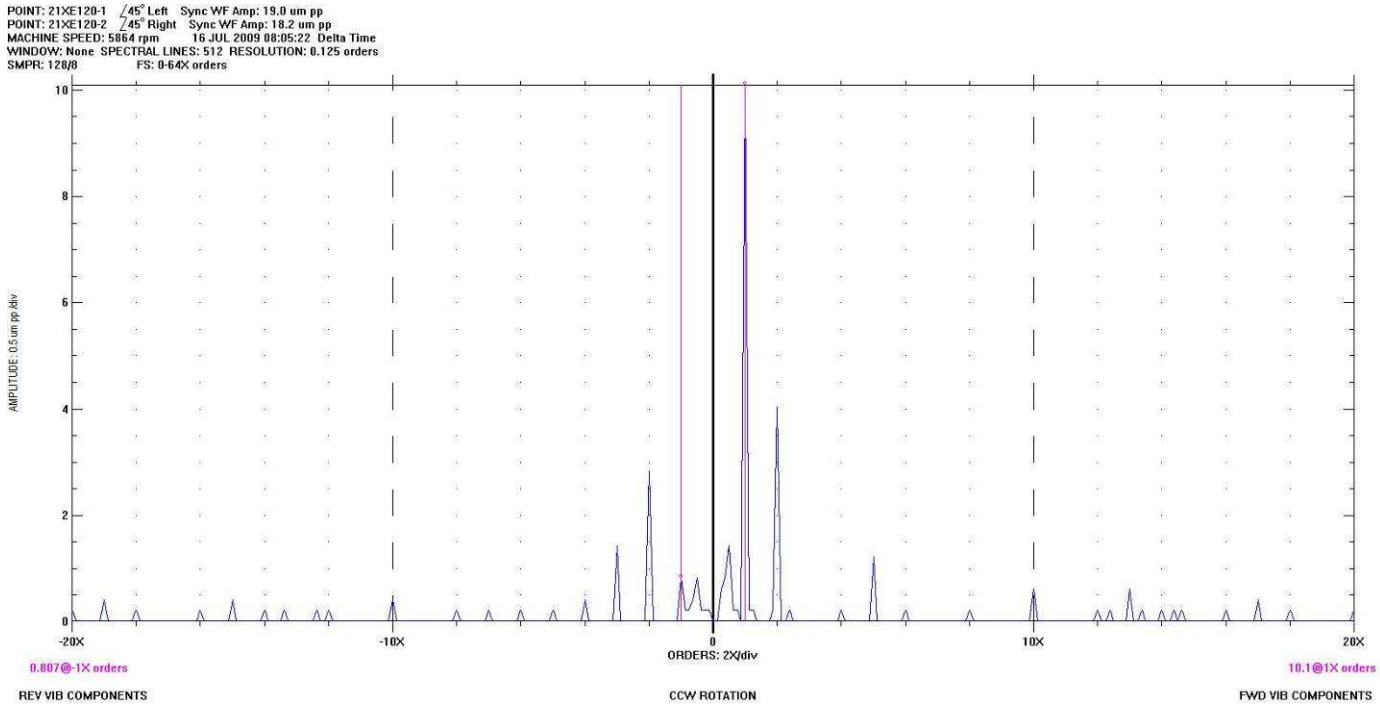

Fig. 4. Full spectrum plot

Bode plots for turbine shut down and restarts up were then analyzed. These plots for speed range from 1120 rpm to 5864 rpm did not show any significant difference between turbine shut down and start up dynamic behavior (Figure 5). However, Bode plots for speed range from 5666 rpm to 6635 rpm (Figure 6) showed that vibration amplitude of 1X component on the exhaust end of the turbine had suddenly increased above 80 μm pp. Also the vibration amplitude of 1X component on the front end of the turbine had increased above 40 μm pp. A phase angle of each 1X component had slightly changed. By analyzing the full spectrum plots (Figure 7) it was confirmed that 1X component was still dominant (its amplitude was very high). Acceptance region plots (Figure 8) also showed significant increase the amplitude of 1X component with a slight change of its phase.

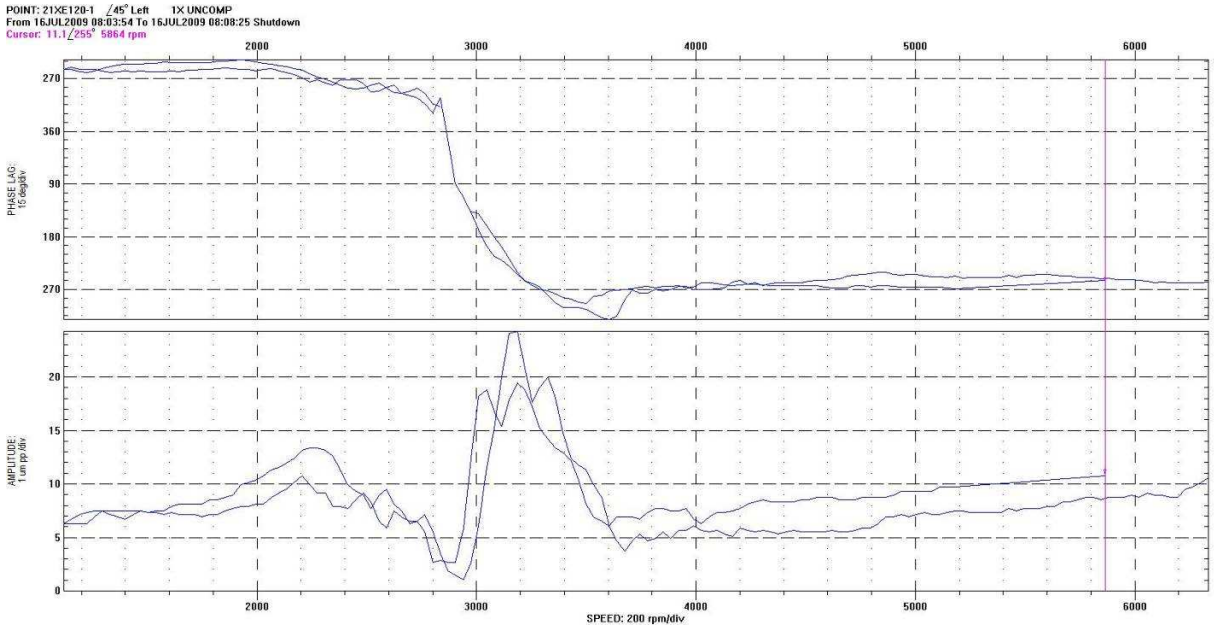

Fig. 5. Bode plot – turbine shut down and starts up

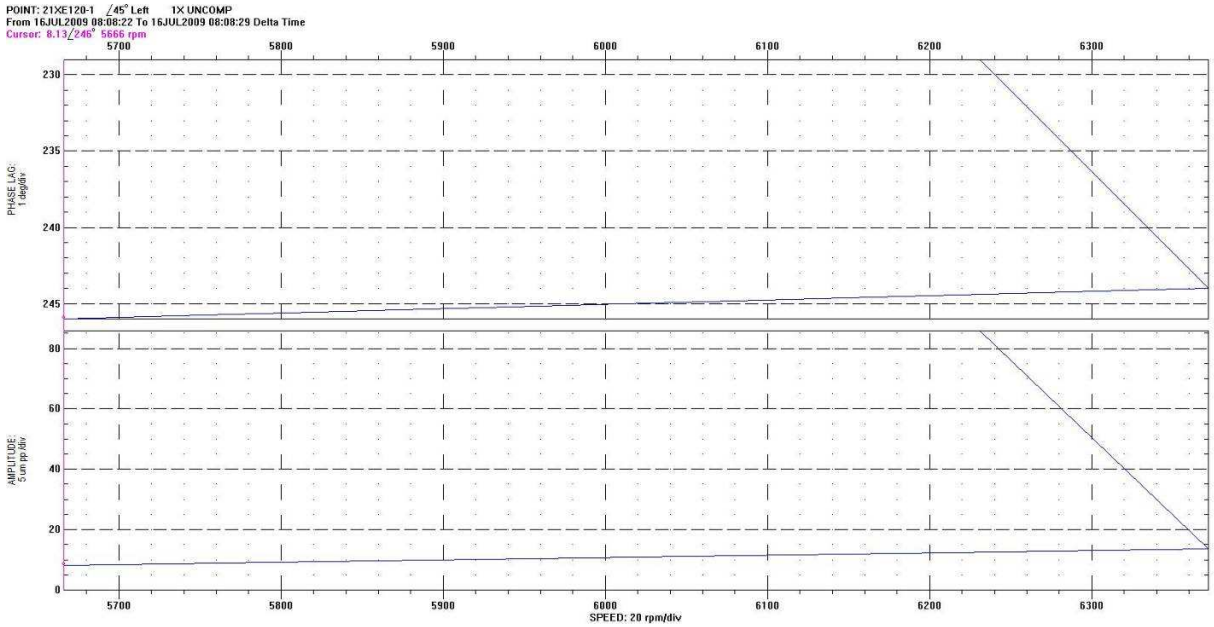

Fig. 6. Bode plot – turbine start up

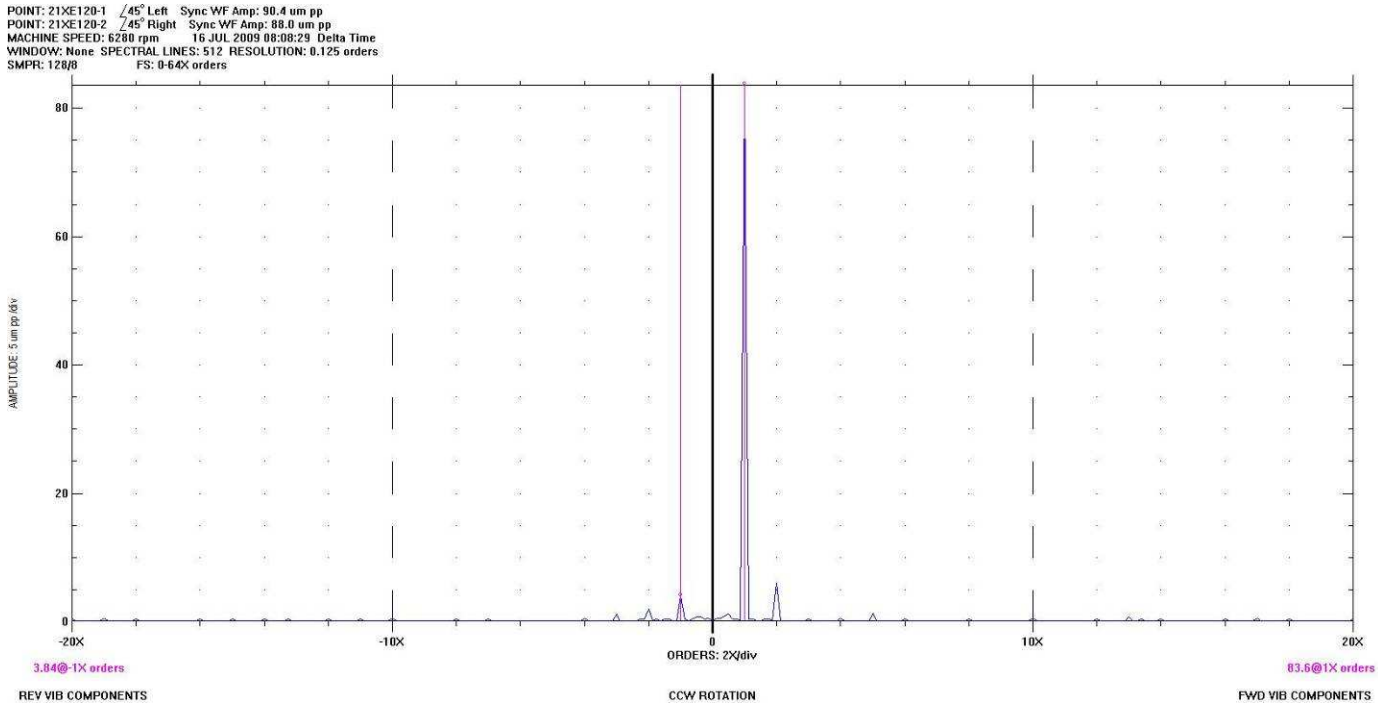

Fig 7. Full spectrum plot

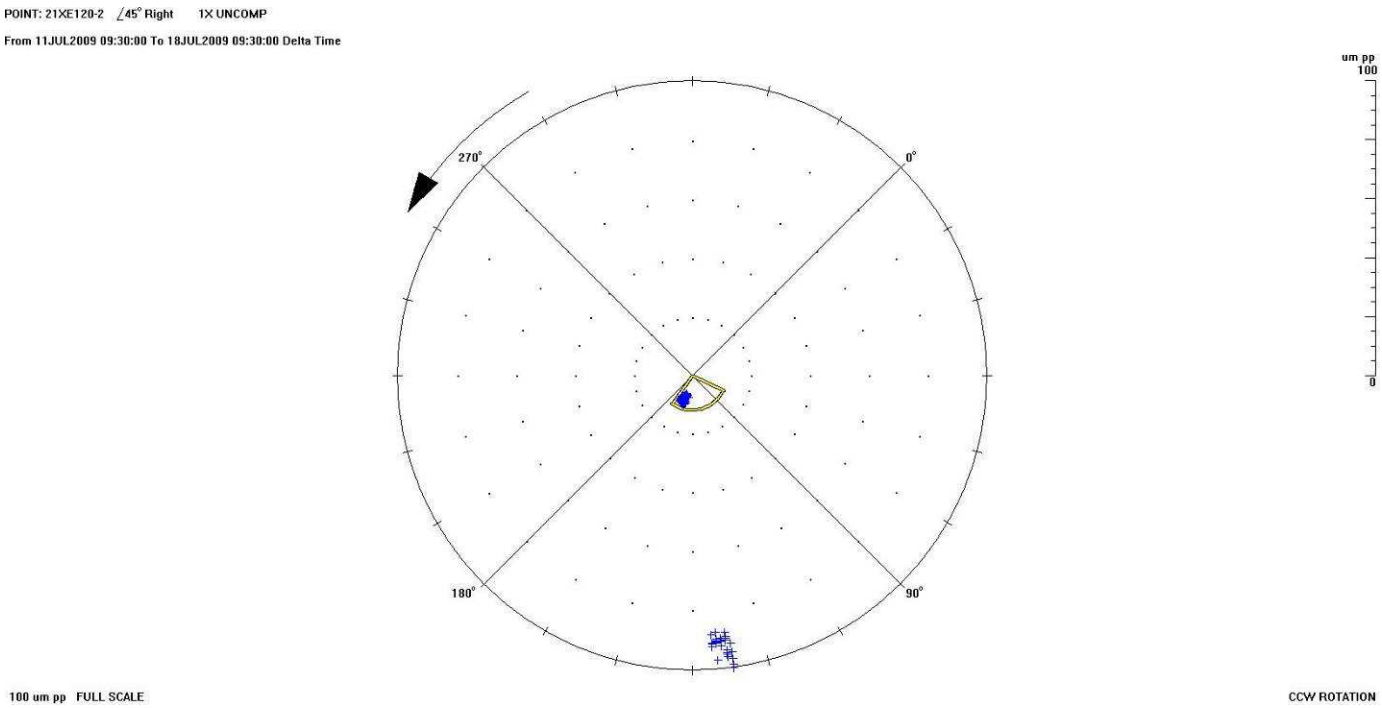

Fig. 8. Acceptance region plot

According to the vibration theory 1X vibration component is primary symptom of rotor unbalance, which is the most common rotor system malfunction. However, there are many other malfunctions that

produce 1X vibration. Thus, to properly diagnose above described problem, it was important to understand both the mechanism that produced unbalance and the other malfunctions that produced 1X vibration.

It is well known that vibration is the ratio of the acting force to the dynamic stiffness of the rotor system [1]:

$$Vibration = \frac{Force}{DinamicStiffness} \quad (1)$$

Thus, a change in vibration indicates that either the force has changed, the dynamic stiffness has changed, or both. The force in rotor systems is most often rotating unbalance, which can change due to erosion or loss of material or accumulation of foreign material on rotating parts. However, most often, a change in vibration is caused by a change in dynamic stiffness of rotor/bearing system.

According to the above performed analysis it was suspected that amplitude rapid change had been caused by sudden loss of rotor blade and/or shroud band.

By analyzing, all other possible causes of increased rotor vibration were excluded.

Measured mechanical and electrical run out of the proximity probe tracking surfaces was acceptably low (about 6 μm pp). Its primary characteristic is that it is constant in amplitude for all running speed range. Unbalance force, though, is proportional to the square of rotor speed, and it does not produce any detectable dynamic 1X rotor response at slow roll speed. Based on this explanation and above analysis it was concluded that run out was not cause of the vibration problem.

A rotor that is bent, or bowed, produces 1X vibration, but unlike unbalance, it produces a high 1X response at slow roll speed. Since the slow roll vector was very low the rotor bow as possible cause of high vibration level was excluded.

Problem of the gear coupling between the turbine and LP compressor shafts can cause 1X vibration too. Lock up of a gear coupling or breaking of a few connection coupling bolts causes a sudden change in 1X vibration. However, this change usually is not so big as in a case of sudden loss of rotor blade and/or shroud. Based on this experience the gear coupling problem was also excluded.

Shaft cracks usually cause changes in 1X amplitude or phase over time. In the first weeks to months of cracks propagation, the 1X response usually changes slowly. In our case it was not noted any slow changes of 1X amplitude or phase over time. Actually, 1X amplitude and phase before sudden vibration level change were more or less stable. It means the shaft crack problem did not cause the rapid change of 1X vibration.

If a part shifts position on the rotor, the unbalance distribution and resulting 1X vibration response of the rotor will change. Since the rotor was integral disk type there was not any possibility that loose part had caused sudden increase of 1X vibration.

Rotor rub produces changes in both the forces and the dynamic stiffness of the rotor system. Because rub involves rotor interaction with a hard constraint, rub also introduces nonlinearities in the rotor system. The result of these effects is a complex rotor dynamic response that produces a wide variety of symptoms. However, the rub is always a secondary effect that is caused by some other malfunction that reduces the available clearance in the rotor system. The reduced clearance can be caused by rotor deflection toward the stator, by out-of-position stationary parts, or by high vibration. Based on the vibration data it was suspected that rotor unbalance was a primary effect caused by sudden loss of rotor blade and/or shroud band. Since vibration amplitude was very high (above 100 μm pp) the rub as a secondary effect had appeared very likely. However, it could not be confirmed by collected vibration data.

The most obvious conclusion based on above analysis was a sudden change in the amount and location of imbalance had been caused by loss rotor blade and/or shroud band. Since the turbine operation with rotor blade failure could lead to catastrophic damage it was decided to put turbine out of operation. The turbine was shut down. By analyzing Bode plots (Figure 9) for turbine shut down it was noted very high resonant vibration peak (above 200 μm pp). This was yet evidence that the rotor balance had changed.

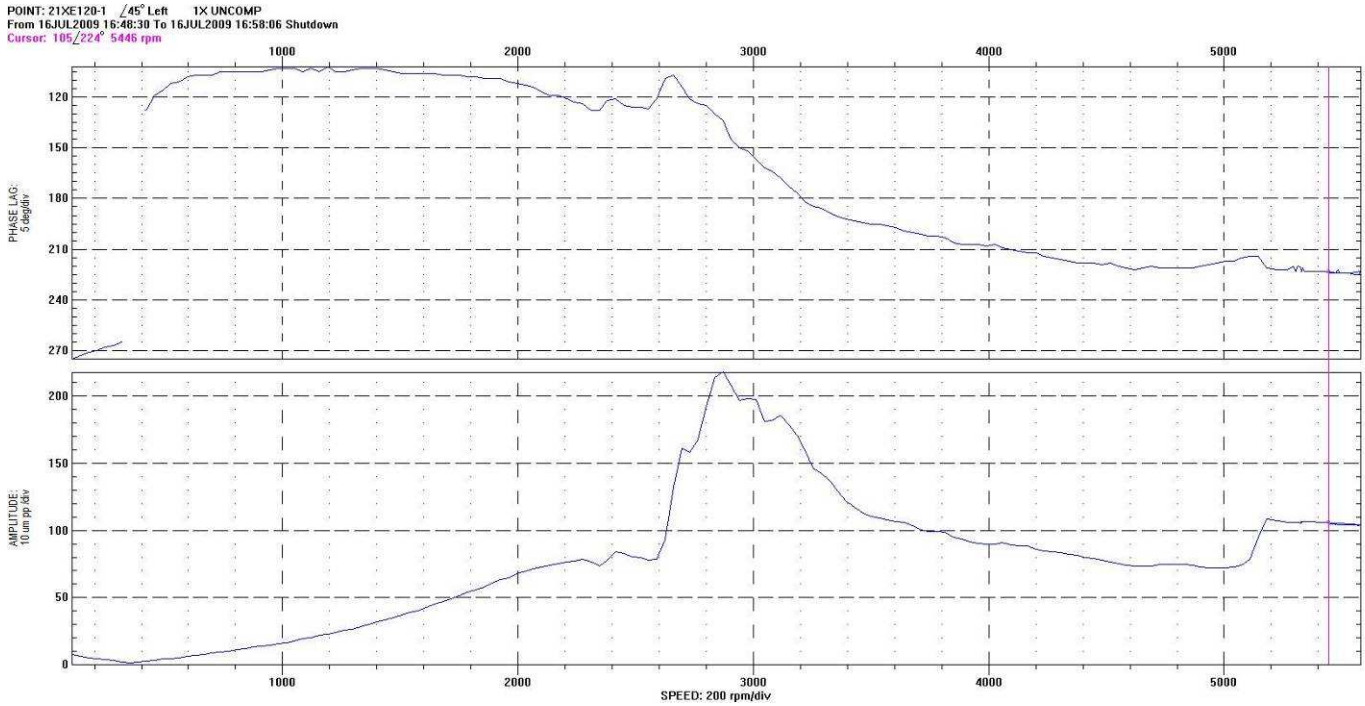

Fig. 9. Bode plot – turbine shut down

3. Fact-finding and turbine repair

The turbine had to be repaired quickly, in a single shutdown. On-site engineers planned for a fast turnaround. They prepared the tools, material and manpower they would need according to the analysis of the problem. When the turbine was shut down, the maintenance crew was ready to perform the repair. The turbine casing was opened in next two days. The visual inspection confirmed that two blades with related part of shroud band on the 5th rotor wheel were missing (Figure 10). Also it was found signs that the rotor had rubbed against the diaphragm band.

Fig. 10. Blade breakage

The rotor was replaced with spare one. The unit was placed back in operation on 27 July 2009, after the repairs were completed. Vibration levels were and still are pretty low and acceptable. Current vibration levels are about 15 μm pp.

4. Conclusions

In this case history a diagnostic process of steam turbine rotor blade breakage detection was presented. Based on sharp and rapid change of 1X vibration amplitude and phase on both turbine ends the following hypothesis was formed: this change had been caused by sudden loss of rotor blade and/or shroud band. Then this hypothesis was supported by vibration data which were showed on suitable plots. Also the other possible causes of 1X vibration were excluded by analysis of vibration data and their known symptoms. Finally, the hypothesis was verified by visual inspection of the turbine rotor.

Diagnostic of the real cause of the sudden increase in vibration helped to avoid a possible catastrophic failure and significant loss of production. Also the diagnostic allowed the problem to be precisely identified so that the repair could be well organized. On this way the turbine was repaired in the shortest possible time and it was placed back in operation without vibration problems.

The most often a rotor blade fracture starts with a small fatigue crack. Under operating loads this crack slowly grow until the remaining, reduced cross section of the blade is unable to withstand the static and dynamic loads that are applied to it. When this happens, the blade will fail in a fast brittle fracture mode.

Blade bending stiffness is related to the blade cross-section area. As a crack propagates across the blade, the remaining cross section becomes smaller and bending stiffness of the blade decreases. Natural frequencies of the blade are affected by changes in blade stiffness. This fact can be used for early diagnostic of initial blade failure caused by fatigue. Thus further work regarding this issue can be development of suitable on-line monitoring system for early diagnostic of blade failure based on above described fact.

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Modeling and conceptual designing solution of friction coupling

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Abstract

In this paper has been shown to generate parameter model of a friction plate coupling on the basis of selection type coupling with all the characteristic of the designing details and calculation. It is made a parametric model of a friction plate coupling those changes by entering the type of coupling. Based on the entered data to generate a calculation finished friction plate coupling. *Based on [1] that describe each type of coupling and provides an example of the calculation with the corresponding tables, in the paper was made parametric model of friction coupling*. The calculation is made in Excel and the parameter associated with the CAD system based on parametric modeling features. Generating the appropriate value type friction coupling in Excel, CAD system parameter adjusts the model generated the type of coupling. It is also designed to connect Excel with Word so that the results of the calculation are automatically changed by changing the type of coupling in Excel.

Keywords: Theory design, modeling, conceptual design, friction coupling

1. Introduction

The two group's overviews are significant for the conception stage: overview function and overview form [2]. In the structural process, products can be presented as a complex technical system [3]. Each product, as a technical system, has its own function. Function makes the link between the application and forms, achieving view on the abstract level. In order to achieve uniformity function, product features can be described by the parameters [4, 5]. Parameters are the basic physical quantities, derived in physical sizes, geometric sizes and physical constants. Geometrical sizes are generated by CAD systems based on parametric modeling features. Using CAD parametric modeling system based on features generated by physical product structure that consists of computer models put in their geometric and dimensional relationships. Physical structure of the preceding a functional product structure. Linkages between functions and forms can be generated using the matrix method, such as morphological matrix [6] or matrix product features and their application [4, 5]. *The connection between function and form in the matrix of product features and their requirements is defined by the mathematical model and using the parameters of which describes the function.* Features that are generated by CAD systems, using mathematical relations and ratios, it is possible to connect to each other and describe the parameters in such a way to get parameterized model that allows, using variant construction, getting a new but similar structural solutions where the primary function does not change.

2. Theoretical basis of the science of designing

The task of design process is to create an optimal product in proposed circumstances in the shortest possible time and with the lower costs [7]. Where the role of the constructor is to implement the adopted knowledge in solving technical problems and optimizes the solution given in the limitations of materials, technology and economics. Design is the intellectual effort to satisfy certain requirements in the best possible way. This is the engineering activities that affects on almost every sphere of human life, based on the discoveries and the laws of science and create conditions for the application of these laws on the production of useful products [8]. Many authors describe the process of designing in different ways and from different aspects. Here are specified all the features of the process of designing and constructor's work by Hubka [9]:

- Designing process is primarily a process of processing and generating information, where is based on the input request generates a set of information which are describing the product.

- Designing process is a synthesis of relatively well-known elements into a single unique, previously unknown entity with demanding certain properties. This synthesis requires a creative work. From this follows an important feature of the designing process - a man must control the process or have a dominant share in the performance of necessary actions.
- The process of constructing from a philosophical view is also a cognitive process: the system initially is unknown – is realizing, respectively becomes known. On this basis we can say that the theory of knowledge is also one source of general laws for the process of designing.
- Designing can be seen as a learning process. Each designing task can be solved in many different ways, and may result with different mechanical systems or circuits. That characteristic variety of possible solutions depends on the amount of product properties which should be determined in the process of designing.
- Any designing process can be decomposed into smaller units (stages, phases of the process, operations) that make up the structure of the process.
- High complexity of a mutually contradictory requirements lead to the need for a multiple repetition of a certain stages after the initial abstractions and setting of assumptions while you do not specify the required values. Iterative process is one of the typical designing features.
- Up to now, mostly self-employed (within the task), increasingly is turning to team work in which are using the advantages of a large information capacity and the mutual exchange of ideas and procedures.
- Designing process is a very demanding creative work, but should not be seen as art, but as a scientific paper. The specific thought processes (intuition, development of ideas) that cannot be rationally explained have the characteristics of artistic creativity. These procedures cannot be formalized in order to create a comprehensive theoretical view of design process.

Each product as a technical system can be represented as hierarchically structured set of functions [7, 8]. Total function of some product as well as designing solutions of a technical system can be represented through a partial derivative (auxiliary) function within the overall designing task. Furthermore, partial functions can be separated on the partial sub functions and so on, depending on the degree of complexity of the product. Overall function, structure of the product we can display as hierarchical (Figure 1.).

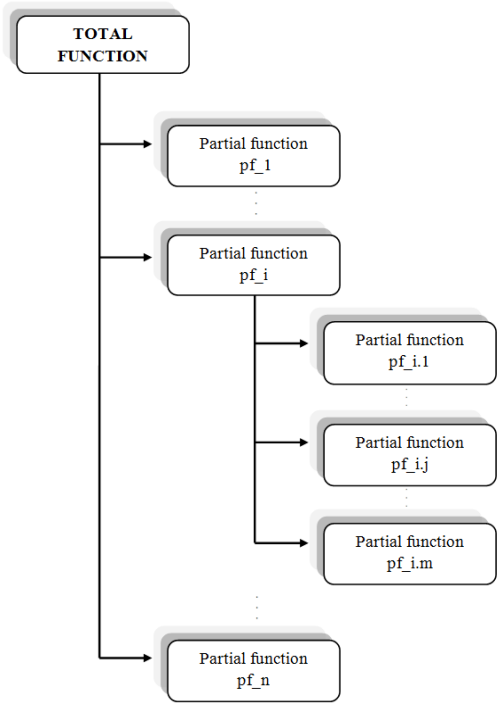


Figure 1. Hierarchical overview structure of a totally function of the product

2.1. Variant design

The basic characteristic of variant structures is that the basic functions and structure of products are defined and they do not change, but it is possible to change the principles of individual partial functions [8]. The term variant design often includes technique of an adaptation of existing construction solutions in order to satisfy the new requirements and constraints [10]. In this way it can be got new, but similar construction solutions. However, there remains the problem of finding similar designing solutions in order to create a new variants of the solutions.

Mechanisms of finding similar solutions come in a wide range of complexity from manual searching to automatic identification. Modern commercial CAD systems use two techniques that are important for structural modeling of variant solutions: modeling features and parametric modeling. Modeling features is the technique that allows the user modeling by combining features that can be understood as part of the building part of a definition product or geometric understanding of the product (such as holes, slots, ribs, etc.) [11]. In addition to the predefined characteristics, many systems allow users to define their own features.

There are two basic ways of getting variant/parametric design [11]:

- generating new construction and modification of existing (similar) structure
- placing the values of all parameters that are input data to a procedure that creates a geometric model

2.2. Modeling features

Modeling with features (Figure 2.) is a modeling technique that allows the integration of geometric modeling and construction [12].

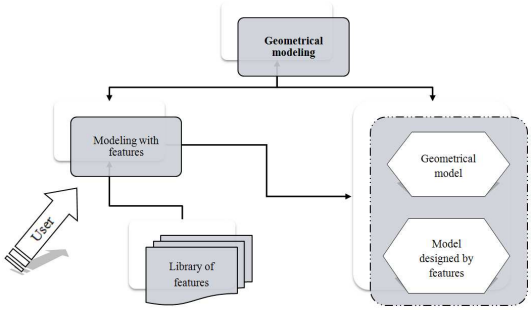


Figure 2. Modeling with features

One of the characteristics of this technique of modeling is the data enrichment that is related to semantic information display products. Additional semantic information delivers advanced communications in the process of designing [13]. One of the primary motivations for the use of the features was arisen from issues related to planning and modeling processes of production (CAPP) using CAD system.

3. Theoretical basis of friction coupling

Couplings are used to continuously or periodically connect two shafts for transmitting torque torsion. Apart from transmitting a torque, certain types of couplings can have additional function [9]:

- adjustment of the axis deviations of shaft incurred by inaccurate production, incorrect installation or under the influence of load,,
- torsional vibration damping,
- reducing the oscillation and torsion torque at startup and strike work,
- controlled or automatically establishing or interrupting transmission of torque torsion,
- provision of overload or unwanted direction of rotation and more.

In the application there are different types of couplings, from the simplest rigid couplings to most complicated friction and hydrodynamic couplings. Couplings can be divided by function into:

1. Rigid couplings
2. Compensation coupling
3. Elastic couplings
4. Diesengeable coupling

Furthermore, the friction coupling can be divided into:

1. Conical friction coupling
2. Plate friction coupling
3. Radial friction coupling
4. Friction plate coupling

a) Friction coupling with one plate
b) Friction coupling with multiple plates

4. Elaboration of structural models of friction coupling showing typical details

During development of a model of friction coupling, we used substrate for exercise "Plate coupling'' [1]. Inclusion of a friction plate coupling generally boils there to be connect the secondary side (driven machine with angular velocity) with the primary side of the coupling (the engine angular velocity). Coupling must with sliding overcome angular velocity difference, that is:

$$\omega_1 - \omega_2 = \Delta\omega = \omega_k \tag{1}$$

(Angular velocity at the beginning of inclusion). Due to the sliding friction torque M_{tk} the secondary side of the coupling accelerates, so that $\Delta\omega$ becomes smaller, and finally becomes to zero. To point t_2 coupling is sliding. Time t_2-t_1 is time of sliding t_k. When coupling is set (ω_1=ω_2) it is possible to transfer friction torque M_t. Friction sliding torque M_{tk} is calculated by the expression:

$$M_{tk} = M_{tn} + M_{tu} \tag{2}$$

At the moment of inertia mass $\mathfrak{I}_2$ of secondary side reduced to shaft coupling, followed the driven momentum of acceleration mass by expression:

$$M_{tu} = \mathfrak{I}_2 \cdot \frac{d\omega_2}{dt} \approx \mathfrak{I}_2 \cdot \frac{\Delta\omega_2}{dt} \approx \mathfrak{I}_2 \cdot \frac{\omega_k}{t_k} \ , \tag{3}$$

and time of sliding

$$t_k = \frac{\left(m \cdot D^2\right)_2 \cdot \omega_k}{4 \cdot M_{tu}} = \frac{GD^2 \cdot \pi \cdot n_k}{2 \cdot g \cdot M_{tu}} \ . \tag{4}$$

4.1. Selection of measuring friction clutch

Survey couplings are chosen according to Table 1. Based on the calculated torque torsion M_t (the nearest higher value in Table 1.).

Table 1.Guide characteristics of a friction plate coupling [1]

Characteristics of coupling		Type of coupling							
		10	20	30	40	50	60	70	80
Torque torsion M_{t1}, Nm		160	200	320	450	640	900	1400	2300
Approximated mass, kg		6	6,5	8,5	16,5	20,5	24,5	43	65
Measurement of coupling, mm	A = d (H7)	30	30	35	45	55	55	60	80
	B	72	72	72	102	102	102	120	153
	D	136	136	150	183	199	209	263	317
	J	85	85	85	120	120	120	145	175
	L	105	105	123	155	155	175	205	230
	K	100	100	100	140	140	140	170	205
	M*	70	70	76	103	103	125	148	160
	N*	53	53	58	78	78	94	111	119
	T	32	32	32	50	50	50	55	70
	U	15	15	15	26	26	26	26	30
	Hod	12	12	16	20	20	25	30	35
* It depends on the number of plates and is needed to determine with construction									

Torque torsion is:

$$M_t = M_{tk} = M_{tn} + M_{tu} = 269.4 \text{ Nm} \quad (5)$$

Angular speed is:

$$\omega = \omega_1 = \frac{\pi \cdot n}{30} = 110 \text{ rad/s} \quad (6)$$

Momentum of acceleration mass of secondary side is:

$$M_{tu} = \frac{GD^2}{4 \cdot g} \cdot \frac{\omega}{t_u} = 144.4 \text{ Nm} \quad (7)$$

On Figure 3. guide characteristics of a friction plate coupling are presented from Table 3.

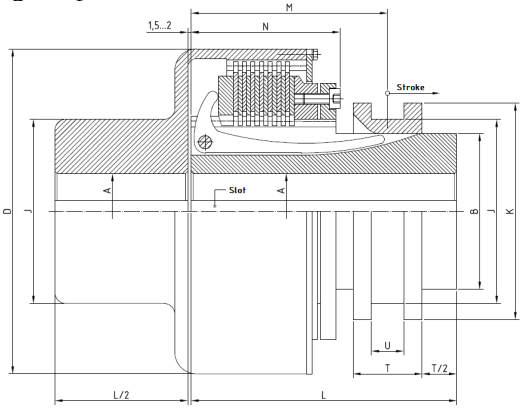


Figure 3. Guide characteristics of friction plate coupling [1]

The nearest value of torque torsion in Table 1. is value M_{t1} = 320 Nm and the value of the coupling type corresponds 30.

4.2. The required number of plates coupling

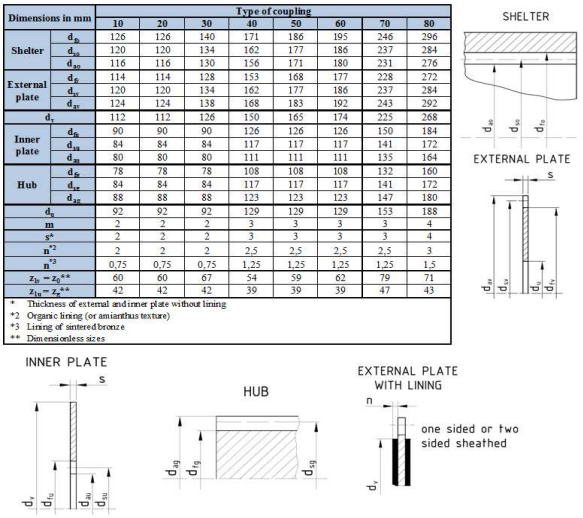
Based on calculated torque torsion M_t and selected coupling it is calculating the required number of plates coupling. The remaining structural parameters of the coupling are determined by Table 2. Torque of friction sliding M_{tk} (respectively torque torsion M_t) is calculated by the following expression:

$$M_t = M_{tk} = \frac{d_k}{2} \cdot F_t \cdot i \quad (8)$$

Table 2. Survey shelter, plates and hub of friction coupling [1]

Dimensions in mm		Type of coupling							
		10	20	30	40	50	60	70	80
Shelter	d_{Bk}	126	126	140	171	186	195	246	296
	d_{Bs}	120	120	134	162	177	186	237	284
	d_{Bo}	116	116	130	156	171	180	231	276
External plate	d_{Ek}	114	114	128	153	168	177	228	272
	d_{Es}	120	120	134	162	177	186	237	284
	d_{Eo}	124	124	138	168	183	192	243	292
d_T		112	112	126	150	165	174	225	268
Inner plate	d_{Ik}	90	90	90	126	126	126	150	184
	d_{Is}	84	84	84	117	117	117	141	172
	d_{Io}	80	80	80	111	111	111	135	164
Hub	d_{Hk}	78	78	78	108	108	108	132	160
	d_{Hs}	84	84	84	117	117	117	141	172
	d_{Ho}	88	88	88	123	123	123	147	180
d_N		92	92	92	129	129	129	153	188
m		2	2	2	3	3	3	3	4
s*		2	2	2	3	3	3	3	4
n*2		2	2	2	2,5	2,5	2,5	2,5	3
n*3		0,75	0,75	0,75	1,25	1,25	1,25	1,25	1,5
$z_N = z_R$**		60	60	67	54	59	62	79	71
$z_{IN} = z_a$**		42	42	42	39	39	39	47	43

* Thickness of external and inner plate without lining
*2 Organic lining (or amianthus texture)
*3 Lining of sintered bronze
** Dimensionless sizes



Brim force (sliding force) F_t depends on the pressure force F_a and a friction factor of common size (Table 3.):

$$F_t = F_a \cdot \mu \cdot i \quad (9)$$

Table 3. Characteristics of the material friction surfaces [1]

Material of friction surfaces	Friction factor of friction surfaces μ		Allowed temperature of friction surfaces ϑ_{dop} in K	Allowed surface pressure p_{dop} in MPa	Specific obsolete q in mm³/(Wh)	
	Work on dry	Work in oil			Work on dry	Work in oil
STEEL/STEEL	0,1 – 0,14	0,06 – 0,11	373	0,50 – 3,0	0,167 – 0,267	0,035
STEEL/SB	0,25 – 0,4	0,08 – 0,16	373	0,30 – 5,5	0,167 – 0,267	0,035
STEEL/AT	0,3 – 0,5	0,1 – 0,20	473	0,05 – 2,0	0,167 – 0,267	0,067

Number of friction plates coupling is:
i = 14 plates.

4.3. Dynamic control of security shaft

Stress shaft on twisting:

$$\tau_t = \frac{M_t}{W_p} = 38 \text{ MPa} \quad (10)$$

Necessary security:

$$s_{post} = s_{din} = 1.843 > s_{potr} = 1. \quad (11)$$

Shaft is good sized.

4.3. Heating surface friction

Frictional work converts into heat during the inclusion of coupling $t_u \approx t_k$, or at an angle to the speed $\omega_2 = 0$ to $\omega_2 = \omega_1$ and it is:

$$W_R = \int_{t_1}^{t_2} M_{tk} \cdot (\omega_1 - \omega_2)\,dt = 17600 \text{ N} \quad (12)$$

From the heat balance $Q_R = P_R$, respectively

$$\alpha_z \cdot A_z \cdot (\vartheta_1 - \vartheta_2) = W_R \cdot z_u \cdot \frac{1}{3600} \quad (13)$$

Follows the temperature at the surface that is in contact with the surrounding air:

$$\vartheta_1 = \frac{W_R \cdot z_u}{\alpha_z \cdot A_z} \cdot \frac{1}{3600} + \vartheta_2 = 360 \leq \vartheta_{dop} = 373 \text{ K} \quad (14)$$

4.4. Durability of plates

$$L = \frac{V}{q \cdot P_R} = 7046 \text{ h} \quad (15)$$

After 7046 hours is necessary to make replacement plates.

5. Modeling and designing of a concept solution of friction coupling

During the modeling is used software Autodesk Inventor that based on parameters was associated with the program from the Office package, Microsoft Excel. Workflow of the modeling friction plate coupling process was developed in several steps:

- in Microsoft Excel was entered a tables with values that describe a particular type of coupling
- then in a Microsoft Excel was created a calculation based on the expresions given in the substrate for the exercise [1]
- After that, in Microsoft Excel was created parameter ratios that describe some part of the couplings
- parameter values from Microsoft Excel are associated with Autodesk Inventor
- Based on these parameters are designed models of friction plate coupling

Based on the above clarified steps it is made a model of friction coupling (coupling type 30). Entering a new data for a particular type of coupling in Microsoft Excel, Autodesk Inventor based on changed data will create a new model that will suit to preferred type of coupling.

5.1. Organizational structure of the model parameters

Parameters are organizationally structured in a set of parameters (Figure 4).

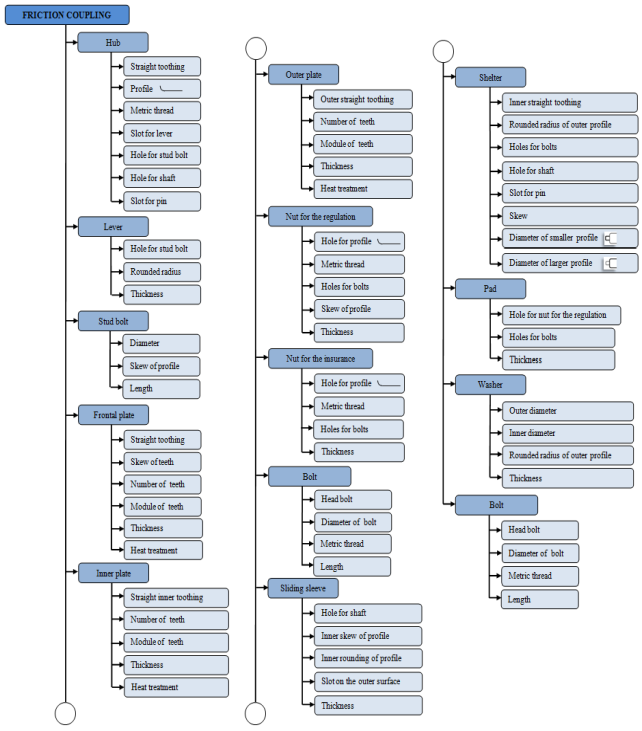


Figure 4. Hierarchical structure of parameters in the process modeling

5.2. Collecting data from the model parameter

Parametric three-dimensional model can be other than geometrical parameters and user defined parameters that include information which are associated with the model (e.g., part number, creation date, etc.). In addition to numeric values (integers and real) user-defined parameters can take a text values. Parameters that was described the pattern within the model can be defined as user parameters. For collecting parameter values within the parameter of three-dimensional model is necessary to have the following information's that are shown in Table 4.

Table 4. Information's needed to collect the values of parameters within the model

Parameter Name	Unit	Equation	Nominal Value	Tol.	Model Value
Model Parameters					
d129	mm	x15	1,000000		1,000000
d126	ul	x	42,000000		42,000000
d123	mm	x01 / 2 ul	44,000000		44,000000
d122	mm	x03 / 2 ul	39,000000		39,000000
d120	mm	x18	1,570000		1,570000
d118	mm	x03	78,000000		78,000000
d117	mm	x02	84,000000		84,000000
d108	mm	x01	88,000000		88,000000
d105	mm	x03	78,000000		78,000000
d97	mm	x9	6,000000		6,000000
d96	mm	x6	6,500000		6,500000
d95	mm	x7	6,000000		6,000000
d90	mm	x4	14,000000		14,000000
d87	mm	x12 / 2 ul	19,100000		19,100000
d86	mm	x13	10,000000		10,000000
d82	mm	x04	35,000000		35,000000
d64	mm	x10	15,000000		15,000000
d63	mm	x5 + 30 mm	185,000000		185,000000
d53	mm	x3	51,000000		51,000000
d50	mm	x01	88,000000		88,000000
d49	mm	x7	6,000000		6,000000
d47	mm	x9	6,000000		6,000000
d45	mm	x8 / 2 ul	12,500000		12,500000
d44	mm	x8	25,000000		25,000000
d43	mm	x10 / 2 ul	7,500000		7,500000
d42	mm	x10	15,000000		15,000000
d41	mm	x03	78,000000		78,000000
d14	mm	x04	35,000000		35,000000
d10	mm	x01 - 2 ul * x07	85,000000		85,000000
d8	mm	x07	1,500000		1,500000
d7	mm	x07	1,500000		1,500000
d6	mm	x2	25,000000		25,000000
d4	mm	x1	56,000000		56,000000
d3	mm	x05	72,000000		72,000000
d1	mm	x06	123,000000		123,000000
d0	mm	x01	88,000000		88,000000
User Parameters					
x	ul	x17 * 10 ul	42,000000		42,000000
D:\FAKULTET\završni...					
x01	mm	88 mm	88,000000		88,000000

Figure 5. shows an example of a parameter model hub. It can be seen that the dimensions of the hub are defined by the geometrical parameters fx: 88, fx 35, fx: 84, fx 25, fx: 72, fx: 6, fx: 7.5, fx: 15, etc. The user data (User Parameters) and parameters of the model (Model Parameters) are in correlation.

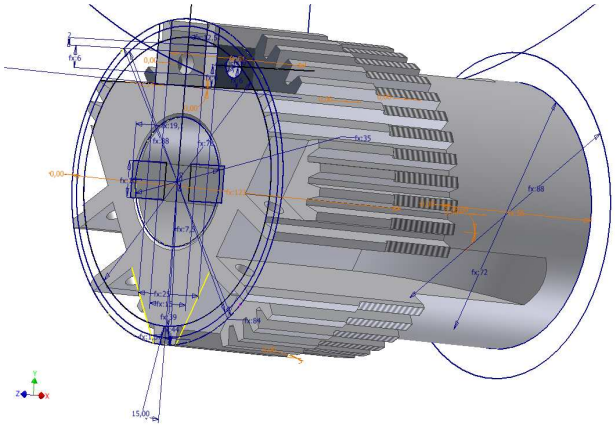
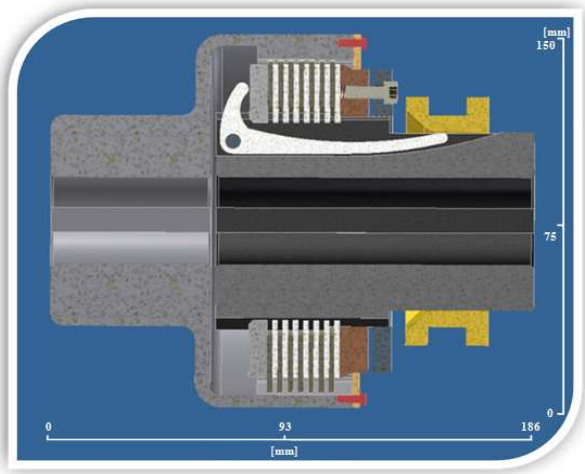


Figure 5. Model of hub

The following images (from 6. to 8.) show the model of the friction coupling assembly. In Figure 6. is shown a cross section of the friction coupling assembly.



Slika 6. Cross section of the friction coupling assembly

In Figure 7. is shown a friction coupling assembly without shelter.

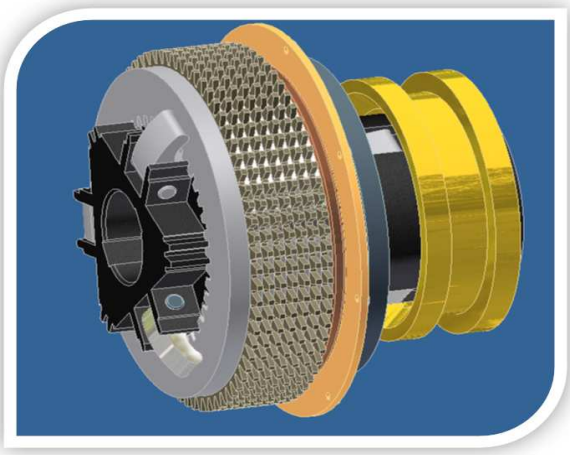


Figure 7. Friction coupling assembly without shelter

In Figure 8. is shown a friction coupling assembly.

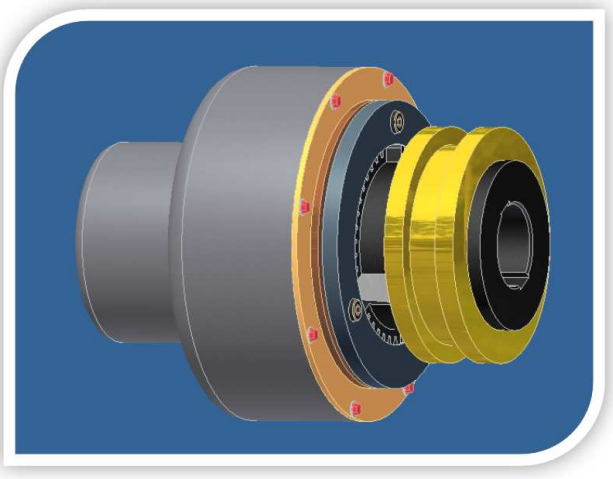


Figure 8. Friction coupling assembly

6. Conclusion

In the virtual model the solutions are implementing as a set of interrelated parameters, with the possibility of change the geometry and without changing of a general solution. This allows generation of a set of structural models according to the principle of similarity in the dimensional and visual sense, and differences in physical features of executive members. Parametric modeling allows constructors to their design ideas make into the construction of models. Geometrical sizes of a product, such as the dimensions may vary at any time during the process of designing and modeling. Parametric modeling works with creating a key form of the model with the help of computer programs. Variables of model that are described by sketches and parameter relations can be used to quickly changing or modification the preferred model. Parametric modeling is used in companies that are dealing with a serial production of similar products, as with the knowledge and skills in the reign of this form of modeling can make a quick re-design of a particular product, its calculation, and complete technical documentation. Parametric modeling significantly shortens the time of production of a particular model.

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Numerical determining of the stress concentration factor around a shaft with a traverse hole

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Abstract

The main objective of this paper is numerical determining of the value of stress concentration factor around a shaft with a hole by the finite elements method, and the comparison of results regarding their accuracy. A shaft with a hole of certain dimensions with a ratio *d/D* has been analysed in this paper. Furthermore, general theory of stress concentration factors has been described, and basic equations have been given. After that, a general description of elements used in the analysis of a shaft with a hole follows, as well as the description of finite elements used in this investigation: Tetrahedral element – SOLID 92 and Hexagonal element - SOLID95. Solutions gained by the finite element method with the program package ANSYS 11 are shown and explained in details, as well as the mesh and applied boundary conditions for each single problem. Finally, we compared solutions gained with the above mentioned types of finite elements on the example of a shaft with a hole for certain ratios *d/D* and values known from the literature given by diagrams.

Key words: shaft with hole, finite element method, stress concentration factor, ANSYS

1. Introduction

Shafts carry static or rotating machine parts, such as belts, wheels, rotors and the like, and these parts constantly rotate and transfer rotating moment. Shafts are usually stressed by bending and torsion (and possibly by pressure, tensile or shear) [1].

Abovementioned machine parts have to be fixed on the shaft what is possible with many different ways. One of them is by bolt through the traverse hole in shaft. A shaft with a hole has maximal stress near the hole much bigger than far from the hole. This effect is called the stress concentration. Nowadays, experimental methods and numerical methods are used to determine the value of the stress concentration. Generally speaking, stress concentration is bigger as the roundness radius of a hole or a groove is smaller.

2. Stress concentration

Expressions for calculating the stress size and distribution on a certain section of a particular construction element, and for a certain load of an element are based on the common hypothesis on deformation, and are given in a simple form. Thus, for example, expression for determining stress along a traverse of axially loaded element is based on the hypothesis of equally distributed stress along the section. With elastic beam stressed at bending, the expression is based on the distribution of stress along the section, so that fibers far from the neutral section axis have greater stress that is to say along linear distribution [2].

Such cases can be in certain situations different from the real state and can largely differ in values, which is caused by [2]:

- Sudden change of the section of an element which can be seen on the change of one radius to another in a shaft, in a place of a keyway on a shaft, in the cog root of a wheel in a different shape of a hole in the plate, etc
- Contact stress in the application area of outer stress, for example in contact points of an engine and rails, and the like.
- Dislocation in material, for example, nonmetal inclusions in steel, gaps in concrete and similar.
- Initial stresses in an element, which are the result of treatment or welding, cold treatment (rolling).

Such conditions, which lead to the increase of stress, are called discontinuity. These geometrical discontinuities, thus, cause the increase of stress in their

surrounding. Such large stress, caused by discontinuities on a small portion of a construction element in the surrounding of a discontinuity, is called local or maximal stress or stress concentration. It is very difficult or inappropriate to do a theoretical analysis in a case of very high surface stress. In such cases experimental and numerical methods are used. Numerical methods, like finite element method lead to approximate solutions. Experimental methods are limiting, but some of them lead to useful results. These are well-known methods: photoelasticity, methods of elastic membrane, tensometry (the method of use of strain gauges), method of electrical analogy, etc. Stress concentration has an important role in designing constructions. In static stresses, the occurrence of these maximal stresses may cause plastic deformations in narrow section area, but it doesn't have to have an important influence. In a case of dynamic stresses combined with stress concentration, especially changeable stresses, which are corresponding to dynamic stresses, serious complications may appear. Experience has shown that most cracks due to material fatigue in changeable stresses occur in areas of stress concentration, which eventually can cause the breaking of an element. Detailed theoretical and practical research was done by *R. E. Peterson* in the first half of the 20th century. Figure 1 shows some geometrical discontinuities and the occurrence of stress concentration [2].

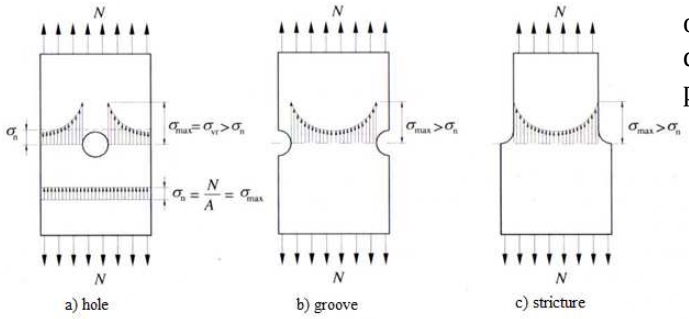

Fig. 1. Ggeometrical discontinuities and stress concentration [2]

Inhomogeneity of stress distribution around geometry discontinuity, shown as stress concentration, is expressed through stress concentration factor. According to Figure 1.a, maximal stress in the plate is $\sigma_{\max} = \sigma_{vr}$, while normal stress is:

$$\sigma_n = \frac{F}{A_n}. \qquad (1)$$

In it A_n is net area of cross section of a plate, that is, it doesn't include the area of the semicircle. If the hole diameter is small in comparison to the plate width, that is, if $d/b << 1$, then we take into consideration the total width of the plate $A \approx A_n$ also including the influence of the hole, without any considerable influence [2].

Stress concentration factor is expressed with the following equation:

$$\alpha_k = \frac{\sigma_{\max}}{\sigma_n} = \frac{\sigma_{vr}}{\sigma_n} \qquad (2)$$

If the value $\sigma_{\max}$ is calculated value of local (maximal) stress by elasticity theory or determined approximately with experimentally gained results on models, then, this factor is called theoretical stress concentration factor and is marked as $\alpha_{k,t}$ (or k_t, S_{CC}) [2].

3. Finite Element Method (FEM)

Traditional methods of solving the problems of continuous systems are based on solving differential equations, which accurate analytical solution can be obtained only for simple calculated models. Generally, it is rather difficult to get a solution which fulfills differential equation on overall area of a considered model. Thus, approximate numerical methods are used. They are based on discretion of continuous system, where differential equations are replaced by the system of algebraic equations. Finite element method is a mathematical technique supported by a computer, in order to get approximate numerical solutions of differential equations which anticipate the response of physical systems enduring external influences [3].

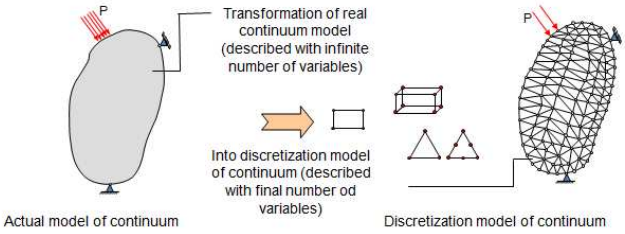

Fig. 2. Transforming real continuum model into discretional continuum model [3]

Considered continuum with infinite degrees of freedom of motion is replaced with a discretional model of connected elements with a limited number of degrees of freedom. In other words, the continuum area is divided into a final number of sub-areas, which are called finite elements. Thus, considered continuum becomes a mesh of finite elements (Figure 2) [3].

Advantages:

- Irregular geometry
- Arbitrary load
- Arbitrary boundary conditions
- Arbitrary material
- Linear and nonlinear problems (geometrical and material nonlinearity)
- Static and dynamic problems

Disadvantages:

- Solutions are approximate
- Solutions depend on the mesh density and regularity of finite elements
- Possible errors in income information are sometimes difficult to discover
- Solutions can not be reliable if a user doesn't know the principles of the method of finite elements and the physics of the modelled problem!

The order of solving problems in structural analysis using a package for the method of finite elements [3]:

- Defining coordinative systems (rectangular, cylindrical, spherical, etc.)
- Making the geometrical model of the structure – either in preprocessor of FEM software or in some CAD program (CATIA, SolidWorks, Pro/Engineer, AutoCAD etc.)
- Defining material characteristics (diagram of material flow)
- Choosing the type of necessary finite elements for the model description
- Meshing of geometrical model into a mesh of suitably chosen finite elements
- Defining the load – concentrated forces and moments, continuous stress, pressure, own weight...
- Defining boundary conditions – fixed and movable supports, wedgings, conditions of symmetry and anti-symmetry
- Calculation (solving)
- Postprocessing: Analysis of gained results.

4. Description of elements used in numerical analysis

4.1. Spatial finite elements *SOLID 92*

SOLID 92 is a 10-noded finite element. The element has three degrees of freedom in each node, displacements in directions *x, y* and *z* axis. The element is suitable for meshing parts of irregular shapes, and it can be used in modelling plasticity, creep, large deformations, etc. Geometry, the position of nodes and coordinative system of this element are shown in Figure 3.

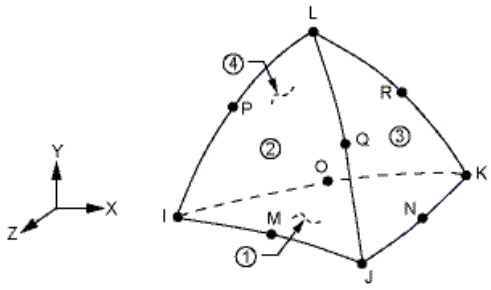

Fig. 3. Finite element SOLID 92

4.2. Spatial isoparametric finite element *SOLID 95*

SOLID 95 is a 20-noded isoparametric finite element. The element has three degrees of freedom in each node, displacements in directions *x, y* and *z* axis. The element can have three alternative shapes: tetrahedron, pyramid or prism (Fig. 4). With its functions of shape, this element tolerates irregular shapes of modelled components of a construction. Finite element *SOLID 95* can be used in modelling plasticity, creep, large deformations, etc..

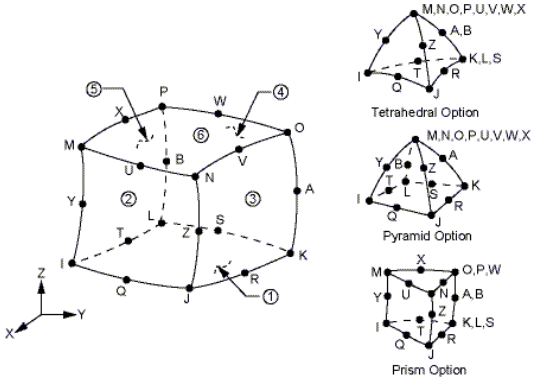

Fig. 4. Finite element SOLID 95

5. Numerical analysis of a shaft with a hole with ANSYS program

Shaft models are meshed with two different types of finite elements and loaded by forces, moments and rotating moment. It should also be pointed out that the model is free in space, that is, it doesn't lean against anything. Figure 5 shows a mesh of finite elements

which is automatically generated. The mesh consists of tetrahedral elements of second order – SOLID 92.

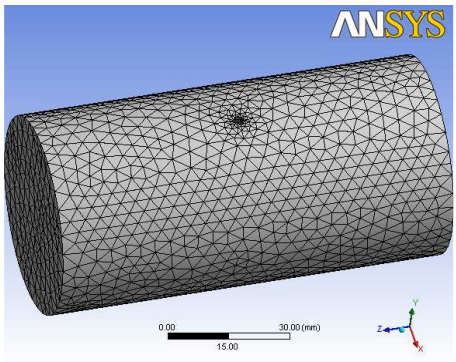

Fig. 5. Mesh of model with finite element *SOLID 92*

Figure 6 shows the mesh of finite elements which is generated in a way that the shaft is meshed in tetrahedral finite element – SOLID 92, while the area around the hole of 7 mm diameter is meshed by hexagonal finite elements – SOLID 95.

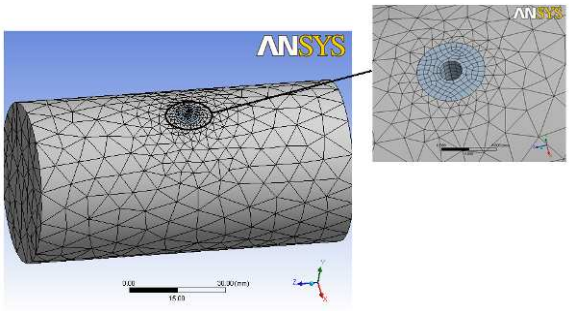

Fig. 6. Mesh of model with mixed type of finite elements SOLID 92 and SOLID 95

5.1. Shaft subjected to the tensile loading

Figures 7 and 8 show the stress concentration factor for the shaft with hole (ratio d/D = 0,2) loaded to the tensile stress for two considered types of elements.

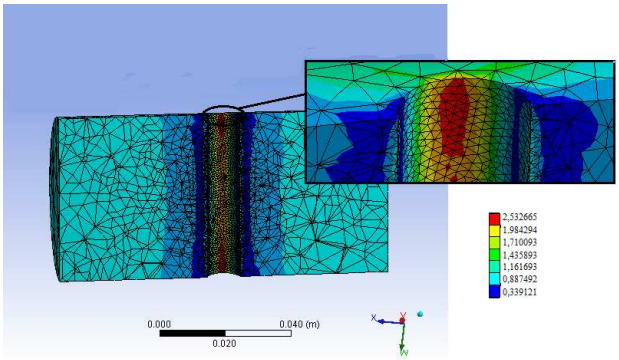

Fig. 7. Results of stress concentration factor with element SOLID 92

Figure 7 shows results of stress concentration factor $\alpha_k = 2{,}53$ for tetrahedral finite element – SOLID 92.

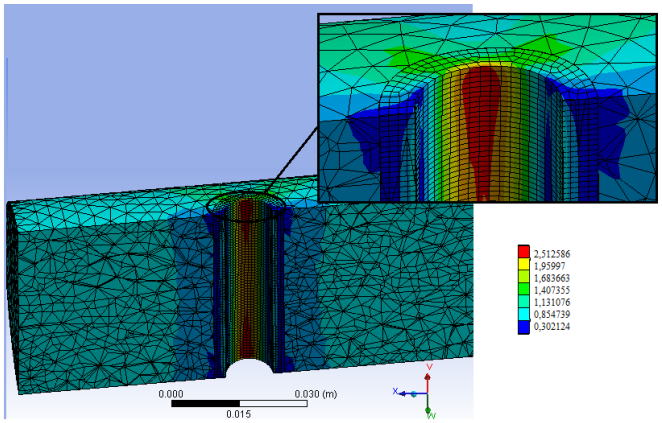

Fig. 8. Results of stress concentration factor with elements SOLID 92 and SOLID 95

Figure 8 shows results for stress concentration factor $\alpha_k = 2{,}51$ for combination of finite elements SOLID 92 and SOLID 95.

5.2. Shaft loaded to bending

Figures 9 and 10 show the stress concentration factor distribution for the shaft with hole (ratio d/D = 0,2) subjected to bending for two types of elements. .

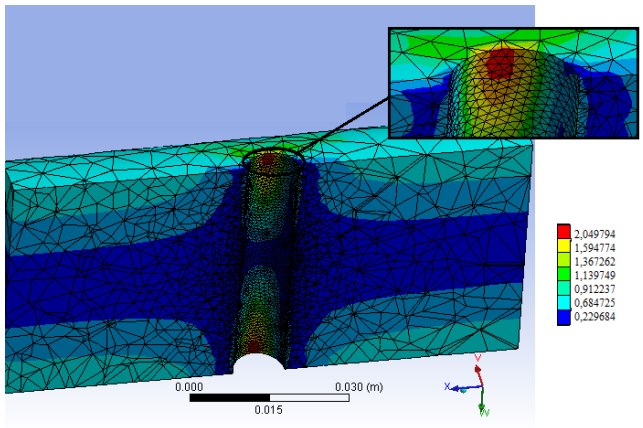

Fig. 9. Distribution of stress concentration factor obtained by using of finite element SOLID 92

Figure 9 shows results for stress concentration factor $\alpha_k = 2{,}05$ for tetrahedral finite element – SOLID 92.

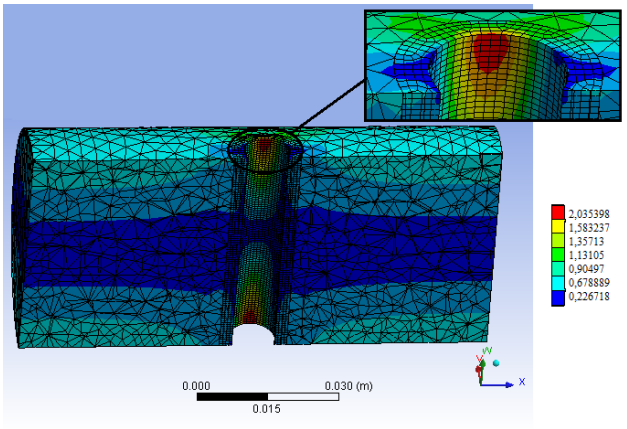

Fig. 10. Distribution of stress concentration factor obtained by using of elements SOLID 92 and SOLID 95

Figure 10 shows results for stress concentration factor $\alpha_k = 2{,}04$ for combination of finite elements SOLID 92 and SOLID 95.

5.3. Shaft loaded to torsion

Figures 11 and 12 show the distribution of stress concentration factor for shaft with hole (ratio *d/D* = 0,2), which is loaded to torsion for two types of elements.

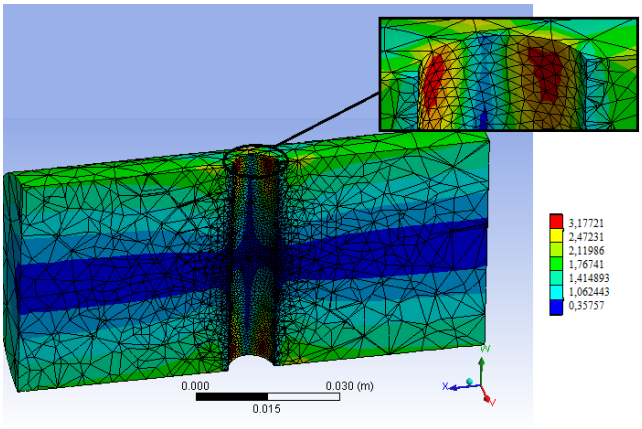

Fig. 11. Results of stress concentration factor with element SOLID 92

Figure 11 shows results for stress concentration factor $\alpha_k = 3{,}17$ for tetrahedral finite element – SOLID 92.

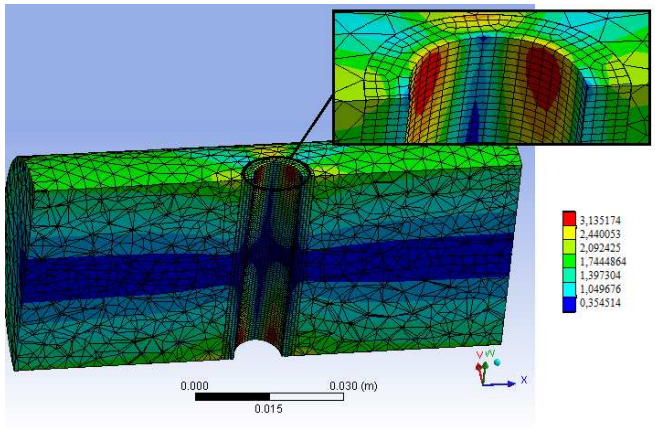

Fig. 12. Results of stress concentration factor with elements SOLID 92 and SOLID

Figure 12 shows results for stress concentration factor $\alpha_k = 3{,}14$ for combination of finite elements SOLID 92 and SOLID 95.

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6. Comparison of results of stress concentration factor gained numerically related to the results known from literature

Table 1 shows results for the stress concentration factor gained numerically for three different kind of loading and two different types of elements.

Tab. 1. Results of stress concentration factor

	SOLID 92	SOLID 92 and SOLID 95
Ratio *d/D*	0,2	0,2
Type of loading	Stress concentration factor	
Tensile	2,53	2,51
Bending	2,05	2,04
Torsion	3,17	3,14

Figure 13 shows the diagram of stress concentration factor for various types of applied loading known from the literature.

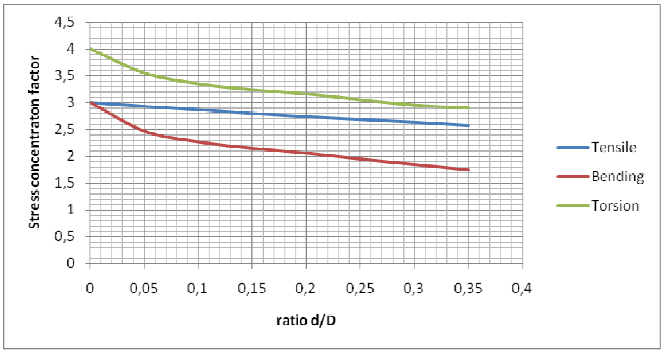

Figure 13 Stress concentration factor variation due to *d*/*D* ratio and different type od loading

In Figure 13 we can read values for stress concentration factor for ratio *d*/*D* = 0,2, which is also shown in Table 2.

Tab. 2. Values of stress concentration factor from literature

	Reference value
Ratio *d*/*D*	0,2
Type of loading	
Tensile	2,75
Bending	2,06
Torsion	3,16

Table 3 compares the difference in percentage between numerical results and those which are referred in the literature.

Tab. 3. Exceptions of some numerical solutions for α_k from solutions given in literature [%]

Type of element	TETRAHEDRONS	HEXAGONS
Ratio	*d*/*D*=0,2	*d*/*D*=0,2
Tensile	8	8,73
Bending	0,5	0,97
Torsion	0,32	0,63

[3] J. Sorić, Metoda konačnih elemenata, Zagreb, Golden marketing, (2004), pp. 245 – 273

5. Conclusion

By choosing the material for shafts, it is necessary to, besides their strength; take into consideration their resistance to stress concentration. Steels of high strength are sensitive to stress concentration that occurs on transitions from one shaft diameter to another, along feather grooves and wedge grooves, grooves for locks and the like.

To calculate the value of stress concentration factor, it was necessary to determine maximal stress around the hole, which is divided by nominal stress, far enough from the hole. Nominal stress is determined by known expressions from strength of material. To determine stress around the hole in all three cases of load, the finite element method (FEM) has been used.

Our objective was to compare FEM solutions gained for stress concentration factor to diagrams for α_k, which were made in the 60's of the last century, using mathematical, empirical or experimental methods. Comparing results of α_k gained numerically, using tetrahedral and hexagonal elements, with the results read from diagrams in different literature, it can be concluded that the use of tetrahedral elements in solving these or similar problems is more justified, because they give more accurate solutions. It can be seen in the above shown percentages of exception for each type of stress, shown in Tab. 3.

However, it should be pointed out that the distribution of stress gained by FEM is sensitive to the number of elements that discretized the model. The use of more precise mesh would certainly give results closer to those from the diagram. Thus, the exception would be smaller, but the time needed for gaining the result would be longer.

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[2] J. Brnić; G. Turkalj, Nauka o čvrstoći II, Rijeka, Zigo, (2006), pp. 234 - 240

Quality Management Systems at hospitals

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Abstract

Quality Management Systems are present for a while in many different areas of production and service provision. Several medical institutions have implemented Quality Management Systems according to requirements of standard EN ISO 9001. Specific problems have occurred and goal of this paper is to emphasize these problems and to explain which elements of ISO 9001 are hard to implement at medical institutions.

Keywords: Quality Management Systems, ISO 9001, hospitals

1. Introduction

Quality has become very important factor of our life. Competitive markets require higher and higher level of quality for all participants at world market. This includes production and service organizations. The Quality management includes coordinated activities to direct and control an organization with regard to quality [1]. The organization has to choose suitable processes that will ensure that the product provided by the organization can meet the defined requirements. The work methods that help to achieve these objectives in an efficient and effective manner constantly and reliably are an important part of the Quality management system. To achieve higher quality of their products and to sustain high level of quality many production organizations implemented requirements of ISO 9001 standard. When ISO 9001:2000 was issued more and more service organizations have started to implement these requirements at their Quality Management Systems, because ISO 9001:2000 issue was more suitable for service organizations. Today standard ISO 9001:2008 is in use, which is even more suitable to service organizations. During past few years several medical institutions accepted and implemented requirements of ISO 9001 Quality Management System. Intention is to improve quality of medical services in Croatia. Quality management systems are something new for hospitals, so different kind of problems have occurred during implementation of these requirements. Goal of this paper is to point out most specific problems at implementation of ISO 9001 requirements at medical organizations and to propose solutions and improvements for these problems.

2. Research Methods

Standard ISO 9001 define requirements for Quality Management Systems. These systems are organized as presented at figure 1 [2] which is known as Quality circle. Documentation system is established in organization to define responsibilities and to describe how specific actions and processes are performed. This is phase of planning.

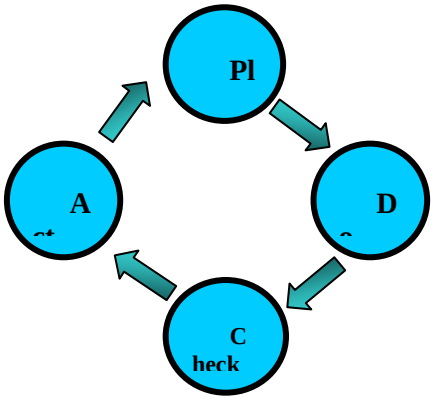

Fig. 1 Quality circle

When rules are established organization is performing its processes as defined in documented procedures and work instructions. This is phase Do.

After that organization is evaluating how its Quality Management System is functioning and if it is effective. This is phase Check. Obtaining this information, organization has found weak points and can make some steps toward improvements. This is phase Act.

2.1. Quality audits

To find out what are most common problems at implementing requirements of standard ISO 9001 at medical institutions phase Check of Quality circle will be used. This phase is usually performed by Quality audits. A process of quality audit is very important for the evaluation of efficiency of the management systems. The quality audit is performed by trained auditors, according to the prepared audit plans and documented procedure for the quality audit. These audits can be performed as the internal and external quality audits. The internal audits are performed by the organization itself to find out how requirements of relevant standard were followed. The external audits are performed by an independent organization to confirm that relevant requirements were fulfilled. Example of external audit is certification audit. Out of all the elements of the quality management systems based on ISO 9001, the internal audit requires a lot of time and effort, once a system is implemented. Making the most of internal audits will create greater employee involvement, improve job satisfaction and provide more opportunities for the constant improvement. The auditors must be aware of the requirements against which they perform an audit. These requirements are defined in the standards on which the quality management systems are based on as presented on figure 2 [3].

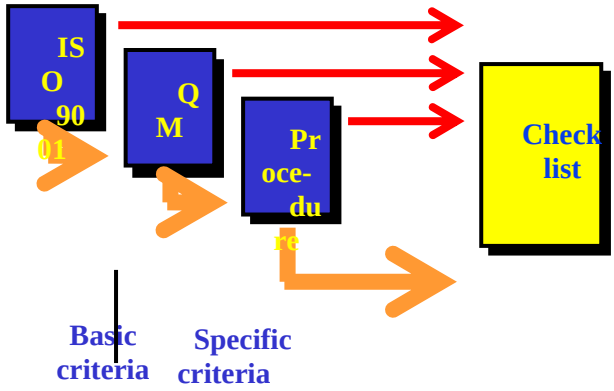

Fig. 2 Audit criteria

Criteria for audit is not only taken from relevant standard, but also from organization Quality Manual (QM), quality procedures, documents and records presented during audit, relevant legal requirements and other sources. Based on this, auditor create check list that will help to perform audit as planned, and to check all relevant requirements of organization's Quality Management System.

For the purpose of this paper, results of internal audits and external audits will be analyzed only for companies audited by author of this paper. Documented non-conformities from performed audits are analyzed.

3. Results of investigation

Results of analysis will be presented related to clauses of standard ISO 9001 that are noticed as requirements which were difficult to fulfill by monitored organizations. These will point out problems which appear at implementing Quality Management Systems at medical institutions.

3.1 Management review

This requirement is presented in standard ISO 9001 as clause 5.6.

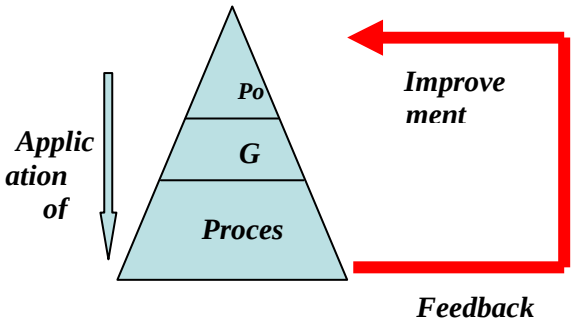

Fig. 3 Improvement process

Management review is crucial part of improvement process which is presented at figure 3 [3]. Quality management representative collect information generated from Quality Management System including, audit reports, service conformity, corrective and preventive actions, customer satisfaction, former management review conclusion and some others. Management analyzes these reports and based on these analysis take actions that lead to improvements of Quality Management system.

Problem that is found at hospitals implementing requirements of ISO 9001 standard, is that information feedback presented at figure 3 is not working properly. Situations at Quality Management System are monitored, problems are noticed, documented and solved, but information about it, is not always distributed to management. Therefore management can not take proper actions to eliminate causes of non-conformities to improve their Quality Management System and to achieve higher quality of their services. Root of this problem is probably that departments in hospitals have significant autonomy, and are not used to inform others department or management about problems in organization.

3.2 Purchasing

Purchasing is defined in standard ISO 9001 as requirement clause 7.4. Requirement of that clause is to monitor documents that are used in purchasing process. This requirement is fulfilled as law requirements apply for purchasing of common procurement. But when purchasing is performed for products that are not covered by common procurement, then documents are not always controlled as they should be.

Important requirement at purchasing process is also evaluation of suppliers. Standard ISO 9001 requires that suppliers are evaluated based on their ability to supply product in accordance with the organization's requirements. Criteria for selection, evaluation and re-evaluation shall be established. Records of the results of evaluations and any necessary actions arising from the evaluation shall be maintained. Process of evaluation of supplier related to customer and its requirements is presented at figure 4 [4].

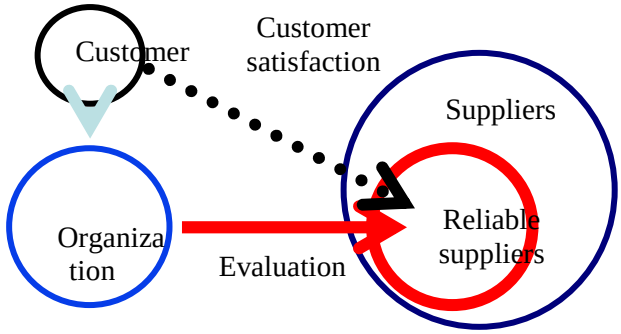

Fig. 4 Evaluation of suppliers

Evaluation of suppliers and creation of List of qualified suppliers is something new for hospitals and problems occure at establishing of evaluation criteria. Standard clearly states that evaluation is related to organiza-tion’s own criteria, but some hospitals implement criteria that are clearly not defined by themselves. Consultants propose complicated systems of points which are accepted by hospitals, but this evaluation systems are not properly applied. Not all criteria are evaluated as defined or points given make no sense (like points system from 0-100 points for every purchasing order).

3.3 Identification and traceability

Identification is important requirement from standard ISO 9001, clause 7.5.3 that is not implemented well, too. It is required to identify the product by suitable means throughout product realization in all phases [5]. Organization fail to implement proper way of identification. It is not good enough to identify patient with his name and surname, or additionally with date of receipt. It is necessary to use unique way to identify patients, which is not done in all hospitals, yet.

3.4 Non-conforming services

The organization have to ensure that service which does not conform to product requirements is identified and controlled to prevent its unintended use or delivery. Non-conforming services should be documented and analyzed. This is requirement 8.3. Problem at Quality Management Systems in hospitals related to this requirement is identification of non-conformities. At production organizations, it is normal and usual situation to find and document non conforming products. But, in hospitals employees are not familiar with meaning of non-conforming services, and sometimes are not able to recognize such services.

3.5 Corrective and preventive actions

Corrective and preventive actions are taken to eliminate causes of non-conformities. Intention is to accomplish improvements in Quality Management System by removing causes of problems, so that these problems do not appear again, clause 8.5.2 and 8.5.3.

First step at corrective action process is to identify non-conformity (Figure 5). Then, organization have to understand nature of that non-conformity, what are main issues related to that non-conforming service.

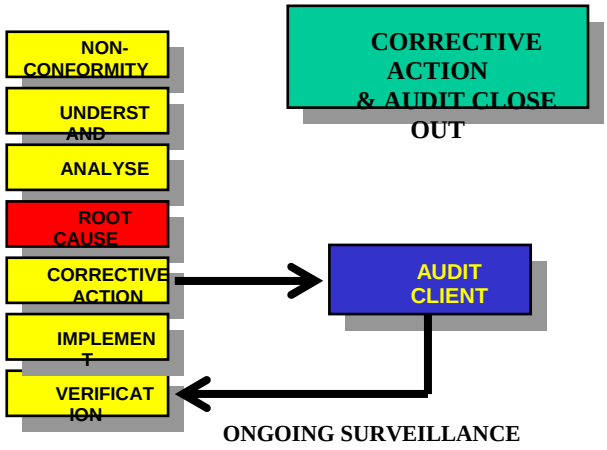

Fig. 5 Corrective action

When non-conformity is determined and understood, responsible person for process where problem appeared, should analyze non-conformity to find out cause of problem. That is point where most organi-zations fail to fulfill requirement of standard ISO 9001 clause 8.5.2. They simply overlook fact that root cause of noticed problem should be determined. If root cause is properly determined, documented corrective action should be taken. Implementation of corrective action could take some time, but organization should try to implement it as soon as possible. Verification of effectiveness of taken corrective action could be performed later, usually at surveillance audit. Main problem is that corrective actions are mixed up with solving of non-conformity, which is wrong. Noticed non-conformity should be, naturally, dealed with and solved, but corrective action, if it is taken, should address root cause of problem not consequence.

4. Improvements

Main goal of this paper is not only to specify main weaknesses at implementation of requirements of standard ISO 9001 at hospitals, but also to suggest actions for improvement. These actions could help that noticed problems do not happen again at all, or at least, not in significant numbers.

Problems with requirement for management review, could be eliminated with establishing communication lines between Quality Management System and Management of organization. It could be performed by regular reports (monthly, quarterly) about quality issues, which will include non-conforming services, corrective and preventive action, complaints, internal audit documentation and similar.

Purchasing process is important for every organi-zation, so it is also for medical institutions. Evaluation of suppliers is activity that in some hospitals is not understood properly. Responsible person for purchasing should attend training course or some other form of education to help him create efficient system for supplier evaluation.

Identification could be improved by implementing bar code system of identification, which is already used at some hospitals, and it is functioning properly. This solution asks for investment, but it helps manage identification and traceability of patients.

Corrective and preventive actions are one of most important tools for improvement process. If they are not performed properly, improvement process will not be successful. Importance of proper corrective actions should be repeated at training courses, daily meetings related to quality problems and all other topics where quality issues are discussed. Proper determining of root cause at corrective action process is one of the least understood requirements of ISO 9001 in service companies, so additional training related to this problem is necessary.

5. Conclusion

Implementing requirements of ISO 9001 for Quality Management Systems at hospitals will surely improve quality of medical services in Croatia. However there are requirements which are found to be harder to implement. Problems which are determined at this paper, and suggested solutions could help those people in hospitals, to implement their Quality Management systems in a more efficient way.

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3D Model Design for New Production Technology Application

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Abstract

The contribution deals with the modelling of the part with difficult shapes within the Reverse Engineering for new production technology application. Many of the hand-made prototypes are created without drawing documentation and so the manufacturing of such real parts is very complicated. The utilization of computer techniques can become basis for suggestion of new manufacturing technology of part. CL data, as direct output of CAM system, serve for NC program creation, so the data digitizing can considerably decrease the economic cost and greatly affects the efficiency of the part manufacturing.

Keywords: 3D model; Digitizing; Complex-shaped part; NC program; Reverse engineering

1. Introduction

The computers become an important part of our life and about its benefits nobody doubts. The programmers get the strong tools into the development hands that use the potential of computer techniques for the creation of completely new applications, which alleviate the solution not only of common problems, but already the special defined, too. New technologies bring the change of mind. The classic way "imagine the solid figure, and then create the drawing to make the solid figure again by means of them" is often substituted by technology today that thanks to three dimensional graphic enables to solve the difficult phases of the body suggestion direct in its real version of full-value stereometric body. The creating of 3D object on the basis of drawing documentation is routine in today plants. The advantages of such processed object can be reduced to the following points:

- The visualisation of the object enables the optimization of its structural solution before the production, its quick modification (the dimensions editing), eventually the quick suggestion of the similar objects inside the group technology.
- The utilisation of the object in the assembly allows detecting the conflicts with other components not only in static, but in kinematics state, too.
- The defining of the couples, loadings, materials and other 3D model properties enables to execute the various types of analysis (structural, thermal, dynamic…) on the object and so predicts the object behaviour in real conditions.
- It is possible to simulate the machining process by means of the created 3D models and so to find out collisions between the tool and the piece.
- One of the major advantages of 3D model is the possibility to generate CL data and with the utilization of postprocessor to make the NC program for the selected control system in very short time.

A considerable number of companies in Slovakia produce components on the basis of component drawings which can be drawn manually but nowadays most often by a computer technology. The software using 3D technique notably facilitates the work of constructors and designers. At the design stage of a new product, a 3D model is created at first then the analyses and simulations of the production process are conducted. After the fault elimination, drawing and

technological documentation is completed and only on its basis is the component being produced. [4]

The problems occur when the actual component exists, e.g. in the form of a hand-made model, is complex-shaped and its geometric characteristics are unknown. The production of other (exactly the same) components is in this case problematic, especially where a mass production is concerned. (Fig.1)

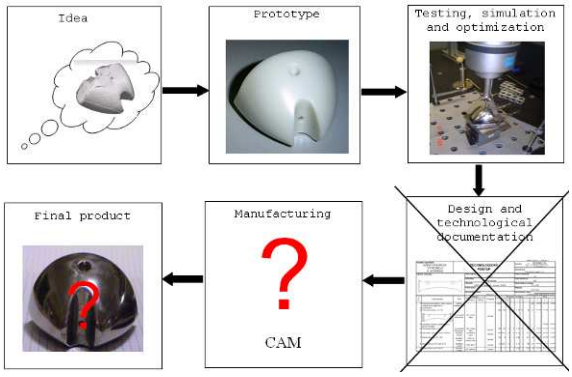

Fig. 1. Problem with undefined part manufacturing

2. Modelling of complex-shaped part

The dimension characteristics are essential in order to create a 3D model, drawing or to produce the component itself. Acquiring further data about the component, processing of this data, e.g. by a computer becomes a necessity, and only on the basis of acquired data is the drawing preparation and direct generation of CL data for the component production on NC machine possible.

Nowadays the research regarding the data acquisition on the shapes and dimensions of the real (three-dimensional) objects is in the stage of rapid development. Precise, fast and non-contact methods are significant in many industrial applications including the quality control, surface control or visual systems on assembly lines. They are no less important in recognizing 3D objects, in securing the area or in navigation. With respect to the required precision and quality of the subsequent production in mechanical engineering, the most precise and advantageous method of acquiring information on the topography of the real product appears to be a 3D digitization of the examined object, using modern technical devices within the scope of the so-called technological 3D scanning. This method is known as Reverse Engineering. [1]

2.1. Reverse Engineering description

"Reverse Engineering is the process of the existing component, composition or product duplication without having the drawings, documentation or a computer model at the disposal." Reverse Engineering includes all the activities which enable the determination of the function principle of the product, idea or technology originally used at the product's development. It is possible to use it in order to master the process of design or to use it as a foundation for the process of redesign in the way to make the following feasible:

- monitoring and evaluation of the mechanisms which enable the product's functionality,
- analysis and research into internal processes of the mechanical product,
- comparison of the existing solutions with own ideas allowing improvement proposals.

Within the scope of Reverse Engineering several techniques of acquiring data on the solid geometry are being used, for instance triangulation (both active and passive triangulation, measuring systems with theodolite, focusing techniques, techniques of "shapes from shading"), optical interferometry, time of flight measurement of modulated light and others. [3]

The digitization of real objects is possible due to scanning equipment which enables the conversion of the real three dimensional objects into a digital form. The principle of the majority of these equipments is based on the scanning the object's surface in its discrete points and it follows that the digitized object is presented on a computer as a large number of points in space, i.e. the so-called point cloud. Scanners differ from one another especially in the way the scanning of the object's surface points is implemented. The scanning equipment can be divided according to whether the scanning technology is contact or a non-contact one. The former concerns 3D scanners and stationary co-ordinate measurement systems CMM (Control Measuring Machine). This category offers the digitization equipment ranging from 3D desktop equipment to the systems used for measurement of large objects of several meters in size. The latter, non-contact systems of measurement, i.e. scanners, generally operate on laser or optical principle. [2]

For the most part, a choice of the scanner type depends on the requirements posed on the accuracy of homogeneity between a real and a digitized model. Further, another important factor when selecting a scanner is the scanning time. The fastest scanners are the laser ones. Also, a significant factor is the size of the scanned component or, possibly the mobility of the

scanning equipment. The majority of scanners are limited by the scanning space in which it is possible to scan. 3D scanners are usually constructed to be able to scan objects as large as 50 cm. For more sizeable objects the larger scanning equipments are produced.

Apart from hardware devices, a substantial role at digitization of 3D objects is played by software equipment. Individual scanning equipments use own software for processing of the scanned data, however these need to be transformed several times and eventually transferred into a neutral format (IGES, STEP,…) which CAD/CAM systems can operate with.

2.2. Complex shaped part digitizing

An example for the processing of a complex shaped component in Reverse Engineering can be a template for winding of the stator of electromotor (See fig. 2).

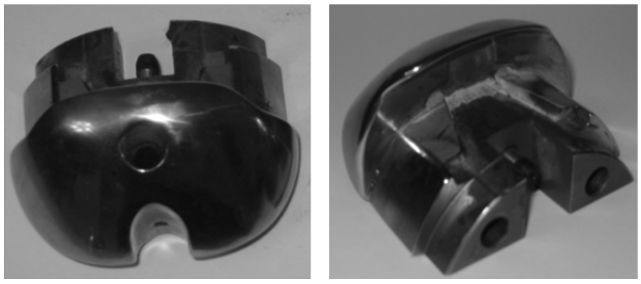

Fig. 2. A template for winding of the stator of electromotor

It is a real component, which used to be produced abroad in a way that its finite shape underwent a hand grinding into an anti-template but the drawing documentation of the resultant topography was not available. The average delivery time was longer than 3 month.

A 3D scanner Roland Picza LPX 250, in which all digitizing operations are controlled by a program Dr. PICZA, was selected for scanning. This software enables the scanning of data to be optimized, edited and transferred to NURBS surfaces. Then the data can be exported to STEP, STL or IGES formats for further processing in 3D programs. Considering the surface of the original component was too reflexive (as it was polished), it was necessary to decrease its gloss values, e.g. by spray-painting it with a gray undercoat colour. At the same time, it was essential to evenly apply the sprayed layer as this factor may also affect the approximation rate of a created model toward its original and a finite accuracy of the component created on the basis of a virtual 3D model.

The data after the scanning it was necessary to save in „*.pix“ format and consequently to import in software PIXFORM. The obtained characteristics represent the geometry as the model with the unsmoothed face and with the curves, which are not continuous. Also some technological features (for example the holes) were not scanned completely, but only as the surfaces that indicate the position of these features. (Fig.3)

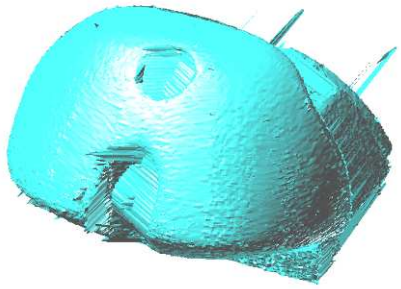

Fig. 3. Scanned model of the part in PIX format

The software Pixform next allowed:

- to translate one complex shaped surface through a cloud (a grid) of scanned points, whilst the accuracy of coverage depended on the number of selected checkpoints,
- to modify the polygonal meshes by means of editing control points, polygon edges and surfaces (removing, moving or adding new surfaces),
- a reduction of a polygonal meshes, i.e. a reduction of the number of polygons in the meshes, however, at the expense of the quality and display fidelity,
- to fill the cracks which arose at the scanning in polygonal meshes on the basis of the NURBS surface definition, and repair a partially insufficient representation of the scanned data,
- to partially polish the obtained model, however, not with a sufficient accuracy

For next processing it was necessary to export the acquired data, transferred it and subsequently imports into CAD/CAM software. Concrete procedure used on FMT TU Kosice with seat in Presov is shown on Fig.4.

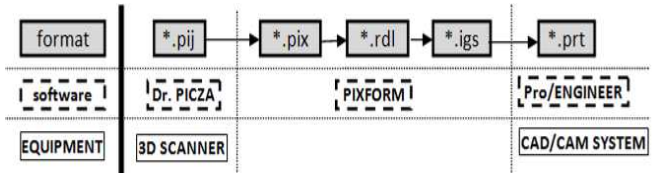

Fig. 4. Data transferring

Geometric data describing the established surface were neither applicable for various types of analyses, nor for a CL data generation. As a result, it was necessary to export them again in IGES, STEP or STL format and import them to a selected CAD/CAM system, in order to further process them. Pro/Engineer system was selected as a CAD/CAM system based on the experience and in connection with the software availability. It is advantageous to utilise the surface operations in this system for work with complex shaped design. For this purpose, sections were created on an imported model and the interpolating or approximating curves, defining the profile of "top surface" in the section plane, were translated through a point set via a mathematical apparatus. Approximating curves of Bezier and Spline types were used most often at work as they best represented the imported template shape in the parallel planes. The curves were covered with a coat surface which was created as Pro/Engineer system's own element so the geometric data describing this surface were readable also for CAM system area. As with the curves, it was also possible to control, analyse and modify the curvature and "smoothness" of the selected surface.

In the process of 3D model version finalising, various techniques and tools were used, which a user is offered by a selected CAD/CAM system Pro/Engineer. It is advantageous to utilise the surface operations in this system for work with complex shaped design. For this purpose, sections were created on an imported model and the interpolating or approximating curves, defining the profile of "top surface" in the section plane, were translated through a point set via a mathematical apparatus. Approximating curves of Bezier and Spline types were used most often at work as they best represented the imported template shape in the parallel planes. The basic curves for 3D model creation are shown on Fig. 5.

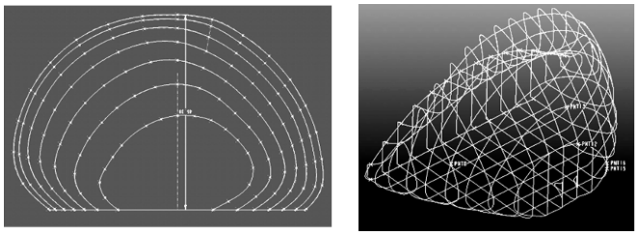

Fig. 5. The basic curves for 3D model creation

The curves were covered with a coat surface which was created as a Pro/Engineering system's own element so the geometrical data describing this surface were readable also for CAM system area. As with the curves, it was also possible to control, analyse and modify the curvature and "smoothness" of the selected surface. In the process of finalising of a 3D model version, various techniques and tools were used, which a user is offered by a selected CAD/CAM system Pro/Engineer. The final version of a 3D model created without geometric and drawing definition is on the Fig. 6.

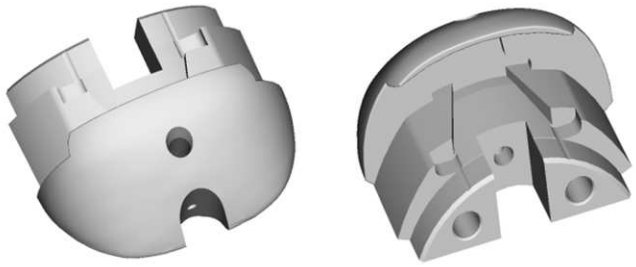

Fig. 6. The final shape of the model

3D model was compared by geometry with the scanned shape in Pro/Engineer. The spaces between measured points were 2 mm and the tolerance was ± 0,1 mm. It could be said that 98 % of the surfaces were inside tolerance. (Fig. 7)

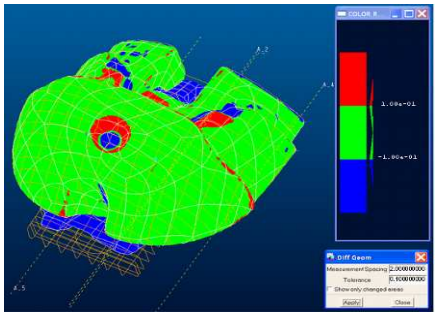

Fig. 7. The comparison of scaned and created model

On the basis of created 3D model was made the new physical part by Rapid Prototyping method. The geometry and dimension data of model were exported from Pro/Engineer to STL format that are used for the producing of silicone form.

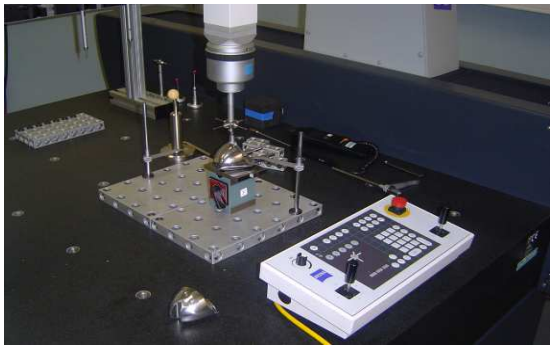

Fig. 8. The comparison of 3D model and scanned part

The cast plastic part was compared with the primary real part by means of 3D measuring equipment (Fig. 8) and then it was used in real situation.

It was possible to allege that the model corresponds to the real steel part in required accuracy and so CL data were generated. The short block of CL data list is shown on Fig. 9.

CL data	NC program
$$* Pro/CLfile Version 200112 - 9837	
$$-> MFGNO / POSTPR	
PARTNO / POSTPR	
$$-> FEATNO / 13	
MACHIN / MILL, 01	
UNITS / INCHES	
LOADTL / 1	
$$-> CUTTER / 4.000000	
$$-> CSYS / 1.0000000000, 0.0000000000, 0.0000000000, 0.0000000000, $ 0.0000000000, 1.0000000000, 0.0000000000, 0.0000000000, $ 0.0000000000, 0.0000000000, 1.0000000000, 0.0000000000	
SPINDL / RPM, 1500.000000, CLW	
RAPID GOTO / 30.0000000000, 75.0000000000, 20.0000000000	G00 X30 Y75 Z20
RAPID GOTO / 30.0000000000, 75.0000000000, -20.0000000000	G00 X30 Y75 Z-20
FEDRAT / 200.000000, IPM	
GOTO / 30.0000000000, 75.0000000000, -25.0000000000	G01 X30 Y75 Z-25
CIRCLE / 50.0000000000, 60.0000000000, -25.0000000000, $ -0.0000000000, 0.0000000000, 1.0000000000, 25.0000000000	G03 X25 Y60 I20 J-15
GOTO / 25.0000000000, 60.0000000000, -25.0000000000	
GOTO / 25.0000000000, 20.0000000000, -25.0000000000	G01 X25 Y20 Z-25
GOTO / 30.0000000000, 20.0000000000, -25.0000000000	G01 X30 Y20 Z-25
CIRCLE / 50.0000000000, 5.0000000000, -25.0000000000, $ 0.0000000000, 0.0000000000, -1.0000000000, 25.0000000000	G02 X70 Y20 I20 J-15

Fig. 9. CL data as output of of CAM module

The obtained data were transformed by postprocessor and applied as NC program for controller of concrete CNC machine in company. The manufacturing of new part by means of CNC machine is very quickly and simple today, any inventories of this part are needed.

4. Conclusions

The automation of the manufacturing is one of the main goals in present days, what is enabled by the quickly development of information technology and by the sequential application of computer aid into all areas of the production.

Within the automation the NC program creation and the complex manufacturing with the utilization of CNC machines are needful for the every plant that wants to be a success with its products on the market today. Created 3D model and the data digitizing enable to execute the various types of analysis, for example the computing of the model volume value, to determinate of the centre position with regard to the selected coordinate system and the calculating of the mass on the basis of material density. The calculations listed above would be very difficult and too inaccurate in the case of complicated part without the analytical and dimensional characteristics. [5]

It can be said that the suitable using of the modern methods, technologies and its bilateral combination can greatly decrease:

- delivery time of parts,
- investment quantity blocked in stores and
- costingness to its pandering.

After the creating of 3D model and after the generating of NC program, the terms of delivery were shortened about 98 % (from 180 days on 2-5 days), the number of stored templates decrease about 50 % and the price of the parts made in Slovakia derogated about 60 % compared with original foreign supplier.

The creation of a 3D model also allows conflicting situations predicting not only at the machining but also at their putting together to assemblies resulting in the reduction of the preparation time, expenses and the quality enhancement of production. One modelled component can thus become the basis for its simple modification and subsequent production of other, type similar components, e.g. within a group technology. The company uses several types of these templates and so it will be created other of them by similar manner in the future.

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Simulation of Manufacturing Systems by Virtual Reality Technology

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Abstract

With the advent of high-resolution graphics, high-speed computing, and user interaction devices, virtual reality (VR) has emerged as a major new technology in recent years. An important new concept introduced by many VR systems is immersion, which refers to the feeling of complete immersion in a three-dimensional computer-generated environment by means of user-centered perspective achieved through tracking the user. Main advantage of virtual reality application usage is possibility of creation and simulation of new technological unit before its realization. This may contribute to increasing of safety and ergonomics and decreasing of economical aspects of new proposed unit. Virtual model of proposed workcell could reveal hidden errors which elimination in later stage of new workcell creation should cause great difficulties.

Keywords: automated manufacturing systems, simulation, virtual reality technology

1. Introduction

Virtual Reality is technology currently used in a broad range of applications, the best known being flight simulators, walkthroughs, video games, and medicine (virtual surgery). From a manufacturing standpoint, some of the attractive applications include training, collaborative product and process design, facility monitoring, and management. Moreover, recent advances in broadband networks are also opening up new applications for telecollaborative virtual environments in these areas [1].

Historically, virtual reality has entered into the public awareness as medial toy with equipment „helmet-glove“, which was preferentially determined for wide public and the price of this system had also to correspond to this fact, so price could not be very high. As follows, the producers of virtual reality systems have aimed at developing and providing of the systems for data collecting and analysing and systems supporting economic modelling. It is obvious that, from among areas, where virtual reality systems can be most frequently used are applications based on 3D-space analysing and physical dimension visualisation. Virtual reality with ability to show data 3D and attach sounds and touch information increases extraordinarily data comprehensibility. Along with increasing the number of data are increased the effects from virtual reality, too.

2. Virtual reality technology

At the beginning of 1990s the development in the field of virtual reality became much more stormy and the term Virtual Reality itself became extremely popular. We can hear about Virtual Reality nearly in all sort of media, people use this term very often and they misuse it in many cases too. The reason is that this new, promising and fascinating technology captures greater interest of people than e.g., computer graphics. The consequence of this state is that nowadays the border between 3D computer graphics and Virtual Reality becomes fuzzy. Therefore in the following sections some definitions of Virtual Reality and its basic principles are presented [5].

Virtual Reality (VR) and Virtual Environments (VE) are used in computer community interchangeably. These terms are the most popular and most often used, but there are many other. Just to mention a few most important ones: Synthetic Experience, Virtual Worlds, Artificial Worlds or Artificial Reality. All these names mean the same [7]:

- “Real-time interactive graphics with three-dimensional models, combined with a display technology that gives the user the immersion in the model world and direct manipulation.”
- “The illusion of participation in a synthetic environment rather than external observation of such

an environment. VR relies on a three-dimensional, stereoscopic head-tracker displays, hand/body tracking and binaural sound."

- "Virtual reality lets you navigate and view a world of three dimensions in real time, with six degrees of freedom. In essence, virtual reality is clone of physical reality."

Although there are some differences between these definitions, they are essentially equivalent. They all mean that VR is an interactive and immersive (with the feeling of presence) experience in a simulated (autonomous) world – and this measure we will use to determine the level of advance of VR systems. Many people, mainly the researchers use the term Virtual Environments instead of Virtual Reality "because of the hype and the associated unrealistic expectations". Moreover, there are two important terms that must be mentioned when talking about VR: Telepresence and Cyberspace.

Virtual reality technology has proved to be a promising, powerful, and cost effective tool in new workplace design work. It enables designers to spend more time evaluating creative new ideas, helping them to identify and eliminate potential problems early in the design process, and enables end-users to actively participate in the design process. However, more knowledge should be obtained about the quality of results from utilization of VR technology in guideline verification.

3. Virtual automated workplace creation

One of the most useful techniques for acceleration of the design process is virtual model creation. This technique resolves interface dependencies between all system components, thus enabling parallel, rather than sequential, development of hardware and software components of the system. Paper describes creation of workshop model followed by design verification in virtual reality environment. Main goal was to verify proposed arrangement of automated workplace design in order to test accessibility of welding robots to workpiece and to confirm spatial set up of whole workshop. Procedure of virtual model creation could be divided into three main steps:

- creation of 2D drawing,
- creation of 3D models,
- creation of workshop virtual mock-up.

First step, the 2D drawing creation was made according to input information in Autocad software. Output 2D drawing tented as basic start point for all other activities for virtual model creation.

Further process consists of creation of 3D models which are based on above mentioned drawings. After model building they have to be exported in generally accepted format in order of their following usage and import in virtual reality system. For 3D models creation was used Pro/Engineer Wildfire 2 and as transfer format was chosen Wavefront format. Model created in this format are described with two files while one held information about measure and geometric characteristics of model the second contains additional information for example about model's material. Selection of this format was because of it support in virtual reality system which was used by this experiment [3].

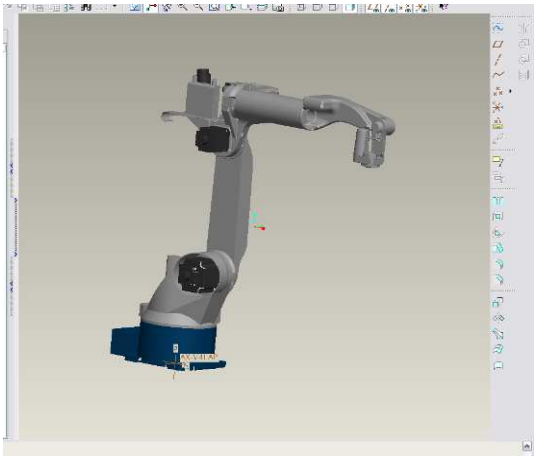

Fig. 1 Model of robot created in Pro/Engineer system

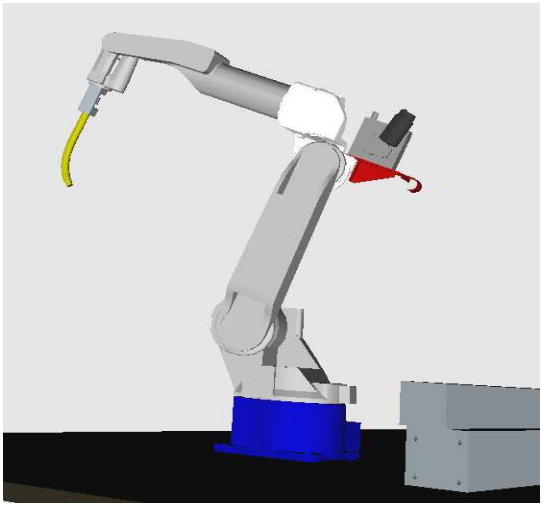

Fig. 2 Virtual model in virtual reality environment

4. Creation of workplace's virtual mock-up

A complete VR system is a large software system, consisting of many modules. Every VR system contains an object manager, renderer, device drivers, communication module, navigation and interaction module, and, usually, physicallybased simulation, sound rendering, scientific visualization, application-specific modules, etc. The visual part of a virtual world is represented by a hierarchical scene graph. Everything is a node in this graph: polyhedra, assemblies of polyhedra, LODs, light sources, viewpoint(s), the user, etc. Most of the functionality and interaction presented below will operate on the scene graph, i.e., it will, eventually, change some attribute(s) of some object(s).

For creation of virtual reality for verification purpose were used following components:

- virtual reality environment creation system Vizard,
- head mounted display Emagin Z800.

Vizard system for virtual environment creation is package of high-end graphical tools designated for graphical applications creation including virtual reality, scientific visualizations etc. Vizard uses powerful engine based on object-oriented programming which includes full usage of OpenGL and DirectX possibilities. VR environments created in Vizard environment are optimized with usage of VizardLAXMI tools for achieving of full graphical performance. Selection of this application is usage was because its support of wide range of VR hardware and conversion formats. Output visualization was performed with HMD E-magin Z800. This HMD is equipped with OLED visualization technology with high contrast. HMD has integrated motion sensor for head position and orientation location.

Fig. 3 E-magin Z800 HMD

Creation of virtual environment started with defining of new virtual environment its parameters and behavior. This action was followed by objects importing and their allocation in virtual environment. Arrangement of each object followed primary 2D drawing so the workplace virtual shape was build in 1:1 ratio to its real model. Purpose of our virtual model is verification of design proposal with reference of robot access to workpiece during work mode. In order to fulfill this goal it is necessary to define motion action of robot which can be controlled by user. In this way can designer verify correct proposal of workcell design [4].

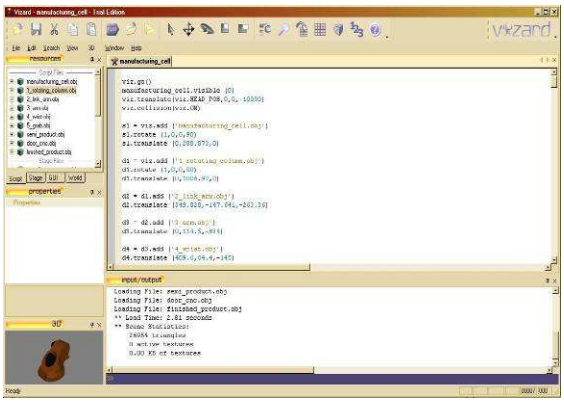

Fig. 4 Environment of Vizard system

5. Simulation of automated workplace

One of the main goals of using a VR system for design verification is the potentially high degree of “reality” which can be experienced when immersed in a VE. In order to achieve this, the VR system needs to be able to visualize object behavior at interactive frame rates. Other tasks of a VR system in the context of design verification are geometrical and spatial analyses. In order to check serviceability of a proposal, the VR system has to track the work space necessary for the objects move and it has to report collisions. During verification it is often necessary to simulate kinematics in order to perform a sensible design study. Real-time collision detection of polygonal objects undergoing rigid motion is of critical importance in many interactive virtual environments. In particular, simulation algorithms, utilized in virtual reality systems to enhance object behavior and properties, often need to perform several collision queries per frame. It is a fundamental problem of dynamic simulation of rigid bodies and simulation of natural interaction with objects. Simplified principle of verification of design in frame of object collision detection can be presented:

collision detection within a visualisation loop

loop forever
move objects according to user input
check collisions
if collision detected take appropriate actions based on collision reports
else continue in visualisation
End of visualization

With collisions there are two tasks to be handled: collision detection and collision handling. The former is the general problem of determining whether or not objects penetrate (i.e., “something happened”), while the latter is the problem of determining appropriate steps based on the current collision status, which is usually handled.

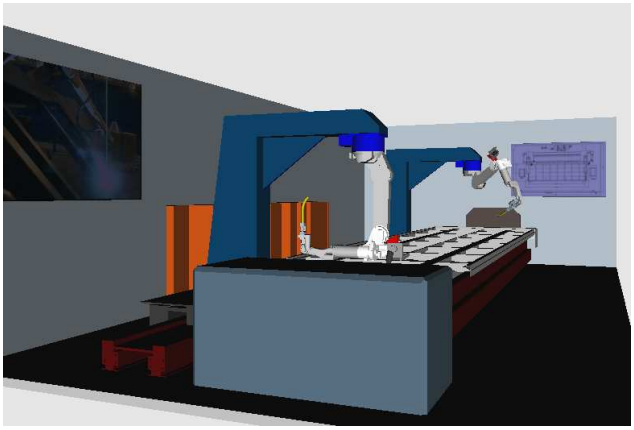

Fig. 5 Virtual automated workplace

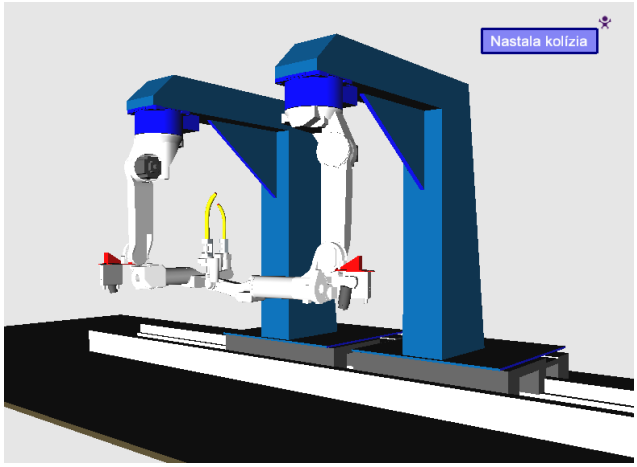

Fig. 6 Example of collision error message

This application allows verifying spatial arrangement of machines of newly proposed workplace and helps in revealing of hidden errors or may contribute to creation of better alternative.

6. Another virtual reality application

Representative applications of virtual reality technology are presented in a number of areas. Applications in manufacturing or pointers to it have been emphasized particularly. Immersive display technology can be used for creating virtual prototypes of products and processes. The user can then be exposed to an environment that is next best only to an actual product or process. Examples from the product standpoint include virtual prototyping of a product, such as earthmoving equipment, instead of expensive physical prototyping. From the process standpoint, such examples include detailed layout design involving hard-to-quantify factors such as adequate illumination, sources of distractions for operators caused by heavy goods, and personnel movement [6].

The issues here are concerned with CAD model portability among systems, trade-offs between highly-detailed models and real-time interaction and display, rapid prototyping, collaborative design using VR over distance, use of the World Wide Web for virtual manufacturing in small and medium-sized business, using qualitative information (illumination, sound levels, ease of supervision, handicap accessibility) to design manufacturing systems, use of intelligent and autonomous agents in virtual environments, and determining the validity of VR versus reality (quantitative testing of virtual versus real assemblies/equipment).

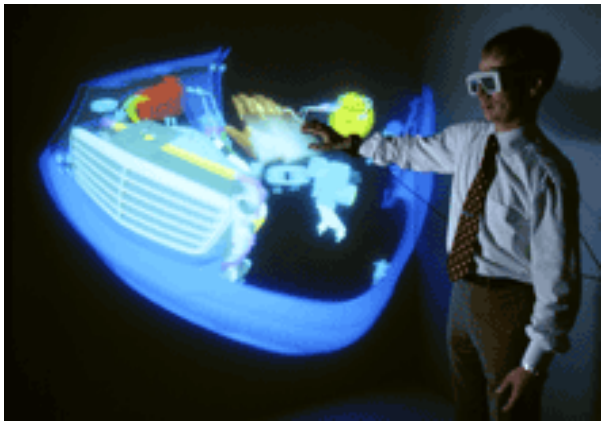

Fig. 7 Testing of real assembly in virtual assembly

A number of initiatives in this area have been undertaken at the National Institute of Standards and Technology (MIST). Engineering tool kit environments are needed that integrate clusters of functions that manufacturing engineers need in order to perform related sets of tasks. Integrated production system

engineering environments would provide functions to specify, design, engineer, simulate, analyze, and evaluate a production system. Some examples of the functions that might be included in an integrated production system engineering environment are [2]:

- Identification of product specifications and production system requirements,
- Productibility analysis for individual products,
- Modeling and specification of manufacturing processes,
- Modification of product designs to address manufacturability issues,
- Plant layout and facilities planning,
- Simulation and analysis of system performance,
- Analysis supporting selection of systems/vendors,
- Procurement of manufacturing equipment and support systems,
- Specification of interfaces and the integration of information systems,
- Task and workplace design,
- Management, scheduling, and tracking of projects.

When a single factory may cost over a billion dollars (as is the case in the semiconductor industry), it is evident that manufacturing decision makers need tools that support good decision making about their design, deployment, and operation. However, in the case of manufacturing models, there is usually no testbed but the factory itself; development of models of manufacturing operations is very likely to disrupt factory operations while the models are being developed and tested [8].

Sophisticated computer simulations, what might be called *virtual factories*, call for a distributed, integrated, computer-based composite model of a total manufacturing environment, incorporating all the tasks and resources necessary to accomplish the operation of designing, producing, and delivering a product. With virtual factories capable of accurately simulating factory operations over time scales of months, managers would be able to explore many potential production configurations and schedules or different control and organizational schemes at significant savings of cost and time to determine how best to improve performance.

7. Conclusions

Virtual reality is one of the enabling “technologies” for all kinds of physically-based visualization in VR and other applications. Main advantage of virtual reality application usage is possibility of creation and simulation of new technological unit before its realization. Usage of virtual reality in such way as a verification tool can help to minimize errors which may occur by creation of new workplaces. Paper presented simplified procedure of creation of such model with exemplar selection of software and hardware components which is followed by main description of system function principle. It presents step by step actions which have to be done in order to proceed from idea of new workplace thru 2D drawing design and 3D models creation and till import of virtual models in virtual reality environment and virtual parameters set up.

Acknowledgements

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Review of Design Process on the Example of Equipment for Husker Maize

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Abstract

In this paper are presented usefulness of approach by making three models of products called – mobile device for husking maize, in 3D software for parametric draw and design SolidWorks 2008. This software is a product of Dassault Systemes S.A. company. After such approaching, it is possible, in the same software, very quickly to make technical documentation and to approach for production of three prototypes this product. The models of this product were made on the base List of customer requirements, as well as experience of designer in designing similar products. Experience of designer did enable using already checked modules from similar products, what is pretty accelerated making of tehnical documentation for this product. For making this product designer did carry out analysis of product design according to axiomatic theory. The author in this paper want to show that three presented models, of course if they successfully pass phase of testing in exploitative conditions, very easy can be family of products, because by the making design of models the designer did use modular architecture and platform of products, what as a result could give family of three products.

Keywords: Husker Maize, Theory of design, conceptual design.

1. Introduction

Modern industrial and technological development sets higher and higher criterions for quality, variability and performance tuning for products which come to the market. On the other side companies tend to increasing of productivity and competitively in a whole production process and swiftly come out of products on the market. Those reasons are led to the fact that lifecyce of product is became shorter than ever before. The shortening lifecycle of product led to the fact that all phasis in the process of formation and production for product are shortened, and this is especially related on the process of designing. The designer have less and less time for development of product and for making techical documentation , though is well known that design process has the bigest influence on the costs of production [1], i.e. on the market price for the product, and consequently for the profit for company. Thus designer can achieve those requirements only by using modern tools for designing with application specific design knowledge in solving tehnical problems. Author of this paper will present, further in text, usefulness of using software SolidWorks 2008 by making technical documentation for the mobile device for husking maize. The object science of designing make primarily technical products and systems which need to develop as new or further development existing product. Hubka and Eder [2], were defined that technical system (product), man and environment are necessary for performing technical process where operandi make transformation input from state to state output (Fig. 1).

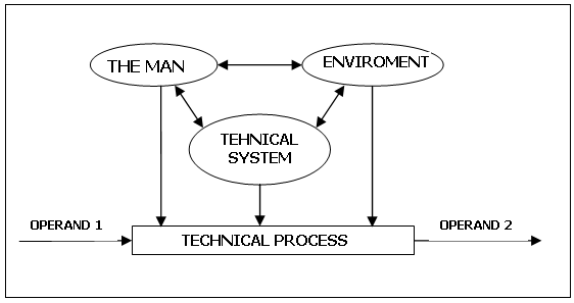


Fig. 1 Common model of technical process

The product that is presented in this paper is mobile device for husking maize, and it present new technical system. For this product are:

- operand 1 – corn cob that is not husks (only partially clean)
- technical process – process of cleaning (husking) or taking off placenta of corn cob
- technical system – new machine, mobile equipment for husking maize
- operand 2 = fully husked (cleaned) corn cob
- for carrying out of work with this machine is required participation of a man, one or more poeple serve this machine.

There is more different approach in process of designing of product. In this paper, on the example of mobile equipment for husking maize is executed analysis demands design of product on the basis of axiomatic theory. Design process in axiomatic design is usually presented by transformation Fig. 1. of customer requirements (CRs) to functionality domain requirements (FRs), domain of physical requirements (DPs) and process variables domain (PVs).

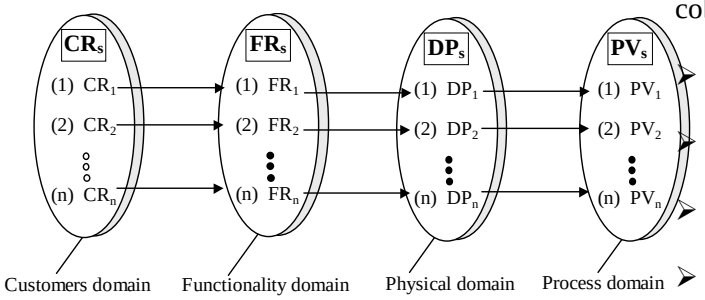


Fig. 2 Design process according to axiomatic theory

Design process as interaction between defined domains is given by matrix equation $\{FR\} = [A]\{DP\}$ acc. [Suh 1990].

Due to more options when buying this device, designer did develop three variants of prototypes of this product. Main characteristic of variant designs is that base function and structure of product are defined and do not change, but change the principles of some particular function [4]. Accordingly, mobile equipment for husking maize is founded like a product with modular architecture.

Characteristic of such architecture is that product is divided in modules which can be changed and have possibility of changing geometrical sizes or functions with goal getting different variants of product. Modules are usually described as group functionally and structurally independent components whose interaction is usually directed inside same module, and interaction between modules is reduced to minimum.

Advantage of modular production are [5]: decreasing prices of product variants, increasing product variability, faster product delivery, and easier maintenance, assembly and disassembly. This machine has base module and optional modules.

2. Customer requirements list

Customer requirement list is important because it present first step in setting up problems, and can be described as a list of needs which satisfy the potential users of product expected.

The basic rule used to define list of requirements, e.i. what is expected from product is: „Set the right question to the right consumer at the right time" [6]. Except for requests, the needs of potential users of products can be described with desires, too.

For the purposes of development and eventual serial production of this machine has done market research on a sample of 30 family farms which picking maize in cobs, and have obtained the following results:

- After passing through maize husker cobs must be totally clear (without husks and other uncleanness)
- The Maize husker must has possibility of driving with tractor or electric motor
- Due to better manipulation machine must be trailed (on two or four wheels)
- The Maize husker must has two inlet for feeding of cobs at the same time and one outlet for exit husked cobs
- One inlet for feeding should has possibility to get about 60 pieces of cobs in ones discharging of vessel (there are about 60 pieces of cobs in the vessel)
- The Maize husker should comply all of traffic rules and laws for trailed vehicle
- The Maize husker should comply all rules of safety at work regulations
- Has to proportion of human labour by process of husking be reduced to minimum
- The machine should be simply for operating, adjustment and maintenance
- Must have an acceptable price

Also, the market research did define that basic and only purpose of this machine need to be husking maize cobs, after picking maize cobs on the field with

machines for picking maize cobs, and before storage maize cobs in silo.

3. Clarification of problems, search and selection solution

By product development is much higher effect is achieved by using existing experience in developing similar products, therefore, by the development of models and design of this machine is used the experience of development and production of trailed maize picker/husker, because it is a machine that in some of its segments has similar requirements as equipment for husking maize. After analyzing and processing the request list, and based on their own experiences in developing of trailed maize picker/husker, designer has defined the basic physical structure, i.e. subassemblies of this machine. Given that the goal of designing in this paper focuses on the development of variants for the equipment for husking maize, and basic characteristic of variant designs that are the basic functions (in this case husking of maize cobs) and structure of product are defined, but it is possible to change the operating principles of some partial function, variation of sizes and deployment (in this case for example husking table) within the boundaries of the system that does not change (rest of the machine).

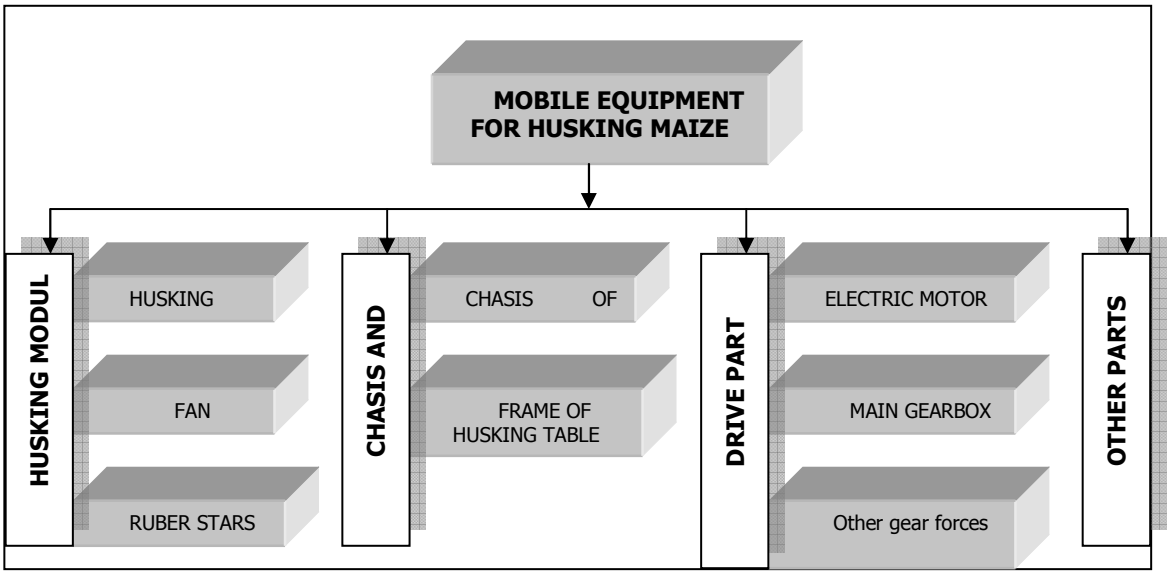


Fig.3. Main subassemblies for equipment for husking maize [5]

Given that the goal of designing in this paper focuses on the development of variants for the equipment for husking maize, and basic characteristic of variant designs that are the basic functions (in this case husking of maize cobs) and structure of product are defined, but it is possible to change the operating principles of some partial function, variation of sizes and deployment (in this case for example husking table) within the boundaries of the system that does not change (rest of the machine).

Such an approach in the designing will be obtained by families of the three variants equipment for husking maize cobs, who have: common structure to the certain level

- common features and the same overall function or purpose of use
- in a significant percentage they have same parts, subassemblies, components and modules

Therefore, it is necessary first to define a modular architecture and platform products for these machines. In this paper a modular architecture is defined with two types of modules: basic and optional. Basic module, i.e. the module that is common to all three variants of the product is shown in Fig. 4.

It consists of a chassis with wheels (1) which carries all the parts of the machine, frame of husking table (2) which is mounted with screw connection on the chassis, main gearbox (3), that receives power and torque of the tractor or electric motor and transmits them to the working organs of the machine, and manual hoist of the machine (4) which serves to

regulate the height of the machine, and provides stability (third pillar) for machine, if the machine is powered by an electric motor.

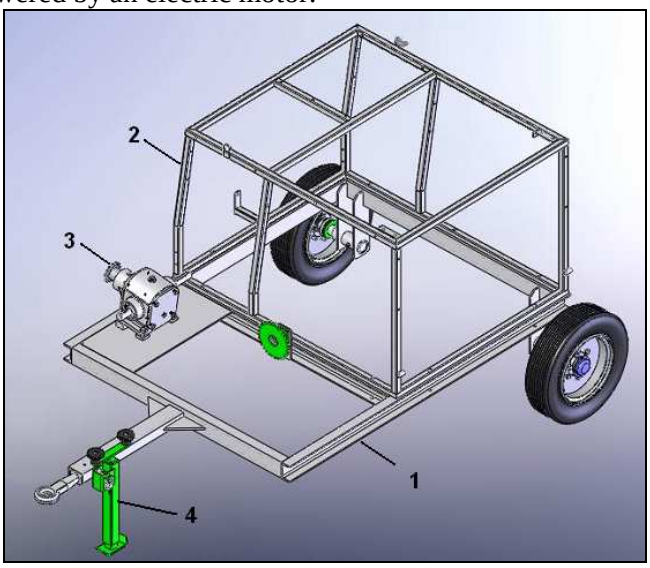
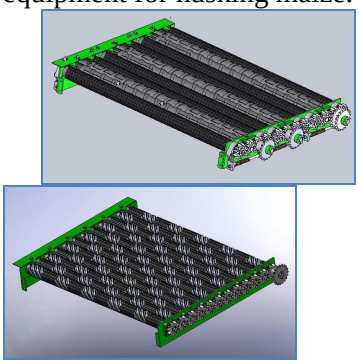


Fig 4. The basic module of three variants of the equipment for husking maize cobs

Optional modules, i.e., those modules that provide a variety of the product variants are husking table, fan, electric motor, gimbal, and drive elements on the working parts of the machine (sprockets, chains, belt pulleys). The combination of basic and optional module provides a platform and as a final result the product family - the three variants of mobile equipment for husking maize.



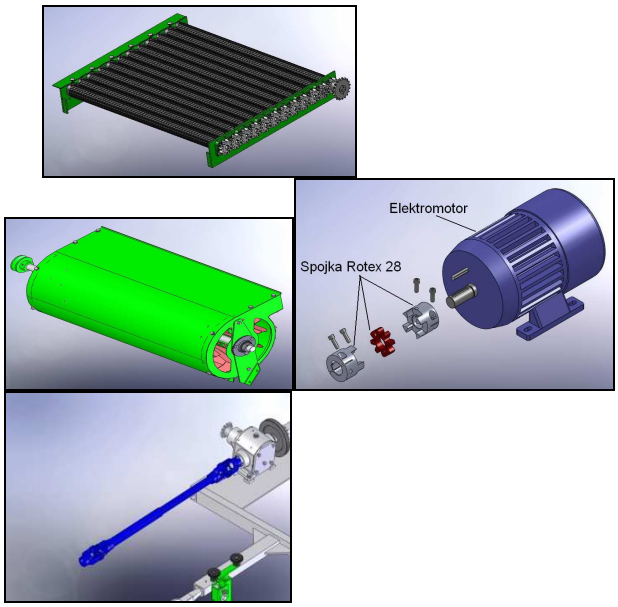


Fig 5. Optional modules of mobile equipment for husking maize

The combination of these modules to obtain three variants of the mobile equipment for husking maize. With this variant, on the basis module has sets the first variant husking table, then the fan and covers of the machine.

Such variant of husking table, precisely drive and geometry of husking rolls, are same as on some solutions husking tables on trailed maize picker/husker.

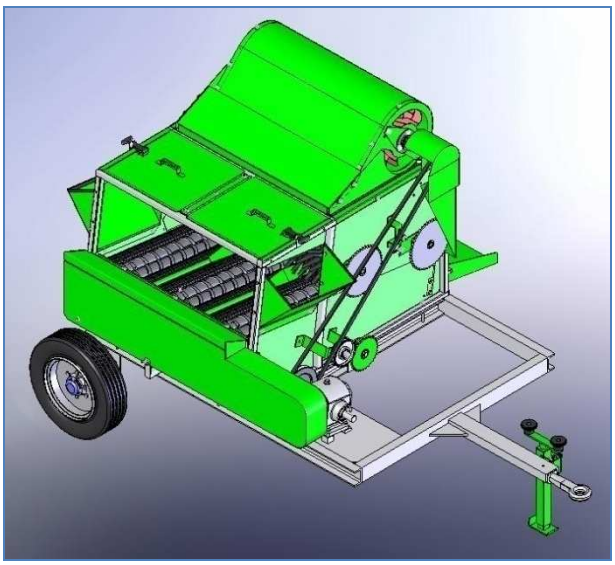


Fig 6. First variant of mobile equipment for husking maize

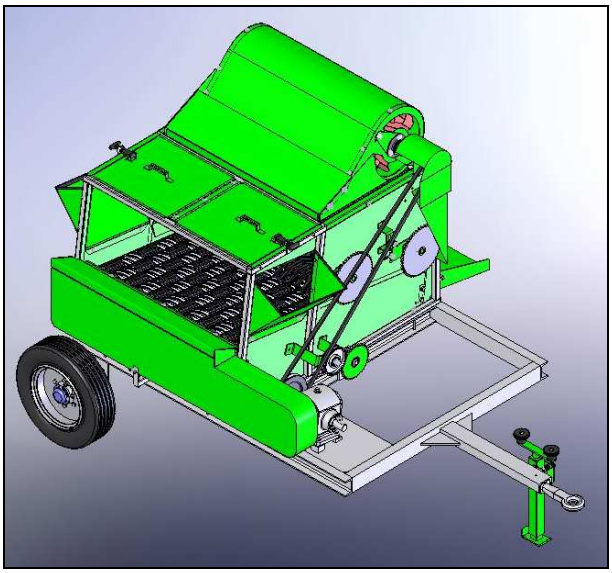


Fig 7. Second variant of mobile equipment for husking maize

At this variant on the basis module has sets the second variant husking table, then the fan and covers of the machine. The fan and covers are totally same as on the first variant. Such variant of husking table, precisely geometry of husking rolls is same as geometry on the French producer maize picker/husker Bourgoin, while the drive of husking table is wholly new – original solution.

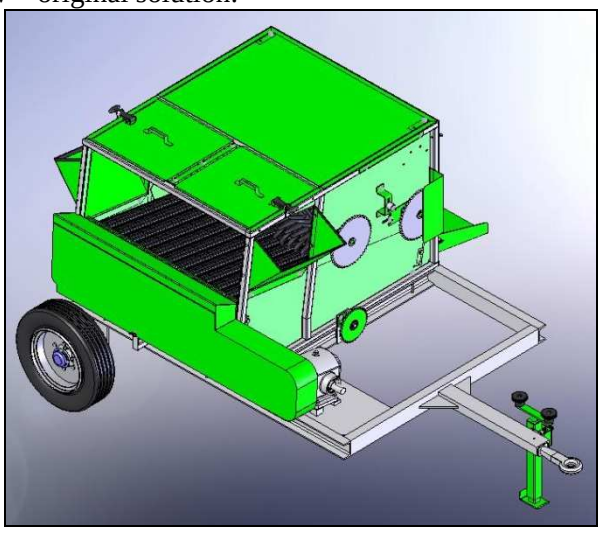


Fig. 8. Third variant of mobile equipment for husking maize

With this variant, on the basis module has sets the first variant husking table and covers of machine.

Such variant of husking rolls is totally new solution. The drive of husking rolls is same as on second variant.

4. Variants design solutions of the husking table

Based on the analysis and processing of the request list, and constructor experience, it is clear that it is necessary to achieve the first and fundamental functional requirement of the new machine, and this is that % of husking of maize cob must be 95 – 100%. This requirement is possible achieve only on the husking part of this machine.

Functionally, husking table has three tasks:

1. Husking, i.e. clearing maize cobs from rest of husks, i.e. placenta in which cob there is.

2. Leading husks, foliage and impurities between the couple of husking rolls.

3. Transport of maize cobs over the husking table.

To achieve this functions on husking rolls both by trailed maize picker/husker and equipment for husking maize, it is necessary to choose appropriate design solution, i.e. design shape of couple husking rolls.

For this reason for the first variant of husking table has taken well-known design solution of husking table from trailed maize picker/husker, which have good husking (for example models ZMAJ and CORNLINER). First variant husking table consists of 6 couples rubber and metal rolls, which are rotating in the opposite direction. As can be seen in figure 9. two rollers are pressured to one another, bring corn cob among themselves, then has broken its placenta and on that way they husks it, then placenta, foliage and so on is led through rolls and they are dropped on the land.

Fig 9. Husking rolls couple

As can be seen in Figure 10. rolls there are in bearing housings (pos. 5 i 6) which are located on the bearing plates (pos. 2 i 3). Every husking roll has one gear (pos. 9), who translate drive and torque on the next husking roll. Huskin table in such solution consists of three independent husking sections. Every section must have two couples of rolls, as well as its own drive by the sprockets. Therefore this husking table solution has three sprockets, one is two-rows (pos. 10) who receives drive from the gearbox and sends it to the other two sprockets (pos. 11).

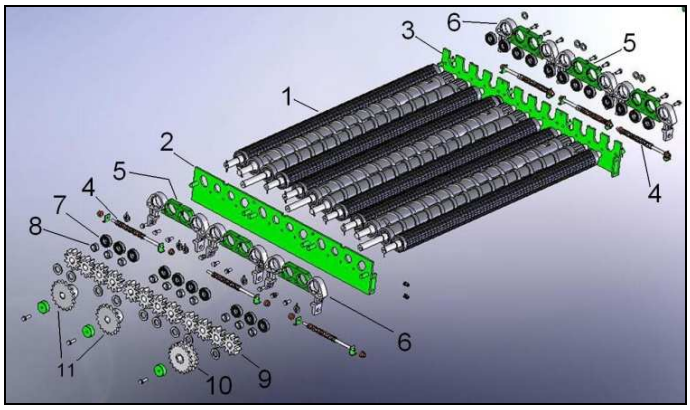


Fig. 10 First variant exploded display

After assembly of husking table in the frame, the module of first variant of husking table looks as in a figure 11.

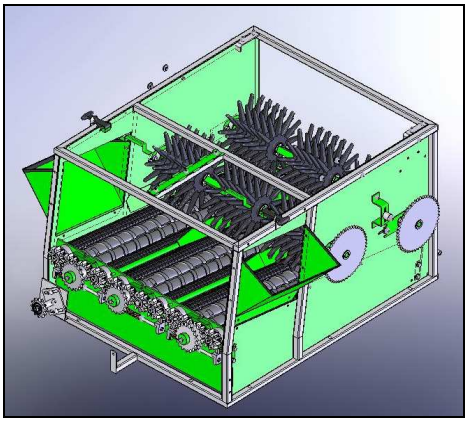


Fig 11. All parts of husking table assembled in the frame

Second variant of husking table is very different if it is compared to the first variant. In the second variant is completely changed husking rolls geometry, housing of bearing, principle how husking table works, and completely is changed the drive of husking table. Geometry of metal husker roll is changed because geometry of first variant of metal husker roll is a very demanding for casting (must be cantered, equal thickness on the circumference, enough addition for machining, and so on), and can be expected a certain percentage of refuse in the casting. Also, this solution has a lot of machining, and just after machining is possible to establish that the roll must be rejected because is not well casts.

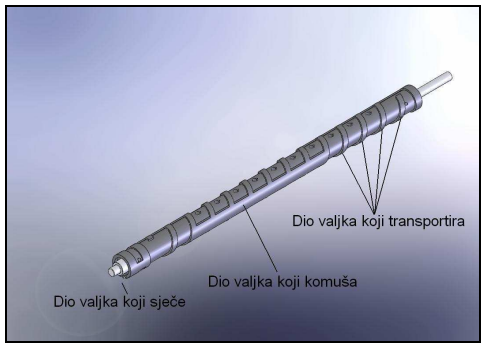


Fig 12. First variant of husker roll assembled

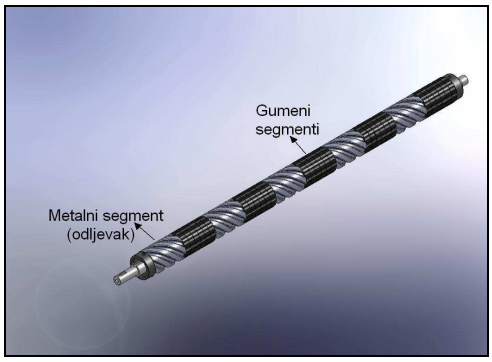


Fig 13. Second variant of husker roll assembled

Advantages of the new design solution husker roll relative to the previous design solution are:

- Metal segment of new husker roll has no high demands by casting in comparison with first solution
- Quality of casting material can be GG 250, and in first variant material must be GGG 40
- has no a lot of machining
- there is no danger for breaking by this solution of roll

Disadvantages of the new design solution husker roll relative to the previous design solution are:

- bigger weight of the pair of combined husker rolls in relation to the weight of the previous design solution of husker rolls pair
- increased the time required for such a roll assembly compared to the previous design solution
- shaft for this roll has more machining

Fig. 14 Couple (pair) second variant husker roll

The housing of bearing shape is changed because work principle of husking table is changed, and new, second variant has simpler geometry, and therefore is simplest for casting.

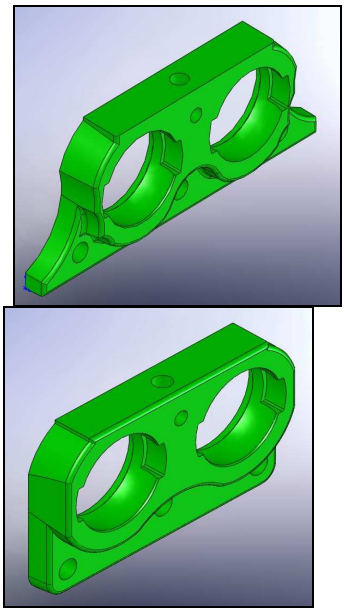


Fig 15. First and second variant of housing for bearing

In new variant of husking table, because work principle is changed, housing of bearing on the figure 20, is removed.

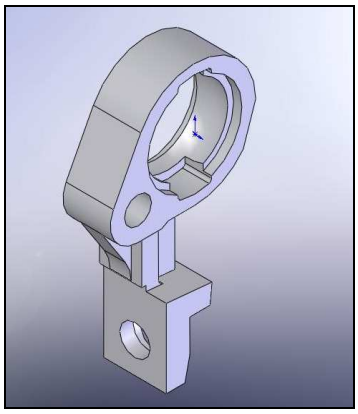


Fig 16. Housing of bearing

Second variant of husking table is displayed on the figure 17., and whole module of husking table is showed on the figure 18.

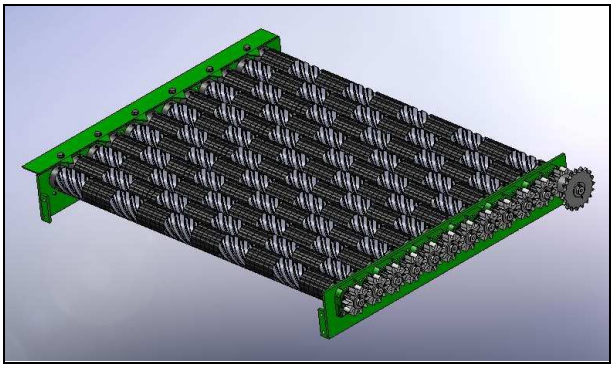


Fig 17.Husking table of second variant

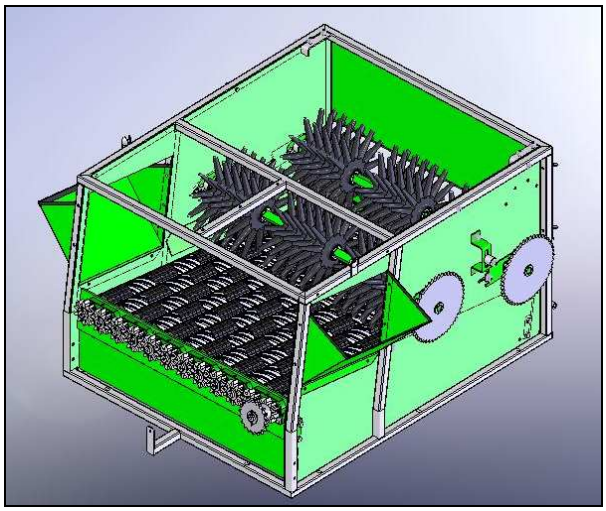


Fig 18. The module of second variant of husking table

In third variant of husking table has made the new simplifications and variations in design solution. The new solutions are reflected in the new variant of a pair of husker rolls, as well as and removing the fan in the structure of the machine. New variant of husker

rolls consists of shaft (pos. 1), with rubber rings (pos. 3) and two metal rings (pos. 4) (there is no any cast in structure). The new solution has following advantages in comparison with previous solutions:

- considerably decreased weight of husker roll
- decreased portion of casting and machining
- simplier subassebly of roll
- considerably decreasing costs of production

Disadvantage of this variant is that it has yet to be examined, as confirmed in the exploitation conditions.

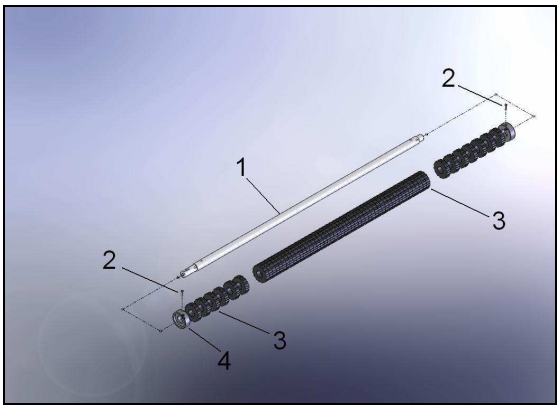


Fig 19. Husker roll of third variant

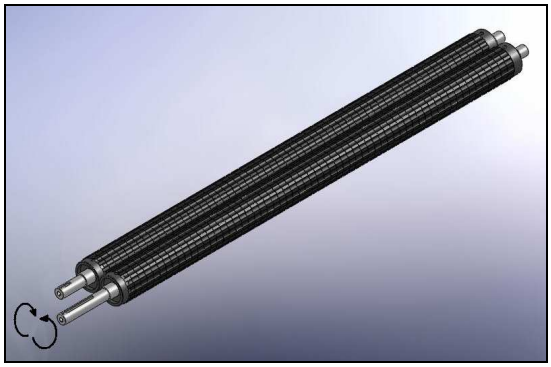


Fig 20. The couple husking rolls of third variant

Also, it would be reasonable to examine the role, significance and contributions to the fan on the equipment for husking, i.e., make and test a prototype of this device in terms of exploitation without fan. Third variant of design solution for husking table (displayed on figure 21) has following advantages if is compared to the previous two variants:

- minimum weight
- the easiest way to create
- the simplest assembling
- with the lowest production costs

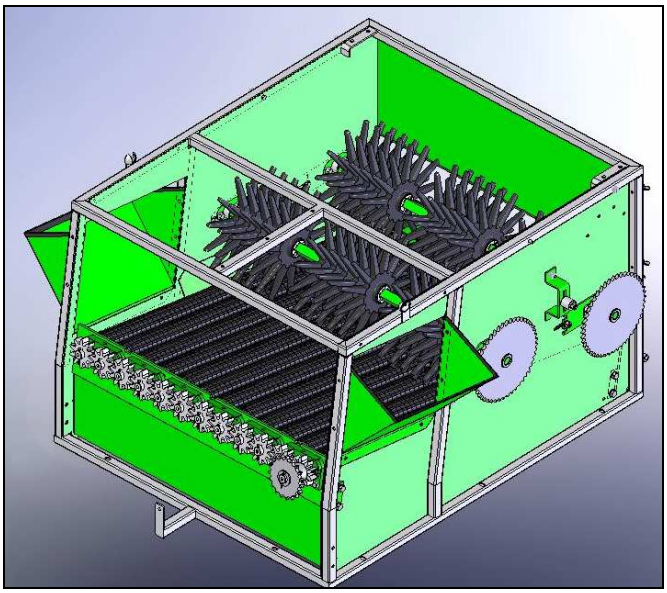


Fig 21. The Module of third variant of husking table

6. Conclusions

In this paper was presented an approach of designing models for three variants of the mobile equipment for husking maize. The reason for making designs for the three variants of the machine is that it is a new product who must undergo testing of the prototype, after which will be able to assess which variant is the best. After testing the product easily can happen that all three variants of the product are acceptable for the market and in this case, the result is - families of three different variants of products for the same purpose, which is in line with modern trends that companies products different versions of the same produces to meet the needs of the market and its customers. The platform of the three variants will be acceptable only if each of the variants has an acceptable cost of production. So, the reliability and efficiency of the machine is not the only measure that has to be achieved that the three variants become the family of products which will be manufactured in serial production. Platform for the design process presented in this article makes Axiomatic theory combined with the experience of the author in designing similar products, and a parametric program for drawing and designing Solidworks. This program is a tool that is significantly shortened the time required for the designing of this machine, and is

known that the process of designing has the most significant impact on production costs.

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Efficiency of Carbon Toner Removal by Double Stage Flotation

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Abstract

In order to investigate the efficiency of black toner removal by double stage flotation, recycling was performed on Navigator office paper printed by two different colour laser printers XEROX PHASER 7700 and LEXMARK C920. In chemical deinking by flotation the sodium laurylethersulphate as the nonionic surfactant was used. Froths collected by flotation were re-floated in purpose to increase the usage of fibers. For an efficiency evaluation of above-mentioned method, an image analysis of all formed handsheets was done. During the first flotation the removal of particles bigger than 0.07 mm^2 is very well achieved, whereat some better efficiency for Lexmark toner removal was obtained. By second flotation extra removal of particles bigger than 0.04 mm^2 was accomplished. Image analysis results gained on froth handsheets point out the good efficiency of carbon toner removal from Lexmark and Xerox froth suspension. These results indicate the need for froth flotation in purpose to achieve enhanced usage of fibres which were in previously done flotations removed from suspension together with impurities.

Keywords: Office paper, Recycling, Chemical deinking, Double stage flotation

1. Introduction

Office papers are widely used every day, not just in photocopying purposes, but also for handwriting and printing documents used for archiving. This type of paper, like any other, is the product made from vegetable origin fibers, mostly of wood. In order to decrease the cutting of trees, which are used as the raw materials for paper production, the recycling of papers is necessary. The production of a good quality paper requires an adequate modification of the secondary fiber properties and the removal of a large amount of contaminants, namely stickies, sizing and coating agents, mineral fillers and inks.

Recycling of the used papers is a complicated technological process composed of four basic process units: a) disintegration or defibering – which comprises the preparation of used paper suspension, b) removal of impurities from the suspension, mostly by washing or flotation, c) whitening of fibers and d) treatment of the process water [1].

It is difficult to define the recycling rules, which would be equally valid for all papers on global landfills. Chemical composition of paper, printing ink and printing technique have an important influence on the recycling efficiency. Also many printer producers are available on market: Xerox, Canon, HP, Lexmark, Epson and others. Nonimpact printed white office papers that include xerographic and laser printed papers are difficult to deink with conventional deinking methods [2]. Because offices use more laser printers and copy machines every year, the amount of nonimpact printed papers entering the recycled paper stream is increasing. Ink removal from these papers remains still a major challenge. Conventional chemical deinking is not an effective mean for deinking nonimpact printed papers. The efficiency is due primarily to the strong adherence of the toner particles to the paper surfaces [3], [4].

Enzymatic deinking methods represent a new approach to convert these recycled papers into quality products [5], [6].

Nowadays the requirement for paper manufacturing from recycled fibres is increasing. Chemical deinking flotation for impurities removal is a usual method for paper recycling used in paper mills all over the world. However, during flotation process the lost of fibres is unavoidable. Fibres are important raw material for recovered paper production. So in this work the maximal usage of fibres after flotation was tried to

achieve. That is why the double stage flotation as well as the froth flotation collected during flotation was performed.

2. Methods and materials used for research

For the deinking flotation investigation the Navigator paper (grammage of 80 gm^{-2}) printed only with black toner by laser colour printer XEROX PHASER 7700 and LEXMARK C920 has been used. Each printed output contained 848 words arranged in 56 lines. Navigator paper was chosen for printing as one of the most used office paper on Croatian market.

Chemical deinking by flotation was done using Enrico Toniolo disintegrator (V = 2.0 L), laboratory flotation cell (V = 12 L) and handsheet former for handsheet dimensions 340 mm x 250 mm (Figure 1). The apparatus consists of two parts separated by screen. In upper part suspension and water are repelled, while the bottom part is filled with water.

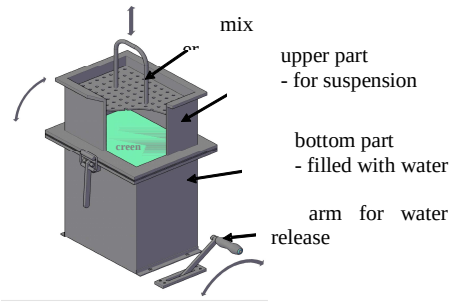

Fig. 1. Laboratory handsheet former.

The schematic presentation of deinking flotation process flow is presented in Figure 2. At the same experimental conditions, but separately, paper samples printed by different printed was recycled. Disintegration of 100 g printed paper sample during 10 minutes in 2 litre tap water at the temperature of 50°C, pH value of 11 (adjusted with soda alkali) and the consistency of the suspension of 5% was performed. The sodium laurylethersulphate as the nonionic surfactant was used. The suspension obtained by the disintegration was homogenized with 10 litre of cold tap water, and the temperature was decreased at 30°C, with the pH value of 7.5 and the consistency of 0.83%. This homogenized suspension was divided into two parts A and B, of equal volume, which were separately floated during the time of 8 minutes after the addition of 6 litre of tap water (the first flotation). Need for suspension partition was occurred as a result of too big suspension volume for flotation cell. Namely, suspension was agitated before division but some differences in solution composition after division was expected because of precipitation of some components. During the first flotation the froth was manually collected.

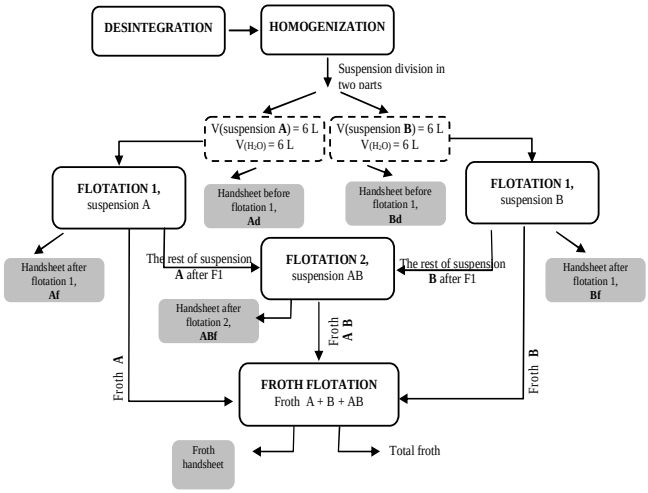

Fig. 2. Process flow of chemical deinking by flotation

Laboratory handsheet before flotation (Ad, Bd) and after flotation (Af and Bf) was made from each suspension. After the laboratory handsheets were made after the first flotation the rests of the suspensions A and B were mixed into the suspension AB that was floated (the second flotation) under the same conditions as A and B suspension during the first flotation. After the second flotation the laboratory handsheet ABf was made. The froth AB collected in the second flotation was mixed with the froths A and B collected in the first flotation. The collected froth was homogenized with the addition of 10 litre of tap water and after that floated for 8 minutes. By froth flotation the impurities were manually collected on the suspension surface. After the flotation time the whole suspension from the flotation chamber was used for making the laboratory handsheet from froth.

On all laboratory handsheets formed after the recycling the image analysis were made.

3. Results and achievements

The total number and the total particle surface on all handsheets made during the chemical deinking by flotation are presented in Figure 3. These results are obtained by image analysis method on all handsheets made from Navigator Lexmark and Xerox printout.

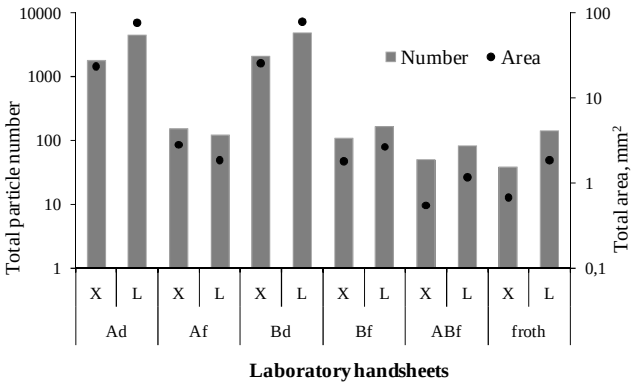

Fig. 3. Image analysis results of the handsheets made during chemical deinking by flotation

It is interesting that although each printed output contained equal number of words arranged in same number of lines, does not contain the same total particle number of black toner in handsheets made at same stage of recycling process for Lexmarx and Xerox printer. For all stages of recycling process handsheets from Lexmark printout contain higher amount of black toner particle. After homogenisation suspension was divided into two equal volume parts (A and B), so before the first flotation laboratory handsheets for both suspensions were formed (Ad, Bd). As it was expected Bd handsheets contains greater number of toner particles for both printers because of precipitation of some components. The laboratory handsheets of each suspension after the first flotation (Af, Bf) consist significantly less number of toner particles.

The flotation efficiency was investigated by detection of toner particles number in handsheets formed before (Ad and Bd) and after flotation (Af, Bf and ABf). The efficiency of the each colour toner particle removal (E_f) is calculated according to Equation 1:

$$E_f = \frac{\text{particle number}_{\text{before flotation}} - \text{particle number}_{\text{after flotation}}}{\text{particle number}_{\text{before flotation}}} \times 100\% \qquad (1)$$

The removal efficiency of black Xerox toner for suspension A is 91.5%, while for black Lexmark toner removal efficiency is 97.3%. The removal efficiency of black Xerox toner for suspension B is 94.8% and 96.6% for black Lexmark toner. During the second flotation (ABf) the part of the both printer toner particles, which was left after the first flotation, was removed. The efficiency of black Xerox toner removal by second flotation is 61.4% and 42.6% for Lexmark toner. The results obtained by froth handsheets image analysing are notable for increasing the usage of fibers. Namely, total particle number in those handsheets is significantly lower for Xerox black toner in comparison with handsheets formed after first and second flotation for same printer printout on Navigator paper. While Lexmark toner removal from froth is not so efficient as for Xerox black toner but is still noteworthy.

By image analysis, the particle with the size ranges from 0.001 mm^2 up to greater than 5 mm^2 divided into 25 size classes are identified. The particle size classes identified on handsheets formed before the first flotation of suspension A (Ad) are presented in Figure 4. Lexmark and Xerox black toner particles are fragmented by disintegration into the size range from 0.001 mm^2 to 0.25 mm^2. The identification of the particles smaller than 0.001 mm^2 was not possible by this method. Although the black Navigator printouts were printed with same number of signs, number and size of black Xerox and Lexmark toner particles in handsheets before the first flotation (Ad, Bd) were not identified. This difference in toner particle size used by different printer machines greatly influence on flotation efficiency, what can be seen on Figures 5, 7, 8 and 9.

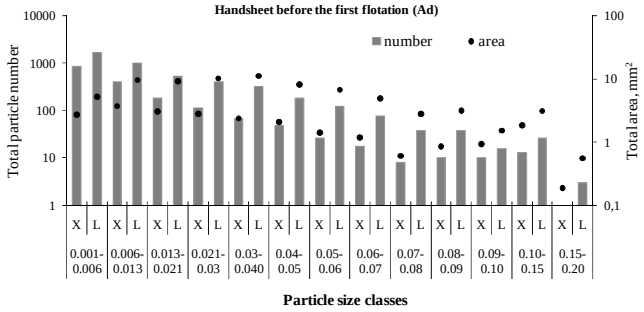

Fig. 4. The image analysis results of handsheets before the first flotation of suspension A (Ad);
L-Lexmark, X-Xerox

The particle size classes identified on handsheets after the first flotation (Af) are presented at Figure 5.

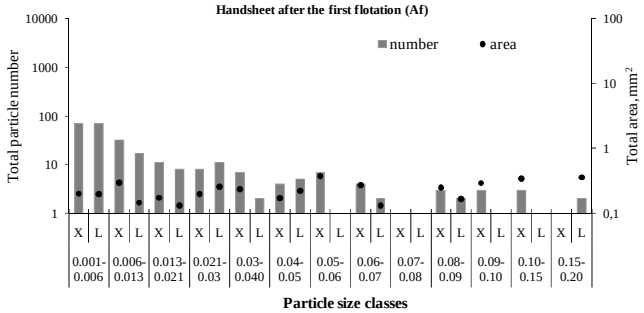

Fig. 5. The image analysis results of handsheets after the first flotation of suspension A (Af);
L-Lexmark, X-Xerox

From these results it is clearly to see that larger particles are easier to remove by flotation. Although handsheets made after Lexmark printouts disintegration made contain higher total particle number than Xerox handsheets (Figure 3), the higher number of black Lexmark toner particles was removed by flotation in comparison with Xerox particles at same experimental conditions.

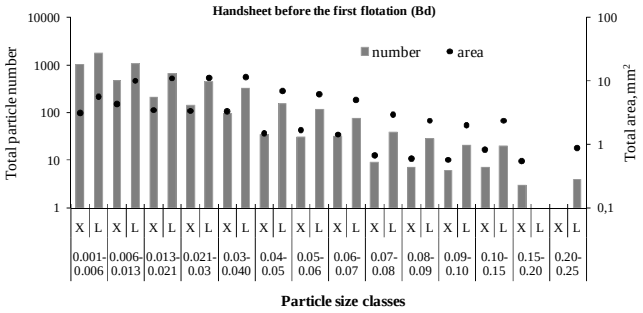

Fig. 6. The image analysis results of handsheets before the first flotation of suspension B (Bd); L-Lexmark, X-Xerox

At Figure 6 classes of the particle sizes identified on handsheets made before the first flotation of B suspension (Bd) are presented. As it was expected Bd handsheets contains greater total number of toner particles for both printers in comparison with Ad handsheets because of precipitation, which is unavoidable consequence of suspension division. From obtained results it could be conclude that size of toner particle effect on precipitation. Higher number of larger particles in Bd handsheets is consequence of precipitation.

The particle size classes identified on handsheets formed after the first flotation of B suspension (Bf) are presented at Figure 7. Just like for suspension A, flotation efficiency for suspension B is better for larger toner particles.

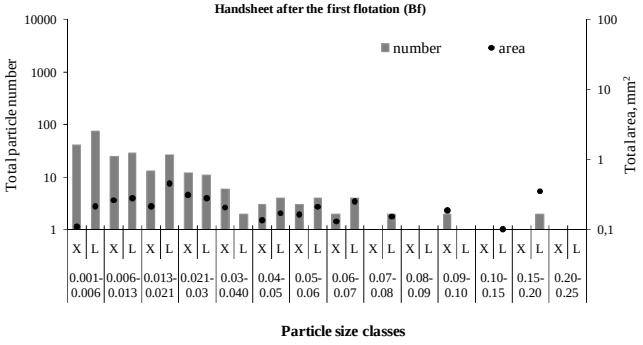

Fig. 7. The image analysis results of handsheets after the first flotation of suspension B (Bf);
L-Lexmark, X-Xerox

After Af and Bf handsheets were made, the rests of the suspensions A and B were mixed into the suspension AB that was floated (the second flotation) under the same conditions as A and B suspension during the first flotation. After the second flotation the laboratory handsheet ABf was made and the particle size classes identified on that handsheet is shown at Figure 8.

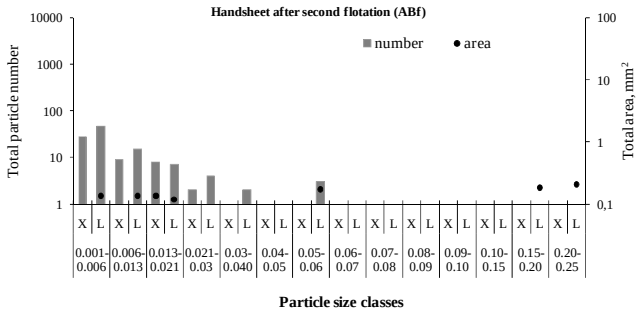

Fig. 8. The image analysis results of handsheets after second flotation (ABf); L-Lexmark, X-Xerox

During the second flotation the part of the particles (especially lager ones), which was left after the first flotation, was removed. It is interesting that the second flotation is more efficiently for black Xerox particles that were heavier to remove by first flotation in comparison with black Lexmark particles.

Based on image analysis results flotation efficiency was calculated according to Equation (1). By the first flotation of suspensions A and B and second flotation of AB suspension 95% of black Xerox toner and 98% of black Lexmark toner were removed.

Image analysis results of froth flotation collected during the first (Af, Bf) and second (ABf) flotation are presented at Figure 9. The suspension for froth flotation (A+B+AB) was made from impurities collected with froth. After flotation of froth suspension froth handsheet was formed. When we compare the total number of particles in froth handsheets indentified by image analysis method with total number of particles in handsheets after second flotation, for both printers, we can conclude that there are no big differences in these numbers. These results pointed out the efficiency of froth suspension flotation, i.e. it is possible to reuse fibres which are usually thrown away with froth.

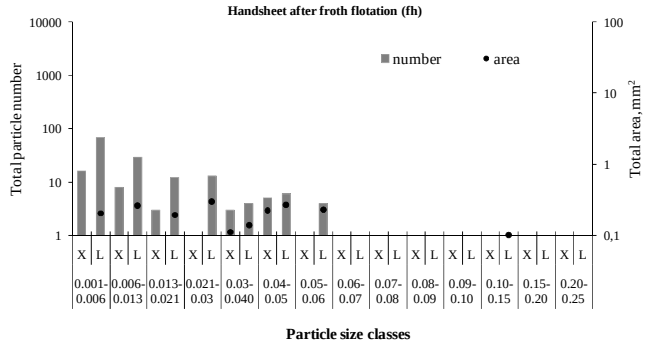

Fig. 9. The image analysis results of handsheets after froth flotation (fh); L-Lexmark, X-Xerox

4. Conclusions

In this work the removal efficiency of black Lexmark and Xerox toner on Navigator paper by chemical deinking flotation is confirmed. Black Lexmark and Xerox toner particles from disintegrated Navigator printouts suspension are all in size classes from 0.001 to 0.20 mm^2. During the first flotation the removal of particles bigger than 0.07 mm^2 is very well achieved, whereat some better efficiency for Lexmark toner removal was obtained. By second flotation extra removal of particles bigger than 0.04 mm^2 was accomplished.

Image analysis results gained on froth handsheets point out the good efficiency of carbon toner removal from Lexmark and Xerox froth suspension. Froth handsheets image analysis results indicate the similar distribution of particles size and number as in handsheets formed after second flotation.

These results indicate the need for froth flotation in purpose to achieve enhanced usage of fibres which were in previously done flotations removed from suspension together with impurities. In all formed handsheets after flotation (Af, Bf, ABf, fh) by image analysis method particles smaller than 0.04 mm^2 were identified. From these results it could be conclude how those small particles are merged in fibres lumen and in that way their removal by flotation is impossible.

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Energy consumption apportionment

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Abstract

This article presented an energy analysis and comparison of energy consumption of two similar facilities for its intended use. This is the catering facilities which are comparable in their activity, based on a comparison of energy consumption in both areas (consumption of electricity and natural gas consumption). There are several coefficients that influence the size of the object which can be easily obtained and they are taken into account. Energy analysis is made during more than a year and passed on the basis of the conclusions related to the relationship between energy consumption and installed equipment for a particular purpose and employer's and guest's habits related to energy consumption for a particular object. There are various parameters which may affect the comparison, but the detailed analysis we propose try to exclude those that will not affect the comparison of the main objectives of the analysis. Here, the comparison is done using different energy sources for air-conditioning facility, which will ultimately affect large or small seasonal variations in consumption of the energy.

Keywords: energy consumption, electricity, natural gas, variability, load diagram.

1. Introduction

It is for sure basic planning engineers' assumption that detailed analysis of power consumption need to last over a longer time. But here is also easy to see, at first glance the real possibility of comparison because energy consumptions of both catering facilities followed simultaneously in the same period of observation (more than one year) on the monthly schedule. The impact of quantitative variations of external temperature on the results of the analysis can be avoided in this way. Of course, there are seasonal fluctuations in energy consumption (here, depending on the number of guests) or increase spending during the holidays. Comparing the measured data of energy consumption given over a long number of years could reach a variable energy amount and the total required energy ratio and ratio of variable energy amount and constant part of the energy consumption.[1] Of course, some assumptions over the monitored period applied here are:

a) There is no new devices to increase power consumption and
b) There is no increase of the capacity of catering facilities, such as interior space, the total object's volume, number of rooms and similar.

The annual consumptions of different kinds of energy for both objects are made and presented like time-depending curves. [2] Electric energy monthly amount is adapted in energy amount per day during monitored month due to inexact number of days between two consecutive registering of electric energy consumption aiming to get more properly measured data. Also, monthly peak electric loads of both objects during a year are made. [3] It is especially important to pay attention to the maximum and minimum values of peak monthly load and monthly energy consumed during the year and the values of deviations from the average value per month during the year. The power system is particularly exposed to problem of large variations in load (power) in a unit time. [4] Variations of electrical power required to satisfy all customers can be analyzed during the day, month or year. [5] These variations are related to human living habits at home, and proper disposition of human activities during the day, such as the duration of the school, working hours of hospitals, public offices, trade and industry. Entire power system, including a large production capacity (power plants or imports) should be dimensioned according to the highest possible expected load on the system. Maximum possible amount of electric power/energy and the energy production prices of a certain amount of electric power/energy in domestic power plants

depends on a number of parameters such as the installed capacity in existing power plants, power plants scheduled closing time, all plants possible load range, specific marginal costs of each plant ($/kW), planned periods of maintenance and cost of maintenance, hydrological conditions, opportunities and the use of pumped storage hydro capacity, the price of primary energy in the world market and so forth. In other words, the power system must continue to perform its function regardless of the size of the load. Clearly, there are certain technical limits. Each of the elements of the system must be able to hold on a peak load over the elements (overhead lines, underground cables, power transformers) which must be transmitted. Also, it is necessary to provide hot reserves in power plants to currently produce increased power/energy demand or the possibility of international agreements for emergency and unplanned energy imports, which is particularly expensive.

2. The analysis of the performed measurements of energy consumption

The comparison of energy consumption of two hotel objects (electricity and natural gas) is shown here. Objects have the same function (business activity) but with different guest's capacities (different surfaces or volume of the object). Although these different size of two objects, it doesn't affect on energy comparison and/or on definition of the main goals of the here performed research. Using proposed step-by-step approach, different energy sources for air-conditioning are analyzed. Air conditioning devices are facility which consumption is ultimately affected by change in outdoor temperature and it can affect on large or small seasonal variations in the total energy consumption.

Of course, monthly energy consumption and coupled expenditure for each of the hotels is easy to estimate and according to applicable natural gas tariff system will not significantly affect the total amount paid for energy. Large volatile in energy consumption demand need to impact on higher prices to penalize necessarily installed capacities in power system. The most of problems connected with development planning in the system and ordering activities of import quantity of natural gas on time-base are caused by established natural gas tariff system in Croatia. Change in tariff polices result in competitiveness increases. When we talk about the problems of our tourism, which stands out as the biggest problem? It is short season and the main goal is to extend it. Why? Due to the depreciation of major investment, total fixed costs of service are high what impact on reducing competitiveness. Comparing it with investments in power facilities and gas network, then we realize that we must take a different energy policy to have a balanced energy consumption curve. To meet peak loads and large seasonal variations in such power systems, large capacity power plants and large gas storage spaces have to be built which as consequence contribute to high investment, which ultimately affects the price of gas and electricity price. In addition, network infrastructure costs in such cases of seasonal use are very high.

Comparing the consumption data, we can see that the hotel that uses gas for cooling facility in addition to heating facility, hot water producing and cooking has negligible little variation in electricity peak load engaged between summer and winter (object 2). Here, peak monthly load deviates 11.5% during the year compared to the average value and monthly energy consumption deviates 11.22%. .[2] Another hotel's peak monthly load deviates 38.5% during the year compared to its average value (object 1) and monthly energy consumption deviates 30.32% to the average consummated energy. It is even untoward if ratio between maximum and minimum monthly peak load are taking into account: 78.4% (object 1) and only 28.4% (object 2), Figures 1-4.

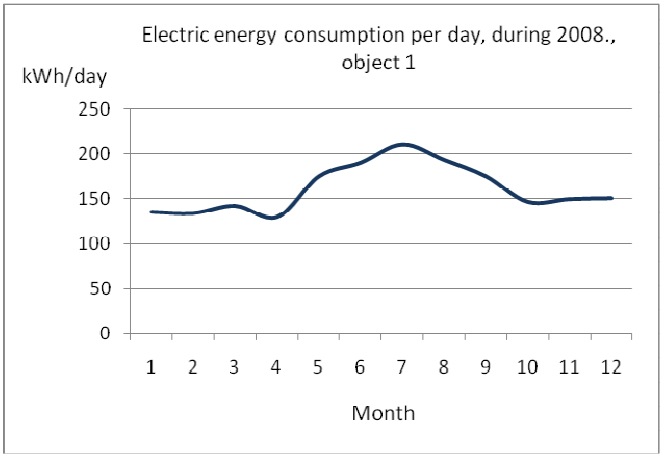

Fig. 1. Electric energy consumption diagram, object 1

Air conditioning devices installed in object 1 are fed by electric energy and it is the cause of such variances in electric power diagram during the summer when there is increasing demand for energy need for air cooling. Exactly that increased peak load in a short time period

(comparing to year) has resulted in increased production and network capacity that can affect the price of electricity to all consumers.

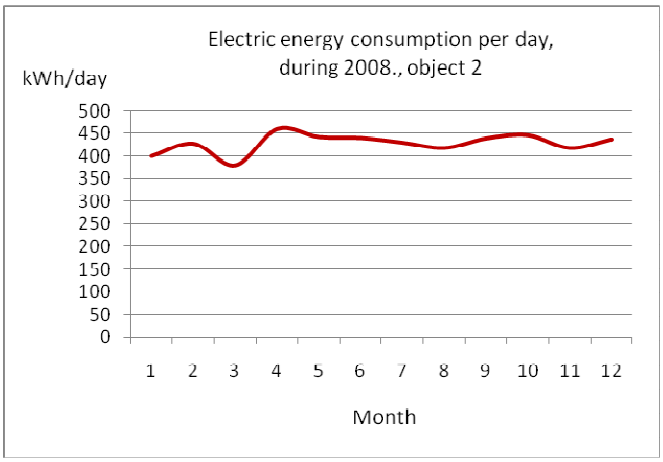

Fig. 2. Electric energy consumption diagram, object 2

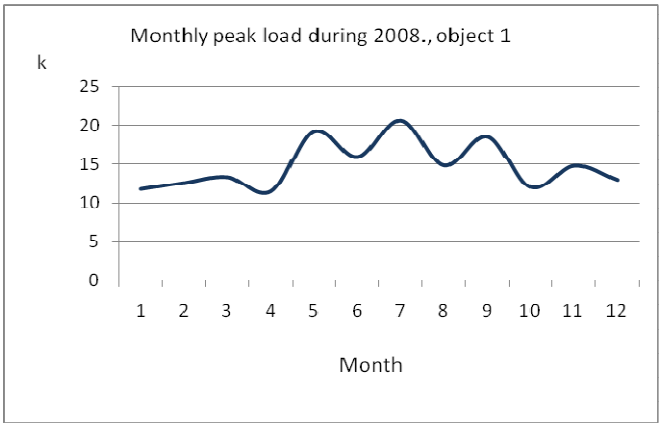

Fig. 3. Electric peak load diagram, object 1

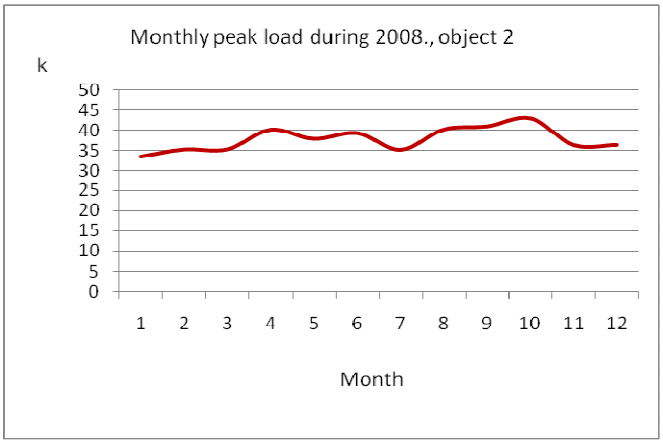

Fig. 4. Electric peak load diagram, object 2

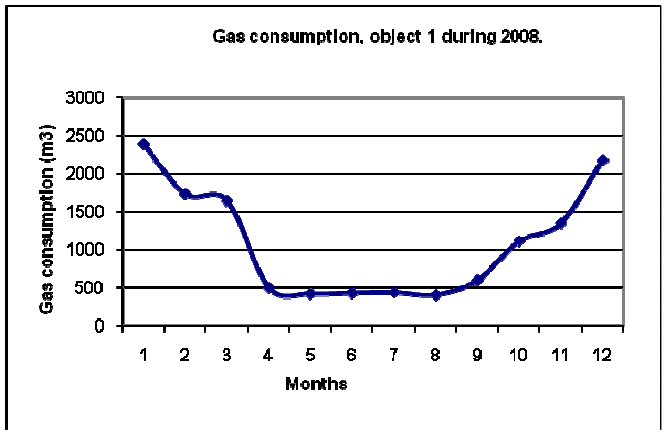

Fig. 5.Gas consumption diagram, object 1

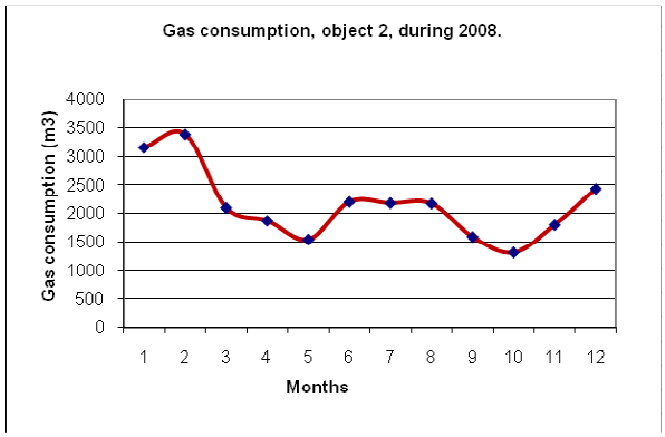

Fig. 6.Gas consumption diagram, object 2

On the other hand, consumption of gas shows that grateful consumer is one with air conditioning fed by natural gas because of its gas consumption varies up to 100% and the lowest energy amount is needed during the transitional period between summer and winter, while the ratio of consumption during the summer compared to consumption during the winter is only 50% (object 2). The relationships of natural gas consumption in periods of summer-winter ranges of up to 600% (object 2) are presented on Figures 5 and 6 for both objects.

4. Consequences on performed analyze of energy consumption

Such a consumer who does not have large oscillations and consequently does not require storage facilities and large investments and also doesn't affect on the price of gas, is actually the most grateful consumer. Such a consumer uses built on network throughout all the year. In comparison with the catering

aspect, it is the same as if you have tourists all year round staying in your hotel. Air conditioning fed by natural doesn't outcome any additional burden for the gas network. Therefore, we have a balanced spending very well used investment capacity of the gas that RH should be encouraged through regulation and so should not address a request for greater capacity of power system and additional gas storage.

The ideal situation to the power system would be existence of the constant load with as little as possible variations in load by means with lower frequency of occurrence of small deviations from the constant load and with the smaller values of deviation. Of course in real world, it is almost impossible to achieve, but the tariff policy need to stimulate the customer to decrease the value of peak power or in other words to punish the large peak power measured by electricity metering devices. Within the existing tariff system for the sale/purchase of electricity only small part behaviour (increase prices in specific parts of the day) of the today electricity market is modeled. Power market energy price is in permanent redefinition during periods of greatest need (maximum load) accompanying with rising energy prices due to congestion of available network capacities which lead to very high marginal costs.

Large customers have permanent engagement to plan peak month load during the next 12 months. Allowed deviation from the planned peak load is +20% and -20%, so realized peak load need to be in range from 80-120% of planned peak load. In the case of lower peak load realization then to 80% of planned value, obligated charge to pay is exact minimum of 80% of planed value. Power system expanses are accompanied with lower system peak load like: too large amount of electricity to product by precise scheduling and agreed upon import of electricity which is typically much more expensive than domestic production and irremissibly (orders with exactly certain amount of energy in exactly a certain time). In contrast, in the case consumer's peak load during the month claimed peak power greater than 120% planned, realized the difference of up to 120% in the double penalized cost power.

4. Conclusion

From the above considerations, the peak load of the power system and/or stabile consumption of the gas system can be changed only by guided energy policy in order to increase the consumption of gas in the summer to take advantage of gas infrastructure, and to reduce imported power during the summer, which ultimately affects the lower price of electricity and gas.

By making the analysis it is possible to implement the planning of consumption of the same objects in the near future, or influence to change devices or energy consumption habits.

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Sealing of Threaded Joints in Gas Pipeline Installations

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Abstract

The problem of gas leaking on threaded joints sealed with hemp in home metering and control units (MCUs) occurs in daily installer´s praxis. Same is affirmed based on leaking analysis provided in this paper. Basic objective of the paper is to investigate reliability and safety of sealing threaded joints in MCUs with sealing cord at different number of turns (from 6 to 10 turns) and at different working pressures (from 1 to 6 bar). Experimental work includes testing of sealing cord Loctite 55 with two material combinations (steel-brass, brass–aluminum) in threaded pipe joints of Whitworth form at temperature 24 °C.

Keywords: leaking analysis, threaded joints, sealing cord, gas pipeline installation

1. Introduction

Application of hemp and non-curing sealing compounds is very often in developing countries for different installation types, especially in natural gas installations. Beside of carefully assembling, industry faces with leakage problems of such joints after few years of exploitation. Nowadays, most of the countries and especially industrial developed countries devote great care to development and application of sealing materials for sealing of threaded joints in gas pipeline installations and installations for other medium.

Main task of thread sealants is to prevent leakage of gases and liquids from pipe joints. All such joints consider being dynamic due to vibrations, changing pressures or changing temperatures, which induct special requests on them. With growth of natural gas usage, possibilities of risk are also increasing, and for that reason, it is necessary to direct all attention on tightness of sealed joints in gas installations.

The usage of various sealing materials for achieving tight threaded joints in gas pipeline installations is regulated with EN 751 [1] standard. According to EN 751 regulations non-curing sealing compounds, polytetrafluoroethylene (PTFE) tapes and anaerobic polymer can be used for sealing.

Apart from mentioned, sealing cord can also be used for sealing threaded joints. The result of developing this kind of sealant is product Loctite 55 that contains sequence of little fibers. Reliability of its application in sealing of threaded joints is going to be investigated in this paper. The leaking of the gas from commercial pipelines is not only safety problem; it should also regard as direct loss of financial resources for gas distributors. Therefore, it is necessary to determine positions and frequency of the gas leaking as well as to analyze the possible causes of leaking and to give the eventual solutions to improve sealing.

2. Leaking Analysis

Standard DIN 2999 [2] defines mode for making threaded joints in gas pipeline installations. In gas pipeline installations threaded joints are made as Whitworth´s where internal thread is cylindrical and external thread is conical. The main task of sealing materials is to fill clearances between internal and external threads, and by that assure tightness of joints under medium pressure.

To set the natural gas consumer in motion, work performer has to make the home metering and control unit (MCU) and to seal all elements safely. An analysis of the gas leaking in home MCUs has been performed

in the gas distributive region Papuk Ltd. (locations Orahovica and Čačinci) [3]. The installation systems of 3 bar inlet pressure have been analyzed. Each MCU consists of seven threaded pipe joints (schematic overview in Figure 1), all sealed traditionally with hemp and non-curing jointing compounds.

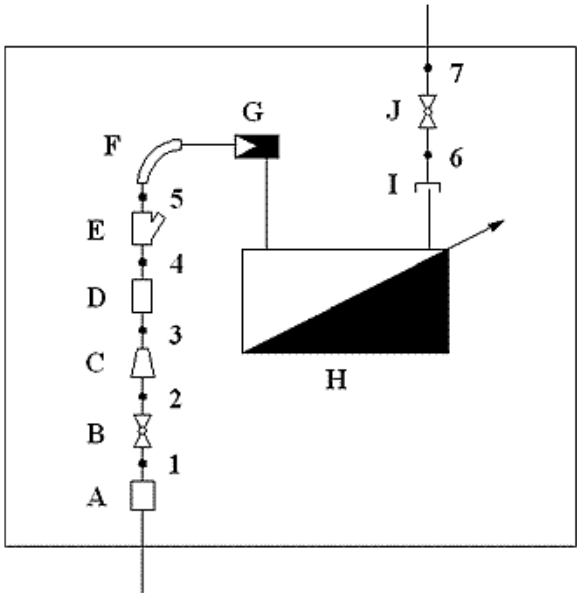

Fig. 1. Schematic overview of MCU (A-sub, B, J-bulb-cock, C-fitting reducer, D-nipple, E-filter, F-bend, G-regulator of the pressure, H-gas-flow meter, I-union flat joint, 1···7 – threaded joints) [3]

Gas leakage on each considered MCUs, has been controlled using a foam-detecting agent [4].

2.1. Results of Leaking Analysis

A total of 100 MCUs (700 threaded joints) have been analyzed in the gas distributive region Papuk Ltd. at 3 bar inlet pressure [3].

From the total number of analyzed threaded joints 42 (or 6%) appeared defective. In even 30 (or 30%), from the total number of analyzed MCUs, has been perceived gas leaking on threaded joint [3].

In the location of Orahovica have been analyzed 50 MCUs or 350 threaded joints. Total number of leaking joints is 18 or 5,1 % [3]. Figure 2 shows gas leaking frequency on each position of threaded joints in the location of Orahovica.

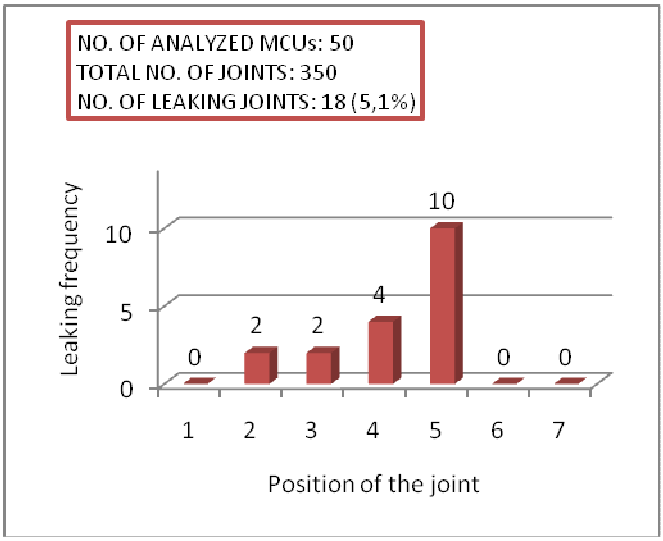

Fig. 2. Gas leaking frequency in the location of Orahovica,
p_{ul} = 3 bar

If leaking positions in figure 2 are observed, it is obviously that all defective joints are placed from position 1 to position 5 where gas pressure is 3 bar. It is also visible that there is no defective joints on positions 6 and 7 where gas pressure is 22 mbar.

In the location of Čačinci have been analyzed 50 MCUs or 350 threaded joints. Total number of leaking joints is 24 or 6,9 % [3]. Figure 3 shows gas leaking frequency on each position of threaded joints in the location of Čačinci.

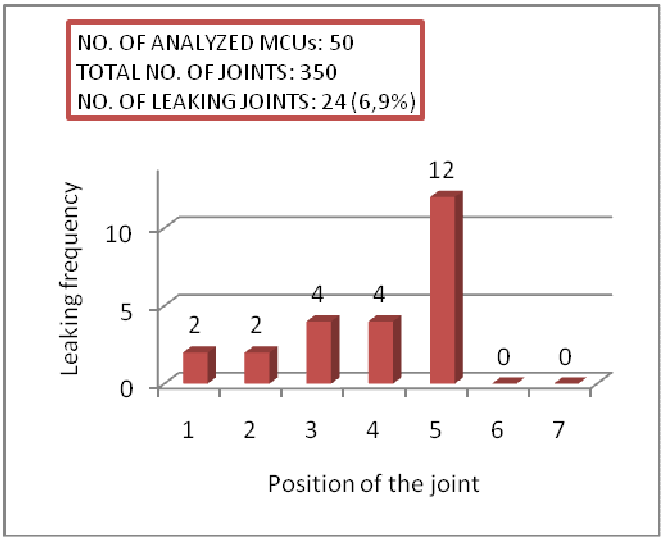

Fig. 3. Gas leaking frequency in the location of Čačinci, p_{ul} = 3 bar

Figure 3 shows that all leaking points are from position 1 to position 5 where pressure is 3 bar (before regulator of the gas pressure). Alike can be concluded that on positions 6 and 7 are no leaking points because those positions are in the area of low gas pressure (22 mbar).

2.2. Discussion of the Leaking Analysis Results

In spite of regular tightness control in MCUs and its sanation, the analysis has shown an unacceptable high number of threaded joints, in which gas leakage has been detected. There are many factors influencing the reliability. It might be the thread length, uncorrected cutting tool, sealing material or man work. However, the analysis has shown that one of the most important factors is applied sealing method [5, 6].

Quality carried out joints in gas pipeline installations are important to distributors not only for safty but also for financial reason.

Therefore, authors have conducted experimental investigations in which sealing cord has been applied in some positions of the commercial gas pipelines and compared with the same positions on pipe work sealed traditionally. That effect previously conducted analysis as an important basis for further investigation on sealing cord Loctite 55.

3. Experimental Investigations

All experimental procedures have been conducted on R¾" pipe fittings of Withworth form [2] with different fitting material combinations, different number of sealing cord turns and at different pressures on each test tube. Working temperature was 24 °C. Among other, objective of experimental investigations was to determinate reliability of sealing threaded joints with sealing cord Loctite 55 at minimum 6 to maximum 10 sealing cord turns (manufacturer recommends from 7 to 9 turns) [7].

3.1. Design and Course of the Experiment

Joints have been carried out on the model made of elements that are used in home metering and control units. Experimental setup for testing joint tightness at different number of sealing cord turns and at different pressures, consists of five test tubes marked with letters A, B, C, D, E that are made of steel pipe construction, brass bulb cock and aluminum plug (figures 4 and 5).

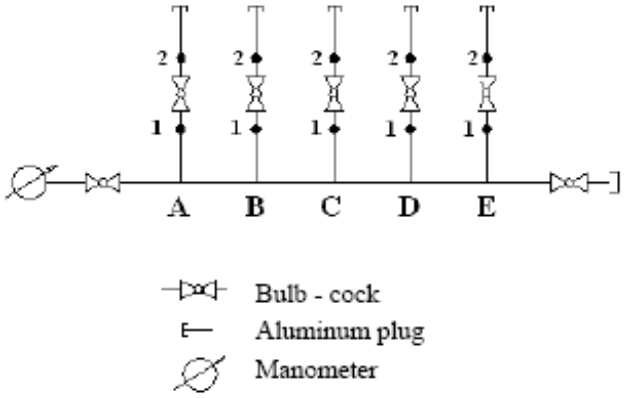

Fig. 4. Schematic overview of experimental setup [3]

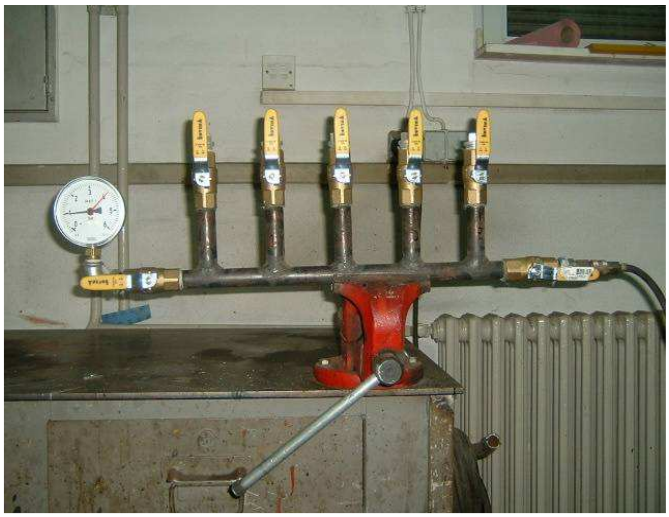

Fig. 5. Experimental setup [3]

Two material combinations in threaded joints were tested: steel-brass (1) and brass-aluminum (2). Three experimental runs have been applied. Summarized, all factors and level values are shown in Table 1.

Table 1. Influencing factors and their levels [3]

Factors		**Levels**	
A	Working pressure	*p*=1 bar	
		p=2 bar	
		p=3 bar	
		p=4 bar	
		p=5 bar	
		p=6 bar	
B	Fitting material combination	steel-brass	1
		brass-aluminum	2

Experimental tubes were prepared in the way that on the first test tube every fitting material combination has 6 turns, on second test tube has 7 turns, on third test tube has 8 turns, on fourth test tube has 9 turns and on fifth test tube has 10 turns. Figure 6 shows prepared test tubes with the number of sealing cord turns as previously described.

Fig. 6. Prepared test tubes with sealing cord Loctite 55 [3]

Prepared specimens have been loaded at working pressure p=1 bar and afterwards tightness of all joints has been controlled using a foam-detecting agent (Figure 7). Experiment has had three runs.

Fig. 7. Testing joints tightness [3]

Besides at working pressure 1 bar, described procedure has also been conducted at pressures from 2 to 6 bar.

3.2. Results and Discussion

Since all threaded joints have been tested on tightness, results were registered and shown in Table 2.

Table 2. Results of an experimental investigation on safty sealing of DN 20 (3/4") joints with Loctite 55 sealing cord

Test tube	A n = 6						B n = 7						C n = 8						D n = 9						E n = 10					
Pressure, bar	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
p=1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p=2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p=3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p=4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p=5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p=6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Legend: × leaking; - not leaking; n – number of sealing cord turns; 1 steel-brass; 2 brass-aluminum

Obtained results show that at minimal number of sealing cord turns (6), at different pressures (from 1 to 6 bar) and with different fitting material combinations (steel-brass, brass-aluminum) has not been detected gas leaking. Even more reliable joints have been obtained with increasing the number of sealing cord turns to maximum recommended (10).

It is clearly that DN 20 (3/4") threaded joints of Withworth form sealed with sealing cord Loctite 55 are reliable when using recommended number of sealing cord turns at working pressure 3 bar.

If sealing cord is wraped more then recommended it should be considered that damage of embedded armature could occur while mounting as well as displacement of sealing cord that effects gas leaking on such joints.

Furthermore is important to mention that joint must be drizzled to prevent displacement of sealing cord while mounting MCU.

4. Conclusion

An investigation of gas leaks in home metering and control units (MCUs) has been performed in the distributive region Orahovica. The analysis has shown an unacceptable high number of threaded joints (all sealed traditionally with hemp and non-curing sealants) in which gas leakage has been detected. Further analysis has shown that one of the most important factors influencing on leaking possibility is applied sealing method. Therefore, an experimental investigation of sealing cord was conducted aiming to improve traditionally sealing method using hemp and non-curing compounds.

The results obtained in experimental investigation affirmed the possibility of application of sealing cord Loctite 55 at any combination of considered fitting materials and pressures aiming to give safely sealed joints.

[8]

From metioned above can be concluded that it is more reliable to use other technical possibilites for sealing threaded joints, such as sealing cord, then hemp and non-curing compounds. It is also necessary to follow up development and new achievements in sealing area, try them on models and in praxis so that sealing of threaded joints in gas pipeline installations become more reliable and permanent.

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Measuring Residual Stresses in Polymeric Plates by Layer Removal Method

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Abstract

The presence of residual stresses in polymeric plates after thermal processing influences to a great extent the deformation behaviour of the product. Usually the plate is flat after the manufacturing process; however in most cases the plate is internally strained. If the internal equilibrium of such plate is disturbed by sectioning, then macroscopic distortion will occur and the plate would curve. These distortions are proportional to the magnitude of stresses in the removed section. A Layer Removal Method is combined theoretical and experimental method for determining residual stresses in polymeric plates. Many mathematical and practical aspects of this method are described in this work in order to give better understanding and expectations when handling with stressed polymeric plates. The validation of the method is presented through numerical simulation of the layer removals from two stressed plates.

Keywords: Production Engineering, Polymeric Plates, Residual Stresses, Layer Removal Method, Curvature Functions

1. Introduction

Thermal processing is a cheap and efficient way of manufacturing plate shaped polymeric products. However, it suffers from am important side effect which may considerably affect the products' final performance. During thermal processing and non-uniform cooling from an elevated temperature, above 100 ºC, to room temperature, strains become 'frozen-in' the material. These frozen-in strains lead to undesirable distortions and residual stresses in the final product [1]. Frequently, the flatness of the plate is of the prime importance to the user, therefore the absolute necessity to the manufacturer and adequate method for measuring residual stresses is required to describe the deformation behaviour of the final product.

Measuring residual stresses in plate shaped polymeric products is a complex process. In general, the residual stresses are not measured directly, but are determined indirectly via other variables that can be measured more easily, like strains and radius of curvature of the plate surface. However, the conversion from measured values into residual stresses is a cumbersome and mathematically demanding process, and can introduce substantial errors. The source of errors lies in the experimental precision of the measurements and more importantly, to the degree to which the actual sample complies with the assumptions incorporated into the stress conversion algorithm.

In this work we concentrate on the layer removal method, a well-established experimental procedure suitable for measuring residual stresses in the plate shaped products [2].

2. Description of the Layer Removal Method

The layer removal method is a destructive method used to determine the through-thickness distribution of residual stresses in plate shaped or sheet materials. In the method, successive uniform layers of the material are removed from the surface of the specimen plate. The removal of the surface material and consequently stresses in it disturbs the internal equilibrium in plate. The plate responds by redistributing the internal stresses to achieve the new equilibrium state [3]. This redistribution of internal stresses is accompanied by a visible distortion of the plate. The plate curves and its curvature can be measured experimentally, i.e. on a Coordinate Measuring Machine [4]. By measuring the curvature of the plate after each layer is removed, the original residual stress profile in the section can be deducted from the measured curvature.

2.1. The Method Assumptions

The derived relation between the measured curvature and the residual stresses is based on the following assumptions:

- The residual stresses in the plate vary only in the thickness direction and are constant in all other directions.
- The material is linearly elastic and responds with linear stress distributions when subjected to bending loads.
- The material is isotropic and homogeneous, i.e. $E = \text{const}$, $\nu = \text{const}$, where E and ν are Young's modulus and Poisson's ratio respectively.
- The process of machining layers off the plate surface does not induce additional residual stresses into the material.

2.2. Plate Geometry

The geometry of the plate element subjected to layer removal is shown in Figure 1. The plane $z = +z_0$ represents the top surface of the original plate and during layer removal this surface shifts to a new location, given by $z = z_1$.

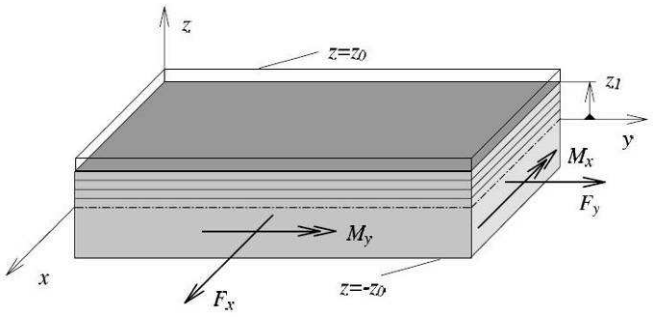

Fig. 1. Geometry of the plate with layers to be removed

Before any layer is removed from the surface of the unconstrained plate specimen, the normal residual stresses $\sigma_{xx}(z)$ and $\sigma_{yy}(z)$ exist in the reference cross-sections of the plate normal to x and y axis. The stresses in cross-sections are in the mechanical equilibrium and produce zero net-forces, Equation (1a) and zero net-moments, Equation (1b):

$$\int_{-z_0}^{z_0} \sigma_{xx}(z)\,dz = 0 \quad \text{and} \quad \int_{-z_0}^{z_0} \sigma_{yy}(z)\,dz = 0 \tag{1a}$$

$$\int_{-z_0}^{z_0} \sigma_{xx}(z)\,z\,dz = 0 \quad \text{and} \quad \int_{-z_0}^{z_0} \sigma_{yy}(z)\,z\,dz = 0 \tag{1b}$$

2.3. Theoretical Description of the Method

If a layer of the material is now removed from the top surface of the plate, the plate deforms. Its deformation can be prevented by applying external loads, forces and moments, equal to the net-forces and net-moments that existed in the removed section. Upon their removal, the plate would elongate/contract and curve in both directions x and y. It is preferable to express all dependent variables in terms of curvatures ψ_x and ψ_y since these can be measured more accurately for the plate, i.e. $\sigma_{xx}(\psi_x,\psi_y)$, $\sigma_{yy}(\psi_x,\psi_y)$ etc.

Due to the initial equilibrium, Equations (1a) and (1b), the net forces/moments in the remainder of the plate $(-z_0 \le z \le z_1)$ are in the equilibrium with the forces/moments that have kept the plate undeformed. Therefore, for the cross-section normal to x-axis, the remaining force F_x and remaining moment M_y can be calculated from:

$$F_x(z_1) = \int_{-z_0}^{z_1} \sigma_{xx}(z)\,dz \tag{2a}$$

$$M_y(z_1) = \int_{-z_0}^{z_1} \sigma_{xx}(z)\left[z + \frac{z_0 - z_1}{2}\right] dz \tag{2b}$$

In Equation (2b), the centroid of the cross-section has moved from the initial position $z = 0$ to the new location $z = -(z_0 - z_1)/2$. The easiest way to derive the required expression for $\sigma_{xx} = \sigma_{xx}(\psi_x,\psi_y)$ is by differentiating Equation (2b) with the respect to z_1:

$$\frac{dM_y(z_1)}{dz_1} = \frac{d}{dz_1}\left[\int_{-z_0}^{z_1} \sigma_{xx}(z)\,z\,dz\right] + \frac{d}{dz_1}\left[\frac{z_0 - z_1}{2}\int_{-z_0}^{z_1} \sigma_{xx}(z)\,dz\right] =$$

$$= \frac{z_0 + z_1}{2}\sigma_{xx}(z_1) - \frac{1}{2}\int_{-z_0}^{z_1} \sigma_{xx}(z)\,dz =$$

$$= \frac{z_0 + z_1}{2}\frac{dF_x(z_1)}{dz_1} - \frac{1}{2}F_x(z_1) \tag{3}$$

Rearranging the terms in Equation (3) we obtain:

$$\frac{d}{dz_1}\left[\frac{F_x(z_1)}{(z_0 + z_1)}\right] = \frac{2}{(z_0 + z_1)^2}\frac{dM_y(z_1)}{dz_1} \tag{4}$$

Integration of the last expression in the interval $[z_1, z_0]$ yields:

$$F_x(z_1)=\frac{2\,M_y(z_1)}{(z_0+z_1)}+4(z_0+z_1)\int_{z_0}^{z_1}\frac{M_y(z)}{(z_0+z)^3}dz \qquad (5)$$

The zero net-force and zero net-moment conditions, $F_x(z_0)=0$ and $M_y(z_0)=0$, are incorporated into the last expression. The Equation (5) relates the external force and the external moment to keep the plate subjected to layer removals flat. If it is differentiated once more with the respect of z_1, the residual stress distribution is determined:

$$\sigma_{xx}(z_1)=\frac{dF_x(z_1)}{dz_1}= =\frac{2}{(z_0+z_1)}\frac{dM_y(z_1)}{dz_1}+\frac{2M_y(z_1)}{(z_0+z_1)^2}-4\int_{z_1}^{z_0}\frac{M_y(z)}{(z_0+z)^3}dz \qquad (6)$$

The Equation (6) shows that the residual stress distribution σ_{xx} is a function of the moment M_y required to keep the plate flat after layers are removed from it. The formula (6) consists of three terms: derivative of the moment, the value of the moment and the integral of it. The main difficulty in using Equation (6) is the derivative term, it is very sensitive to experimental errors. Unfortunately, the derivative term is dominant in the near-surface regions where calculated stress is prone to increased errors. On the top surface of the plate $(z=z_0)$, the residual stress is obtained only from the derivative term:

$$\sigma_{xx}(z_0)=\frac{1}{z_0}\frac{dM_y(z_1)}{dz_1}\Big|_{z_1=z_0} \qquad (7)$$

The residual stress equation (6) does not contain any material property constants and hence can be used for any general material behaviour. However, for linear elastic material we can expand Equation (6) using the plate bending equations [5]. These equations relate the applied moment M_y to the principal curvatures of the plate ψ_x and ψ_y:

$$M_y(z_1)=\frac{E}{1-\nu^2}\frac{(z_0+z_1)^3}{12}\left[\psi_x(z_1)+\nu\,\psi_y(z_1)\right] \qquad (8)$$

Here E and ν are the Young's modulus and the Poisson's ratio respectively. The positive moment M_y curves the plate in a "frown" manner along the x-axis. By convention, this will be considered as a positive curvature and the "smile" deformation considered negative. The inverse of curvature ψ is the radius of curvature of the deformed geometry R:

$$\psi_x(z_1)=\frac{1}{R_x(z_1)} \text{ and } \psi_y(z_1)=\frac{1}{R_y(z_1)} \qquad (9)$$

(+ve = "frown", -ve = "smile")

Releasing the flat plate of a moment M_y is equivalent to superimposing onto it a negative moment $-M_y$, which would result in a "smile" deformation.

By substituting the negative moment $-M_y$ from Equation (8) into the residual stress Equation (6), we obtain the final layer removal expression for linear elastic materials:

$$\sigma_{xx}(z_1)=\frac{-E}{6(1-\nu^2)}\left\{(z_0+z_1)^2\left[\frac{d\psi_x(z_1)}{dz_1}+\nu\frac{d\psi_y(z_1)}{dz_1}\right]+ +4(z_0+z_1)\left[\psi_x(z_1)+\nu\,\psi_y(z_1)\right]-2\int_{z_1}^{z_0}\left[\psi_x(z)+\nu\,\psi_y(z)\right]dz\right\} \qquad (10)$$

In a special case where the plate remains flat in the longitudinal direction $\psi_y(z_1)=0$, we obtain the simplified version of the Equation (10):

$$\sigma_{xx}(z_1)=\frac{-E}{6(1-\nu^2)}\left[(z_0+z_1)^2\frac{d\psi_x(z_1)}{dz_1}+ +4(z_0+z_1)\psi_x(z_1)-2\int_{z_1}^{z_0}\psi_x(z)\,dz\right] \qquad (11)$$

This solution will be demonstrated in the following sections.

2.4. Curvature Functions

Curvatures $\psi_x(z_1)$ and $\psi_y(z_1)$ are measured in discrete increments of z_1. The measured values cannot be used directly in Equation (10), as their derivatives and integrals are also required. The simplest piece-wise linear interpolation functions for $\psi_x(z_1)$ and $\psi_y(z_1)$ between the measured points are not appropriate as they would produce discontinuous residual stress profiles due to discontinuous first derivatives at the measured points. Higher order interpolation functions between measured points, i.e. cubic spline interpolation, are also not appropriate although their first derivatives are continuous throughout [6]. Due to experimental errors, unphysical variations in the first derivatives (changes between positive and negative curvature at inflection

points) can substantially distort the residual stress profiles.

To filter out the experimental errors from measured curvature points, the least square polynomial fit [6] may be used to describe the curvature functions $\psi_x(z_1)$ and $\psi_y(z_1)$. The order of the fitted polynoms must be low (linear, parabolic, cubic) to achieve smooth residual stress profiles. With the polynomial fitting curves employed to describe the curvature functions $\psi_x(z_1)$ and $\psi_y(z_1)$, the residual stress function $\sigma_{xx}(z_1)$ is also polynomial of order increased by one. The parabolic residual stress profiles therefore result in linear changes in curvature during the layer removal experiment.

3. Validation of the Layer Removal Formula

To illustrate the applicability of the layer removal stress formula (Eq.11), numerical simulations of layer removals for two stressed PMMA plates are conducted.

The residual stress profiles within two plate specimens are assumed to be known, see Figure 2. These profiles are predicted numerically from the thermal processing data during the manufacturing process, where during the cooling process most of the frozen-in strains are induced into the material due to non-uniform solidification process [1]. The predicted residual stress profiles are almost parabolic [7]. Two plate specimens referred here are ”fast” and ”slow” cooling, indicating cooling rates during the solidification process.

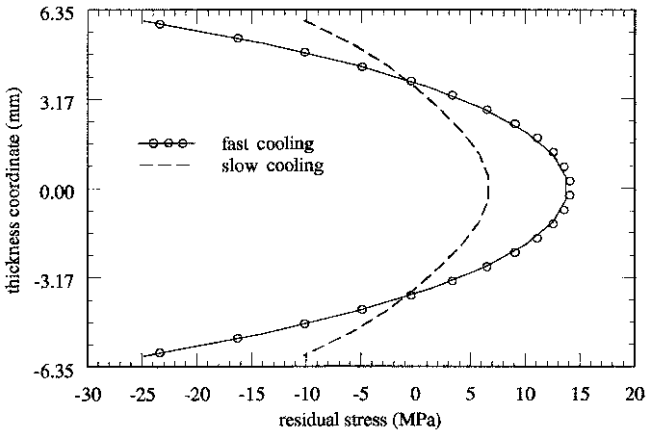

Fig. 2. Residual stresses in two plate specimens

Both specimen plates are 254 mm wide and 12.7 mm thick and very long in the longitudinal direction y, and therefore $\psi_y(z_1)=0$. Both plates are initially flat, i.e. $\psi_x(z_0)=0$. The elastic properties of plates are $E=7.62\,\text{GPa}$ and $\nu=0.35$.

The fast and slowly cooled plates are now subjected to layer removals from the top surface. Each removed layer disturbs the internal force and moment equilibrium. The net-forces and net-moments contained within the sectioned plates can be determined from the residual stress profiles (Figure 2) by means of Equations (2a) and (2b). Quantitatively, these functions are presented in Figure 3.

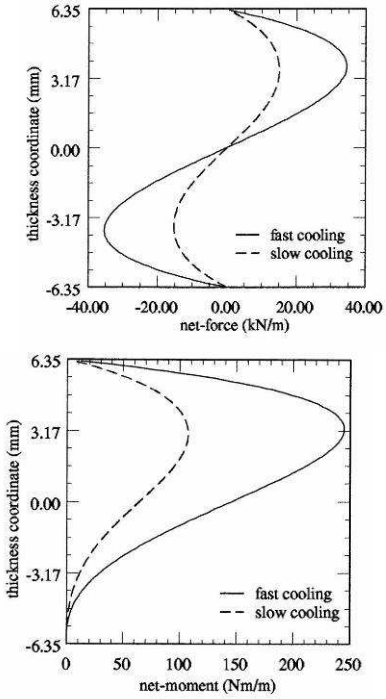

Fig. 3. Net-forces and net-moments contained within the plate as a consequence of residual stresses

The graphs in Figure 3 show that the residual stress profiles (Fig.2) satisfy the equilibrium conditions of zero net-force and zero net-moment (Eq.1a, 1b), when no material is removed from the top surface of the plate $(z_1 = z_0 = 6.35\,\text{mm})$. Since the residual stress profile is symmetrical, the net-force is also zero in the mid-plane of the plate $(z_1 = 0\,\text{mm})$. The maximum force and moment is released when approximately one quarter of the plate is removed $(z_1 \approx z_0/2 = 3.17\,\text{mm})$.

3.1. Deformation Behaviour of Plates

Numerical simulation of layer removals is performed in several stages. In the first instance, a

layer of material of thickness $\Delta z = 6.35/8 \approx 0.8\,\text{mm}$ is removed from the top surface. With one layer removed, the top surface is at the location $z_1 = 6.35 - 0.8 = \ = 5.55\,\text{mm}$. The process of removing layers is repeated 8 times in succession, at which point the original thickness of the plate is halved. The location of the top surface is now described with $z_1 = 0$.

The deformation behaviour of two plates during layer removals is notably different, see Figure 4. The fast cooled plate curves more than twice as much as the slowly cooled plate. These curvatures are in proportion with net-moments contained within the plates via residual stresses.

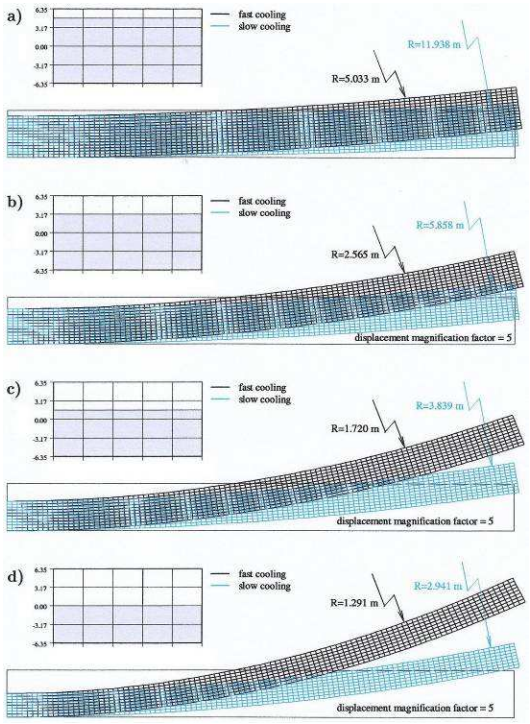

Fig. 4. Deformed profiles: a) 2 layers removed, b) 4 layers, c) 6 layers removed, d) 8 layers (half the thickness)

Although the net-moment, i.e. bending moment, in both cases reaches a maximum after a quarter of thickness is removed, see Figure 3, the curvature of the plate keeps increasing even further when more layers are removed. This is due to fact that the bending resistance of the sectioned plate decreases more rapidly with the removed layers than the calculated bending moments from Figure 3.

3.2. Residual Stress Back-Calculation

The residual stress profiles (Fig.2) and the resulting curvatures (Fig.4) are linked with the general theoretical expression (Eq.11), which applies for the plane strain layer removal cases [2]. This formula requires curvature functions for both plates in a form $\psi_x(z_1)$, which are presented in Figure 5.

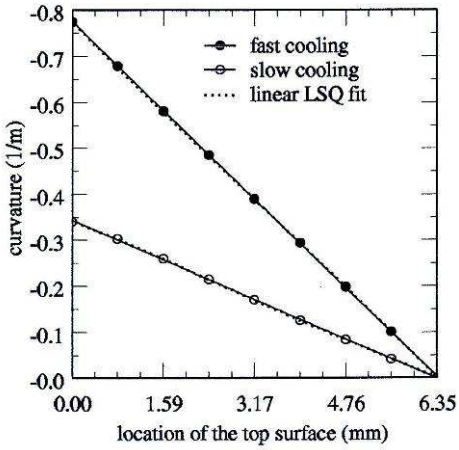

Fig. 5. The layer removal curvature profiles

All deformed shapes from Figure 4 exhibit ”smile” deformations, and thus all curvatures are negative. The symbols in the Figure 5 represent curvatures determined from numerical simulations in Figure 4. The points are well represented with the linear fitting curves, obtained using the least square method (LSQ). The LSQ fitting curves are differentiated and integrated as required in the layer removal formula (Eq.11). The calculated theoretical residual stress curves are plotted in Figure 6.

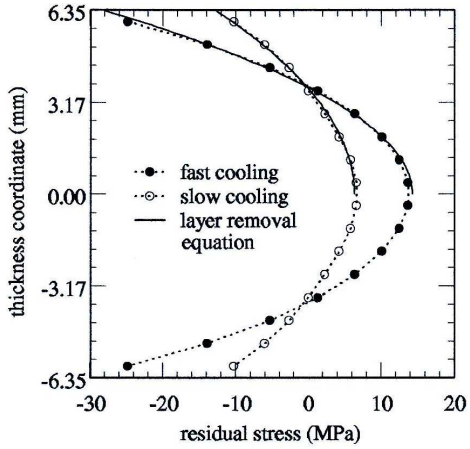

Fig. 6. The layer removal stress profiles

The calculated residual stress profiles correlate very well with the expected residual stresses from Figure 2. However, some discrepancies are still noted,

although the linear LSQ fitting curve seams an almost perfect mathematical fit for the curvature functions.

In Figure 6 we are able to determine only residual stresses in the top half of the plate since only half of the plate thickness was subjected to layer removals and curvature functions are only valid there. However, if the plate is initially flat, the mirror image of the calculated residual stress profile can be assumed for the bottom half of the plate.

4. Conclusions

Measuring residual stresses is important step for polymeric plate manufacturers as residual stresses greatly influence the deformation behaviour of the plate, mainly curving of the plate after sectioning. As shown in this work, the curving of the plate after sectioning, i.e. layer removals may be employed to indirectly calculate the residual stresses in the polymeric plate. This is done via curvature functions that can be measured more easily in technical practice.

With the presented theoretical approach, the plate manufacturers have better theoretical understanding and expectations when dealing with unconstrained stressed plates. For parabolic through-thickness residual stress profiles in the plate, as frequently present after thermal processing, the deformation behaviour is described with the simple linear curvature functions. Although mathematically very cumbersome, the layer removal formula is shown to comply very well with the numerical simulations and can provide reliable residual stress profiles.

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The Cutting Plan Generation in Corrugated Paperboard Production

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Abstract

In this paper, we discuss solutions for the strip-packing problem with sequencing constraint. This type of strip-packing problem is important for many industrial applications, yet we are focused on cutting plan generation in corrugated paperboard industry. It is a strongly NP-hard combinatorial problem, multi-objective and complex. After problem analyzing and main research papers overview, we propose a simple, yet effective, model of solutions space, which is significantly reduced so that it contains only feasible solutions. This approach leads to the whole problem solution based on heuristic optimization algorithm supported by appropriate database model.

Keywords: Corrugator cutting schema; Strip packing problem; Pattern sequencing

1. Introduction to the problem

From the theoretical point of view, the problem under consideration is a kind of combinatorial problems. It is a special type of two-dimensional strip-cutting or strip-packing problems. Specialization of the standard strip-cutting problem is defined through additional requirements. Two most important, are sequencing constraint and guillotine constraint.

Solution of the strip-cutting problem is cutting plan as a sequence of cutting schemas by which many relatively small rectangular items are to be cut from a set of available strips each of distinct fixed length and of large, practically infinite height. Notice that in strip-packing/cutting terminology strip height actually means the strip length, as it is usually named in practice. Sequencing constraint requires that in the solution scheme items need to be arranged as sequences of patterns. Items pattern is to be cut across the whole pattern width – this is required by guillotine constraint. There are also additional constraints; we will explain them later in more details.

As found in the literature, this combinatorial problem is strongly NP-hard [16]. In research papers, this problem is also referenced as cutting stock problem or trim loss problem [19]. It can be also considered as a special case of the strip-packing problems [16]. Notice that problem naming is determined by theoretical background as well as by the level of detail and specifics analyzed. Occasionally in this area, there is a bit of confusion or imprecise use of terms in some of papers.

This class of combinatorial problems is object of intense interest in scientific research. Although significant advance is achieved, occasionally there is a tendency of simplifications of some in reality much more complex problems. This can cause a gap between theoretic models and practical solutions. Applicability of a theoretical solution-model also depends on the scope of real problem, which it encompasses.
For example, in paper packaging industry an exact solution of trim loss problem minimization may be considered as acceptable if other characteristics of the problem are not viewed as the whole: dynamic and uncertain nature of orders arrival time and quantity, rush orders, continuity of corrugator production, scheduling, second phase of production on converting machines, etc. Encompassing all this requirements in an integrated model together with humans as users, require an extremely complex system. User's role i.e., role of people using the system is also often not enough biased in some solutions [22].

From the practical point of view, the problem is important, and it is evident on a daily basis in production factories, notably as in paper converting and packaging, but also in others. Typically, factories are unable to plan frequency, quantity and types of incoming orders. Those factories work by engineer-to-order or/and make-to-order principle. Due to short life cycles of customer products and customers churn, practically each stock at a hand of not ordered products could be a risky decision. Uncertainty of inflow of orders and usually numerous incoming orders, are the main factors of the complexity in the optimal production scheduling process. Optimal cutting scheme as part of production plan should reduce trim loss and make it minimal within given constraints and objectives. The trim loss minimization is connected with significant cost reduction, and is highly important when low cost margin is apparent, as in the case of the paper packaging industry.

Nevertheless, trim loss minimization is not the first concern of scheduling technologist. His primary goal is to schedule daily production plan, which includes all required orders by corresponding due-dates, in required quantities, with an additional constraint, which strictly requires that trim loss is at a tolerable level. If all this is achieved, then a desirable objective is to minimize trim loss, when possible. Else, if some of these requirements are not met, then scheduler is to decide between three strategies.

First strategy is to delay the order that is not possible to be included into actual scheduling plan. As costs of this strategy are not directly measurable and not easily perceptible, it is not chosen very often. Nowadays this strategy due to high market competition and due to customer's expectations is not appropriate; most likely, it leads to loss of customer.

The second strategy tries to upgrade paper-grade and shift order in another cutting schema with higher grade. This strategy leads to higher costs. Additionally, higher costs are not clearly visible and consequently, not easily controllable.

The third strategy tries by increasing some ordered quantities, to "close" some "open" order-combinations (schema-patterns), assuming customer will soon reorder products. The consequence is increase of surplus stock and unpredictable costs increases are certain.

There are various nuances of those strategies, but each of them arouses undesired business effects. Therefore, the best strategy would be to search the whole solution space and try to find hidden solutions. For human scheduler this is impossible due to extremely large solution spaces appearing in the majority of everyday real scheduling problems.

In the last twenty years, corrugated cardboard production changed significantly. Competition is much stronger. Customer's orders are becoming smaller and at the same time due dates are becoming shorter. Orders quantity tolerance is mostly zero. Many of orders are urgent. Sales margins on average are weak. Factories are under time and cost pressure. In the past, most factories scheduled orders manually. Nowadays, it is not acceptable.

2. Historical research retrospective

In contrast with industries like steel, glass, etc., where the strip packing/cutting problems are applicable, there is relatively small number of theoretical papers directly applicable on corrugated paperboard production.

Many hundreds of research papers in the field of cutting and packing problems have been published. Some are general, but the majority of them are focused on applications in specific domains.

Dyckhoff proposed a first systematic topology of cutting/packing problems [2]. Basically, in cutting and packing problems there is one or more sets of large objects and one or many sets of small objects (items). His topology identified a two level classification. First level distinguished four characteristics: dimensionality, kind of assignment, assortment of large objects and assortments of small items.

Besides spatial dimensions, Dyckhoff distinguished two main groups of c/p problems: abstract c/p problems – without spatial dimensions; and c/p problems in narrow sense – with real spatial dimensions. Later group is divided in two subtypes: packing or loading and cutting (stock). Trim loss optimization problem is connected with later subtype. Trim loss is considered as the space of large objects, not occupied by small items.

After Dyckhoff's topology, in the last twenty years, research in this domain was intense. New approaches have been applied, new types of problems developed and new ways of solutions discovered. It was obvious that Dyckhoff's topology is deficient and not appropriate relating to new results.

Based on Dyckhoff's ideas and review of 445 papers, a new "improved topology of cutting and packing problems" was published by Wäscher et al. [21]. Wäscher et al. categorized all c/p problems by kind of assignment, as either output maximization or input minimization problems. New topology identified six basic problem types of c/p problems: identical item packing, placement, knapsack, open dimension, cutting stock and bin packing.

According to topology of Wäscher et al., the corrugator cutting plan problem can be represented as an extended "Open Dimension Problem" (ODP) with additional constraints. In fact, it is a specialization of ODP, which is known as two-dimensional Strip Packing Problem (SPP) with sequencing constraint. We will use abbreviation SPP/sc for that special type of strip packing problem, what is in some way similar to Rinaldi and Franz notation [16]. Here the open dimension means that one dimension of large objects may be considered as variable. This open dimension variable is considered as input to the problem, and is to be minimized. Actually, used area is to be minimized, but the second dimension is fixed for each of large objects (strips). However, this is only one of more objectives to be optimized, known as trim-loss minimization.

Second requirement i.e., sequencing constraint asks for more complex objective optimizations – how to form cutting patterns and how to order them in sequences with respect to additional technological constraints. Here is built-in so called minimization of open stack problem (MOSP), which alone is NP-hard problem [10]. MOSP in corrugated paperboard cutting plan generation is focused on searching for optimal use of machines and order spread minimisation.

While the number of published papers on strip packing problem and other related problems are

measured in hundreds, there is relatively small number of papers devoted to SPP in corrugated paperboard production scheduling. Although there is no rapid growth process, a constant improvement is present.

Early research papers from the fifties of the twentieth century are based on liner programming methods and are devoted to the trim problem, in the manufacture of newsprint. The next qualitative improvement step was provided by Gilmore and Gomory [7]. They introduced new algorithms in linear programming to the cutting-stock problem, which produced significant influence on cutting and packing problems research and solutions. Most commercial solutions were mainly based on linear programming concepts, at last, as we know.

However, in theory and especially in practice, it was acknowledged that linear programming is not fully appropriate way to solve SPP/cs. It was clear that oversimplification of a really complex problem as SPP/cs is, cannot be utilizable. Nature of SPP/cs applied on real corrugator plant requires some nonlinear modeling concepts, which are not solvable using linear programming model. Regardless of use of mixed integer programming methods, those models ware not able to capture all the complexity of the real SPP/cc problems.

An important paper appeared in 1980 by Heasler and Talbot [8]. It was an attempt to improve the model through balancing between trim-loss problem and order spread problem. They used an adaptation of set-partitioning algorithm, previously developed by Garfinkel and Nemhauser [6].

More recent papers use some of heuristics or hybrid optimizations methods. A good example is the work of Rinaldi and Franz, who published the results of formally analyzing SPP/sc problem and applying two heuristics approaches [16]. Another different approach is published by Velasquez, Bellini and Paternina-Arboleda [19]. The authors use multi-objective approach based on evolutionary algorithm. Beside the cost function (running cost, the roll and pattern change cost, waste trim cost and grade upgrade cost), the model includes a compound WPL index (delivery due-dates performance, finished machines queue management and client-related importance). This approach includes complex set of factors, but WPL index may be in some way, arbitrary constructed. However, we think the multi-objective approach is the right way to capture complexity of the SPP/cs problem.

Cited papers, are strictly focused on SPP/sc, but a lot of research papers have been published indirectly related to the problem, particularly on pattern sequencing problem and open stack problem [10],[14] . Another important contribution was coming from metaheuristics and heuristics methods research [1], and particularly from evolutionary optimizations [11][12].

Real industrial practice in a corrugator plant requires dynamic-aware, more flexible and more specific solutions. This is especially true for small and medium-sized plants. Ignoring this requirement, often leads to the unlikable practice of manual scheduling, whereby automatic solutions are abandoned or at least, are not fully used. The main reason is the fact that they do not fully capture all the problem complexity, as Velasquez et al. concludes [19]. Indeed, this optimality should take into account not only this single objective, but also other objectives, which are also to be considered.

Most cases of these types of industrial problems are multi objective, with possibly conflicting objectives. In everyday operations a factory manager may require an entire set of solutions, rather than just a single solution. For example, a strip-cutting solution may be optimal in trim loss minimization, although not optimal in production flow speed or orders spread. There is a number of commercially available software-solutions, unfortunately sold as black box. We do not now about theoretical models they are based on.

3. Formalization of the problem

Now we will describe the problem more formally. At the beginning, let us describe pattern P as a relation of two pattern parts, $P1$ as a left and $P2$ as right part:

$$P_x = (P1_x, P2_x) \qquad x \in \{1, 2, ..., p\}; \quad (1)$$

where p denotes possible number of patterns in the whole solution space of a SPP/sc. Each pattern-part is represented as a relation:

$$(O_x, t_x, w_x, l_x) \qquad x \in \{1, 2, ..., o\}; \quad (2)$$

where:

o – denotes number of different order-items;

x – denotes x-th order

O_x, – denotes x-th order item;

t_x, – denotes number of items participating in a pattern;

w_x – denotes item's width ;

l_x – denotes item's length.

According to this notation, pattern P may be represented as:

$$P = \{(O_x, t_x, w_x, l_x), (O_y, t_y, w_y, l_y)\}; \quad (3)$$

$x, y \in \{1, 2, ..., o\}; \quad x \# y;$

$0 < (t_x + t_y) > (t_{max} - 1)$;

$t_x \in \{1, 2, ..., t_{max}\}$;

$t_y \in \{0, 1, 2, ..., t_{max} - 1\}$;

t_{max} is from corrugator dependent constant.

If $t_y = 0$ then P is single pattern containing only one part:

$$P = \{(O_x, t_x, w_x, l_x), (Null)\}. \quad (4)$$

Over each pattern P_x *is* defined function: *height*(P_x) which returns height h of the P. Height h of P *is* defined as:

If : $i^1_x \; l^1_x \geq i^2_x \; l^2_x$

Then: $h_x = i^1_x \; l^1_x$ (5)

Else: $h_x = i^2_x \; l^2_x$

where i^1_x is number of times left part-pattern is repeated, and i^2_x is number of times right part-pattern is repeated.

A cutting schema S is defined as ordered set of patterns. Cardinality of S is c:

$$S_x = \{P_1, P_2, \ldots, P_c\}; \quad x \in \{1, 2, \ldots\}; \tag{6}$$

Over S are defined functions: (7)

- *height*(S_x) - returns height of the strip of S_x;
- *width*(S_x) - returns width of the strip of S_x;
- *space*(S_x) - returns space occupied by patterns contained in S_x;
- *trim*(S_x) - returns percentage of trim loss on S_x;
- *quality*(S_x) - returns quality measure of S_x.

Notice that function *trim()* may be represented in respect to relative area utilization or may include more complex price and cost calculation, but always returns a scalar value. However, function *quality()* may be represented as a scalar function or as a vector valued function. Functions *height()*, *width()* and *space()* are intuitive and trivially simple.

The solution of the SPP/sc is a cutting plan that is defined as an ordered set of cutting schemas:

$$P = \{S_1, S_2, \ldots, S_x\}; \quad x \in \{1, 2, \ldots, s\}; \quad s \leq o; \tag{8}$$

and *constraint*(P,C) = True; $C = \{c1, c2, c3, \ldots cn\}$

where *constraint*(P,C) is a function that tests if set of additional constraints C, containing n constraints, are all met over P.

If next expressions for a cutting plan P, are satisfied:

$$(o/2 \geq s \leq o) = \text{True} \quad \text{and} \quad \textit{constraint}(P,C) = \text{True},$$

then we will call it regular cutting plan, else it is irregular cutting plan. An irregular cutting plan is an unlikable solution, and should be improved or transformed. Main goal of a solution of the SPP/sc is to find the regular cutting plan. Set of constraints C is plant specific. It allows user defined constraints to be set or released interactively. Notice that regular cutting plan does not mean an optimized cutting plan.

3. Problem objectives

In the previous chapter, we defined model structure and structure constraints. We defined inputs to the model, and output as the solution of the problem. Let us now define what objectives of the considered problem are, and how to represent them and what is to be optimized.

Over cutting plan are also defined all functions from definitions in (7) except of function *width()*, which is not applicable.

There are two objectives of this model of the SPP/sc:

1. Minimize: *trim(P)*
2. Optimize: *quality(P)*

First objective is linear, or at last can be adapted to be linear without of significant loss. The second objective is set over a nonlinear function. In reality, it contains a kind of decision problem and multi-objective optimization problem.

If minimization of trim gives a value above tolerable level, then it cannot be accepted and this will imply new unlikable consequences. Some orders may not be included into solution, or at least all required order items are not included. Not completed orders should be delayed for next cutting plan or should be upgraded in quality, what increases costs.

Measure for second objective may not be scalar value, because there are more points of objective's quality. How many orders are completely included into solution? How many orders are only partially included into solution? How many orders are not at all included into solution?

Some commercially available solutions in case when some orders are not included in the end solution, allow significantly increasing number of items of paring order, trying to complete uncompleted order. This can be a way to usable solutions, but as we explained before, it is a risky decision. It should not be completely left to the computer.

It is obvious that the problem is multi-objective, complex and with conflicting objectives. Good solution requires interaction of human scheduler

4. The solution space

Combinatorial problems are usually characterized by very large search space, which tend to grow exponentially as the number of items grows. It is highly important to represent the problem search space in an appropriate way. Finding a way to reduce or remove infeasible solutions from the search space is an important goal. The representation of the solution spaces determine the number of solutions to be searched. As Michalewicz et.all. point out, in combinatorial problems, the search space is not determined by the problem, but by its representation

[12]. Heuristics approach to the solution of the combinatorial problem tries to find specifics of the problem, and then to use it to construct simpler search space and reduce it to a reliable level.

If we want to find optimal or near-optimal solution, we need to construct search space containing all possible feasible-solutions. If we construct them without unfeasible solutions, we will get a narrow search space and searching it will be more effective. Then, first step in constructing search space of feasible solutions of the discussed problem may be to transform some inputs into constraints, if possible.

Let us construct solution space *SS* of the SPP/sc as set of all possible patterns

$$SS = \{P_1, P_2, \ldots, P_p\}; \qquad p \in \{1, 2, \ldots\}; \qquad (9)$$

Solution space *SS* will not be greater than:

$$(t_{max})^2 (o)^2.$$

Note that *SS* does not contain all possible solutions; it contains only all possible elements, which can be used to constructing a solution. Number of possible steps to construct a solution is huge, even for small number of orders.

If we now want to find solution (a cutting plan), we should use an algorithm for selection procedure, which will form best cutting schemas as parts of end solution. Indeed, choosing a pattern will automatically define in which schema it should be included. Choosing a pattern implies disappearing some of patterns from the *SS*, or at least, changes height of some patterns. After at the maximum *o* iterations, solution space will be empty. Empty *SS*, means that selection process is finished; it does not means that solution is regular or optimal.

It is clear that quality of the end solution depends from quality of applied algorithm. A greedy based constructive heuristic algorithm may give in short time, acceptable, near optimal results:

```
Construct solution space SS
Do while SS # {Null }
  Evaluate( trim(), quality())
   Construct:(P)<- "the best"
   Reconstruct SS
   If (User interaction)
       Reconstruct SS
   End if
End while
```

User interaction in process of solution construction is easily maintained due to iterative procedure. Objective function is evaluated each time before a new construction step. If a given step is not acceptable, it can be resumed.

5. Implementation

An interesting idea about this solution is model implementation. As we formally described this model as set based, it is a natural way trying to implement it into relational database. Consequently, the solution space is easy to represent as Cartesian product of relations.

Constraints may be implemented on declarative or/and on procedural way. Data sets cannot be reentered in case of change. Algorithm steps may be implemented as relational data transformations.

Using relational views gives the model necessary dynamics. The model is focused on dynamic, data awareness and interactive use. Corrugated paperboard plant deals with large sets of data. In a typical not big plant, the number of articles reaches many thousands even tens of thousands. Number of orders a year may go further than tens of thousands. Therefore, organizing data in database is a necessity. Integration of optimization model with data gives opportunity for direct use of plant's data.

6. Conclusion

In the paper, we discussed problem of cutting plan generation. After introductory analysis of the problem, we gave short overview of wider area of research publications, with focus on published milestone research papers applicable on the strip-packing problem in corrugated paperboard production.

In advance follows a more formal definition of the problem, which is set-relationally oriented. A provision for this approach is an easy and straightforward implementation of model into relational database.

An on heuristic algorithm based procedure gives acceptable results in an easy way. Finally, inclusion of constant user interaction, leads to the simple, easy to use and intuitive, but effective solution.

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EU Vocational Education and Training programme in Bosnia and Herzegovina

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Abstract

Postwar system of education in Bosnia and Herzegovina does not bring positive results. Therefore, one needs to modernize the educational process that will function in way to involve every social partner, from students, teachers, parents, Ministries, to potential future employers. Education system needs new national flexible curriculums, standards and goals. The current reform of education developing modern school with new teaching methods will increase student's interests and ambitions, developing better relationships between students, teachers and school social partners for better professional development of young people.

Keywords: EU VET, education reform, education without discrimination.

1. Introduction

Education in Bosnia and Herzegovina is compulsory by law for all children between 6-15 years old. The current structure consists of five levels included in both public and private schools. The different levels are as follows: pre-school, primary school, secondary or high school education, specialized vocational education and training schools, colleges and universities. In any of these levels institutions may be public (government funded) or private.

The responsibility for coordination activities, harmonization of plans of entity authorities and definition of international level strategy in the area of education lies with Ministry of Civil Affairs, but three separate education systems still co-exist in Bosnia and Herzegovina, depending on predominant ethnic population. The major responsibility for school education lies in the local governments. The school system is divided in three areas, Republic Srpska, Federation Bosnia and Herzegovina and District Brčko. Federation Bosnia and Herzegovina is divided into ten cantons. Every cantons has own Ministry of Education.

Education is often misused by providing students with different interpretations of same facts. [1] Often schools separate students on their ethnic, language and religion. Political and nationalist ideology still existed in education. The quality of the schooling provided in Bosnia and Herzegovina today does not meet commonly accepted European norms and standards.

The aim of this paper is to presents education reform in Bosnia and Herzegovina. In addition, this paper will also provide information that can be used for future studies. To elaborate results we used methods of description and basic statistic parameters, frequencies and percentage.

2. Organization of education in Bosnia and Herzegovina

At the level of the State of Bosnia and Herzegovina there is the Ministry of Civil Affairs and Science. There are three agencies for education at the state level: Agency for Development of higher Education and Quality Assurance, Agency for Preschool, Primary and Secondary Education and the Center for Information and recognition of Documents in the Area of Higher Education. There are 13 ministries of education, two entity ones, ten cantonal and one from the Brčko District.

Schools are legal entities, whose principals are appointed by school boards pursuant to the procedure regulated in the law applicable at the government level.

3. Education reform

The main objective of reform was to answers the needs of the labor market through the provision of flexible and high-quality system based on lifelong learning principles.

European Union has supported reform of vocational education and training in Bosnia and Herzegovina since 1998.

Reform activities started 1998. The reform involves significant number of human and other resources. First Project is Phare VET program since 1998. Phare VET program development of new curriculums for six vocations: carpenter, baker, cook, tailor, electric technician and business technician and reeducated teacher for applying new methodology in education.

Since 2000 until 2001, Phare Bridging program has made Green and White paper. First generation students entranced vocational schools developed by VET program at school year 2000/01. During the school year 2002/03 was implementing common contents for five general education subjects in vocational schools (native language, foreign language, mathematics, sports and informatics).

EU VET I sequel of Phare VET. EU VET I exported of workforce market and 2003 legislated Education Law of Elementary and Secondary Level on state level in state parliament. The document issue explained in „Directions of education and culture development 2004–2007“, developed curriculum for agriculture and food refinement. Together with Gesellshaft für Technische Zusammenarbeit, 6 pilot schools from Bosnia and Herzegovina and partner school from Germany, chose vocations forestry and carpentry, machinist technique and metal dressing and electric technique.

 EU VET II, 27 pilot schools, development of curriculum for 4 vocations: forestry and wood arranging, geodesy and building construction, regulation and tourism and economics, law and marketing.

Over the past period, the new nomenclature of occupations has been prepared and harmonized. Their number has been reduced from almost 500 down to 100 into 13 families of occupations, adjusting vocation names in vocational secondary school education, 61 at three year education and 39 at four year education.[2] EU VET III program including last 5 families into the reform process. EU VET cooperated with entities and local education ministries, World Bank, Gesellshaft für Technische Zusammenarbeit, Business Innovation Programme, Kulturkontakt and Organization for Economic Cooperation and Development.

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3.1. Goals of education

There are short-term, mid-term and long term goals. For secondary education the short-term goals adopted the plan for enrolment into secondary vocational and technical schools. Mid-term goals are focused on increased enrolment into secondary education from current 20% to 40%. Long-term goals are increased enrolment into secondary school to 90%, introduction of external mature examination at the end of education and improving linkages between the education and labor market sectors.

3.2. Education curricula

Education curriculums are designed and developed by the experts from schools, pedagogic institutes and university faculties. The education curriculums are passed by the related ministries at the level of the entity of Republic Srpska, Federation of Bosnia and Herzegovina and at the level of the District Brčko. [4]

3.3. Legal and institutional framework

During the reform period, four more laws are adopted:

- Framework Law on Preschool Upbringing and Education in Bosnia and Herzegovina;
- Framework Law on Secondary Vocational Education and training in Bosnia and Herzegovina;
- Law on the Agency for Preschool, Primary and Secondary education;
- Framework Law on Higher Education in Bosnia and Herzegovina.

Legal and institutional frameworks ensure that curricula are adjustable to changes in the labor market and responsive to the social and individual needs of youth and adults.

3.4. Equipment for VET schools

For the better implementation of reform in school, the European Community, represented by the European Commission, provide specialized VET equipment to selected VET schools and training centers in Bosnia and Herzegovina to ensure sustainable VET system reform on the principles of lifelong learning.

3.5. VET training for teachers and school management

In line with the principle of professionalization it is indispensable for all teachers to keep their level of occupation-related knowledge and skills as well as teaching methods up to date. To support reform EU VET improved service training for teachers and school management in developing standards, curricula and assessment instruments.

The main fields for all teachers are occupation-related applied scientific theory, didactics, general pedagogy and personal development.

4. Results from implementation of educational reform

After implementation of educational reform in school the ratio students practice increased over the theory, increasing teachers knowledge and capability in modern equipment and theory, graduates will meet market needs in entrepreneurial aspects, prepare school to become vocational educational and training school for adults, increase the possibility of the school to become a center of excellence offering high quality education and Long Life Learning and introduce EU attitude, regulations and directives towards business practice and opportunities in European Union.

For all education levels, the legislation in Bosnia and Herzegovina allows each individual to have equal right of access and equal opportunities for participation in appropriate education, without discrimination on any basis. [3]

5. Conclusions

Ministry of education and culture made a step ahead, but economical and other interested partners do not follow. There is no connection between interest partners and no proper analyze is made.

If future citizens receive an education that promotes tolerance, an appreciation of complex European identities and civic participation in social and public life, postwar BiH will have a much greater chance at democratic consolidation. And that is exactly what Bosnia and Herzegovina needs, young people ready to stay and make changes to improve their society.

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STIMULATING CREATIVITY IN HIGHER EDUCATION

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Abstract

Contemporary society, faced with unpredictable and unstoppable changes stimulated by globalization processes, is all the more recognizing the importance of creativity in all human activities, particularly in the field of education. During the period from the year 2000 until the present day significant changes in the educational system, particularly in higher education subsystems, have become part of the education policy of almost all European countries. In the Croatian higher education system, the impressions on the implementations of the Bologna Process range from complete questioning to (un)critical advocating. Although it is clear that pedagogical, didactical and methodical issues on the Bologna Process implementation in the Croatian higher education system have been marginalized, the conception that the Bologna Process supports teaching directed towards the student that essentially changes the role of the student as well as the role of the higher school teachers who are faced with demands for new competition that arise from their professional role. In that context, creativity represents a significant competence that demands contemporary education from the higher school teachers, which is placed as a challenge to the new paradigm whose basis consists also of, among other things, the changes towards creative teaching. Proceeding from the fact that the higher school teacher's creativity is the basic presumption for developing creativity in students, the starting point for stimulating changes is made up of advancing the quality of higher school teaching and stimulating the continual professional development of the higher school teacher through the life-long system of education directed towards the development of creativity in students with the aim of freeing their creative potential through which they will realize active involvement and competition in the work market after having completed their studies..

Key words: *creativity, higher school teaching, students, higher school teacher, Bologna Process*

1. Introduction

In the context of unpredictable and unstoppable changes stimulated by globalization process, contemporary society is searching for an increasing number of individuals who, through new discoveries and improving what has already been discovered, are capable to be inventive and creative, and, therefore, the recognition of the importance of creativity is becoming all the more evident in all human activities, particularly in the field of education. In most European countries a discussion has been held in recent years on the need of improving the quality of the educational system as a whole, where, besides implementing changes in the subsystems of higher education, the focus of discussion is directed on increasing the effectiveness of the teaching process by insuring the conditions for quality studying. In this context, the Bologna Process[5], among other things, implies also the changes in higher school teacher training[6] in acquiring the necessary competence for working with generations of oncoming students of the «New Age» who, after having completed their studies, are faced with the need of inventive and creative activity in the work market. Higher school teachers are, therefore, faced with demands for new competence that is a result of their professional role where creativity represents significant competence that demands contemporary education of the higher school teachers faced with the challenge of a new paradigm whose basis is, among other things, made up of changes towards creative teaching stimulating creativity in higher school teaching conditions which represent a contemporary higher school teacher that has become aware of the importance of depending on one's own creativity as the basic presumption for creativity development among his students.

Creativity is subject to many influences that become particularly prominent under the conditions of higher school teaching, particularly when it deals with daily interpersonal relations between students and teachers, hierarchy among teachers, working conditions and various extrinsic motivators that more or less

[5] The Bologna Process is the name given to the reform of higher school education in Europe, with the basic aim to promote student and professor mobility by establishing the so-called European space in higher school education until the year 2010. The name Bologna Process comes from the Bologna Declaration that was signed on June 19, 1999 by the ministers responsible for higher education from 29 European countries, while the formal title for the Bologna Declaration was "European Space for Higher School Education".

[6] The expression *higher school teachers,* in the context of this work, implies undergraduate and graduate studies teachers in Croatian higher school institutions.

influence motivation in the positive or negative sense of the word. When we are dealing with higher school teaching, the opinion still prevails that it has to necessarily be of the lecturing type, eventually accompanied by student's questions and discussions, and, therefore, lectures are still considered the most valuable form of higher school teaching. It is also considered that higher school teaching is to be substantially differentiated from all other forms of teaching, where every effort in making it contemporary represents its «dropping to a lower level». Proceeding from the fact that the success of teaching is evaluated from 5 to 10%, and that teaching is based only on boring lectures that represent a loss of time for the student (Bognar, 2006), it is obvious that teaching with active students gives incomparably better results in the academic sense, where their relationship towards teaching is also changed for they can show their own creativity in developing a range of valuable capacities for life-long studying.

If we start from the reality that our higher school institutions are still, in many cases unfortunately, dealing with some other problems and neglecting the need for educating independent and creative individuals, it is clear that the need for directing the contemporary teaching process towards those forms of work that will enable the freedom of students' creative potentials, while stimulating the quality of higher school teaching through the improvement of existing and development of new techniques and strategies and the introduction of new approaches directed towards the stimulation of creativity, is becoming an all actual theme, as well as a substantial guide in the work and activities of the pedagogical profession. The basic guidelines of thus conceived higher school teaching should give an answer to the demands of contemporary society that is giving particular importance to the need for stimulating creativity in the context of creating a society of knowledge.

2. The Creativity Phenomenon

Intensive researches on the creative phenomenon were started in the middle of the 20th century by the American psychologist J. P. Guilford who divides human thinking in divergent and convergent. Guilford's (1968) considers divergent thinking the basic characteristic of creativity observing that a higher level of divergent thinking development correlates with a higher creativity level in a person, where he considers sensitiveness to problems, fluency (the capacity of creating a great number of ideas in a unit of time) idea originality, thinking flexibility, analysis and synthesis capacity and the skill of realistic evaluation of new ideas as capacities that are important in understanding the creativity phenomenon.

Considering the fact that the nature of creativity is complex and multilateral, and a unique and universally accepted definition of this does not exist. Research and the presentation of more than one hundred different definitions of creativity (Bognar and Bognar, 2007, according to Treffinger, 1996) have come to the conclusion that the characteristics of creativity vary among people, where not one person possesses all the characteristics, nor does a person show them all the time because many of these characteristics can be learned and educated due to which it is difficult to foresee which individuals can be productively creative in their adulthood. Different authors define the creativity phenomenon in various ways. Ozimec (1996) defines creativity as a group of human characteristics and capacities that in their synergic effect enable the individual to observe, discover, foresee, experience and accept things and phenomena in a new and unusual manner. Miell (1968) considers that creativity, as a complex human phenomenon, can be simply defined as a process of connection of earlier disconnected things, Plucker and Beghieto (2002) under the concept creativity imply: originality, motivation, environment interaction process and capacity, while Isaksen (according to Bognar and Somolanji 2008) considers that creativity is not an unequivocal phenomenon that can be precisely defined. Encompassing such points of view, we will commit ourselves to consider the phenomenon of creativity that starts from creativity as a natural capacity of every individual to produce a determined novelty of the already existing state (whether in the material or spiritual sphere) which is original and applicable within a determined social context and positively directed in the process.

Bognar and Bognar (2007) point out four categories of creativity where in studying creativity one must first of all start from the *creative person*. Pointing out the fact that each person possesses a creative potential at birth and that all people are creative at a certain level, they correlate the issue of actualizing the creative potential with numerous creativity performers such as self-confidence, self-respect, openness to new experiences, persistence and motivation, tolerance of uncertainty and readiness in taking risks.

Creative product as a second category of creativity implies a certain novelty in relation to the already existing state, the genuineness, usefulness and economical quality for the entire society that is

displayed through the artistic, technical, scientific and other fields, in which process the creative product can be expressed in the form of expression and the creation of a visible product, or in the form of impression, or the capacity of creative, rich and detailed perception. Arar and Rački (2003) consider that the creative product is, in the most general sense, every act that satisfies the combination of three categories: the solution has to be new, efficient with challenges and of value to the individual or society and also original in so as to reflect impulses from oneself instead of results from outer forces.

The third category refers to the *creative process* which implies the manner of creating the creativity that necessarily leads to unusual solutions and various combinations as a result of expanding the existing ideas with new ones. Various researchers divide the creative process, or the process of creative activity, which implies a range of ideas and actions that lead to the creative results (Arar and Rački, 2003, according to Wallas, 1926; Ochse, 1993; Lubart, 1994) into several different steps of which four important ones are considered, and among which the first step is the period of preparation that consists of the preliminary analysis of a problem with the collection of basic information and conscious work on the problem. The second step is the incubation period when improvement is not visible, and activity is mainly unconscious, where a person does not necessarily have to consciously work on the problem, while the activity of its solution continues outside the conscious effort. The following step represents illumination or the moment of inspiration that is accompanied by strong emotions that lead to a solution, it appears by surprise and in different situations. The last step of creative activity refers to the verification period where the acquired idea needs to be evaluated, its adequacy and solution value verified. If in the verification process it results that the idea or solution does not function, a return to the incubation or preparation[7] period is very likely.

In order to accept a certain idea or creative solution from the environment, Arar and Rački (2003) point out the importance of satisfying a range of social criteria, while Somolanji and Bognar (2008) emphasize the importance of *creative environment* as the fourth category of creativity, or the society of the individual, which, through its relationship can have a stimulating impact on him, but restrain his creative development where in the process various creativity performers (such as family, higher school institutions, wide or restricted community) can influence in various ways the creativity development and restraint.

Treffinger (2002) differentiates four aspects of creativity: creating ideas, their deepening, openness and courage for their research and listening to the personal "inner voice". When we are dealing with the *creation of ideas*, we primarily think of the cognitive features that are usually connected with the concept of divergent thinking, or the capacity of creative thinking. Specific features are such as fluency, flexibility, originality, elaborateness and metaphoric thinking are pointed out in the process. The aspect of *deepening ideas* includes cognitive features that are usually connected with cognitive or critical thinking, while analysis, synthesis, redefining, evaluation, the wish to solve multiple-meaning and complexity understanding appear as specific features. *Openness and courage for researching ideas* represents the personal qualities that refer to interests, experiences, attitudes and self-confidence where sensitiveness to problems, courage, sense of humor, playfulness, intuition, fantasy and imagination, readiness to accept risks, multiple-meaning tolerance, openness to experience, emotional sensitivity, intuition and persistence appear as particular features. The aspect of *listening to one's own "inner voice"* includes the qualities that imply self-understanding, vision and devotion to action, while a specific feature of this aspect includes awareness of one's own creativity, persistence, introspectiveness, inner control, concentration and stereotype freedom.

The Basic Creativity Stimulation Assumptions in Higher School Teaching

Psychological security and psychological freedom are the basic preconditions for freeing the potential of creativity, where psychological security depends on secure environment in which people feel secure when most other people accept what they are doing, similar to the Rogers theory[8] according to which one person will be more creative than another when he

[7] A similar example can be considered the storm of ideas (brainstorming), or the strategy of creative solution to a problem that emphasizes equal representation and divergent and convergent thinking, and consists of three phases: problem defining, solution defining and creating conclusions. The strategy was worked out by A. F. Osborne in 1939 as an approach that facilitates the creative process and stimulates creativity by developing divergent thinking.

[8] The American psychologist C. Rogers (1902-1987), while advocating self-actualization, starts from the ten principles of experienced studying where independence and creativity are facilitated when there is self-criticism and self-evaluation while keeping openness towards new experiences.

is open to new ideas, and in the process devotes more attention to self-evaluation than the evaluation of others. In this context we can ask the question: is the higher school teacher born creative, is it a gift that only some individuals have or is it a characteristic that can be acquired through time? Simplicio (2000) points out that teacher creativity is hard work that demands abandoning the well-established way of instruction and direction towards the creation of new possibilities which assumes, above all, reexamining the methods of instruction as well as the way of evaluating the effectiveness of the teaching process.

In view of the fact that the school system, considered as one of the dominant places of individual creative potential stimulation and development (Bedeković, 2009), is essential to bring to consciousness the fact that teaching, particularly at a higher school level, is a unique and unrepeatable process where the constituent part is the individual, in other words the student, who, with all his individual characteristics and needs, makes a separate subsystem where the teacher has to adapt to the fact whether he wishes to enable the student to be a creative creator, competitive and actively included in the work market world at the end of his studies. In this matter, it is essential for the teacher to understand that while developing the student's creativity potential he also assumes the freeing of his own creativity potential, while the main position for acquiring the necessary competence for creativity stimulation is the intrinsic motivation of the teacher[9]. Besides the motivation for stimulation and the development of creativity in the student, the higher school teacher must possess a range of characteristics that enable the release of his own creativity such as self-confidence, openness to new ideas, readiness to bear difficulties and a sense of humor, while the quantity of his knowledge is of crucial importance in the sense of knowing the teaching forms, techniques, methods and strategies whose application will influence the development of the student creative potential.

Various experiences of direct work in higher school teaching indicate the fact that the application of determined teaching strategies can effectively influence the stimulation of creativity in a student. Research has shown that by applying various aspects of active teaching[10] and cooperative studying[11] it is possible to influence the quality of instruction, while the student besides adopting academic knowledge and developing critical thinking and logical conclusion releases a significant creative potential.

In this context, it is interesting to consider the researches of Cooper and Mueck and Panitz and Panitz (according to Bognar, 2006) whose results have shown positive experiences with teachers and students after having introduced cooperative studying as a possible aspect od stimulating creativity with students in higher school teaching. Cooper and Mueck (1990) have found that 70 to 90% of students have pointed out the advantage of cooperative studying in variables: academic achievement, interest in teaching, working and creative atmosphere, and quality relationship between the student and teacher, while Panitz and Panitz (2005) establish the positive changes in terms of assuming responsibility for teaching on behalf of students,, a more positive relationship towards teaching, speaking capacity development, critical thinking stimulation, qualification for team creative problem solution as well as creating conditions for positive thinking confrontation..

[9] Pastuović (1987) points out that motivation for a certain activity depends on two factors: the attractiveness of the award that is offered to the individual as a result, or for the effect of some activities (that depends on the individual differences and the subjective comprehension of attractiveness) and the correlation between the invested effort and the expected award. Consequently, the teacher will be most creative when intrinsically motivated, or if he is satisfied with the result of his work, compared to extrinsic motivators, when in his work he is directed towards the aim, in other words, the award..

[10] The concept of active studying (active teaching) is indirectly mentioned in the history of pedagogy in various periods of school development, particularly in different pedagogical directions where two basic directions refer to the traditional directions and the new school directions. New school directions have influenced the phenomenon of active studying whose more intensive influence took place at the beginning of the 20th century by directing towards the transformation of the social function and the preparation of the student for social life, independence, freedom and creativity stimulation. In the second part of the 20th and the beginning of the 21st century, didactitians and pedagogues were, however, full of the idea of transforming rigid-receptive teaching into creative-reflecting teaching directed towards the building of an independent and creative individual (Bedeković and Štefančić, 2009). In this sense active teaching implies studying through which a high degree of independence and self-regulation, thinking strategy application and specific cognitive skills are acquired (example: analysis, synthesis, classification, generalization, conclusion) that enable observing the essential, information comparison, connection with actual knowledge and critical judgment of meaning and storage in long-term memory..

[11] Cooperative studying is an instruction model that takes place in groups in which members of the group work together in realizing the group tasks, where, on one side there is the positive interdependence of all the group members, while, on the other side, there is the individual responsibility to realize the tasks. In such a manner every group member is given the possibility of participating personally in the mutual group result, where the group result becomes a reflection of the differences of the group members which makes the studying result richer, more effective and creative.

Similar research results conducted in some Croatian higher school institutions[12] direct to similar conclusions on positive student attitude changes towards the higher school teaching that is enriched with teaching situations that offer students the possibility of creative expression through participation in the process of active and cooperative studying. Research results from Nikčević-Milković (2004)[13] have thus indicated the student satisfaction with active participation in teaching in terms of critical relationship towards new information and creative thinking stimulation, while even the students' expression of satisfaction with the effectiveness of such forms of teaching in terms of storing adopted contents in long-term memory can be considered significant. Researches conducted by Bognar et al (2006)[14] have also indicated the significantly positive student attitude toward teaching during which the dominant form of work that prevailed was cooperative studying, expressed by a general feeling of comfort, satisfaction with the studying process effectiveness and intensified interpersonal relationships, while the creativity phenomenon during cooperative studying is pointed out as significant. The author here emphasizes that the creativity phenomenon is accompanied by positive changes of character i[15], where studying based on one's own thinking emotional and psycho-motoric activities in the context of cooperative relationship results in the release of creativity and self-creation of character. The author furthermore emphasizes that there is sporadic student resistance towards cooperative studying that mainly refer to being unaccustomed to activity during higher school teaching performance, after which teaching enabling their initiatives is very quickly accepted. When we are dealing with teachers, the resistance to cooperative studying is far more intensive than with students and particularly with those teachers that feel insecure in the course of the teaching performance. The basic comments refer to the too big quantity of teaching content needed to be covered, increased time needed for the preparation of cooperative studying teaching and the lack of activity with some students during the cooperative studying performance.

In this context, the consideration of creativity stimulation possibilities in higher school teaching as an important performer of student creativity development needs, by all means, to be directed towards the presumption that school teachers that are aware of the need of nurturing creativity have to be directed toward decreasing stress (with students as well as teachers) where process evaluation is more necessary than product evaluation and where establishing an open atmosphere that will encourage and value self-expression and exchange of ideas is of crucial importance, while instead of hierarchy it is more desirable to value the cooperative relationship and the freedom of exchange of ideas

A Competitive Approach to the Creation of a Higher School Teaching Curriculum

The reform of the European education system starts from a new conception based on competence and standards which represent the starting point for developing the competitive approach to the creation of a curriculum in the higher education system which, among other things, implies concentration on studying results as visible competence[16] directed towards an

[12] The issue of quality in higher school teaching in Croatian higher school institutions was the subject of a certain number of earlier researches (Bratanić, Furlan, Godler, Jurić, 1987; Ledić, 1993.; Kovač, Ledić, Rafajac, 1998), but for the needs of this work we will refer to the more recent domestic researches whose problem area is directed on the application of active teaching a d cooperative studying in Croatian Teacher Education faculties.

[13] Research was conducted on 77 students of the Higher Teacher Education School in Gospić during the performance of the teaching course Developmental Psychology which was dominated by enriched cooperative studying within the framework of the ERR system based on the method of active studying where the teaching contents instruct through three basic phases: evocation (whose aim is to stimulate motivation), understanding (directed towards adopting new contents) and reflection (personal reflection on new contents in the context of current information). During all three phases active studying, critical and creative thinking methods and techniques were applied with the simultaneous development of communication and cooperation skills.

[14] Research was conducted on 167 students of Pedagogy at the Faculty of Philosophy University Josip Juraj Strossmayer in Osijek after a one-semester experience of teaching performance of the course of Didactics dominated by cooperative studying.

[15] Rogers (according to Bognar, 2006) names this phenomenon "essential studying" where under the conditions of positive cooperative relationship with the recognition of individual characteristics for each group individual results in supporting the personal growth of other group members that leads to character self-realization..

[16] Considering competences from three theoretical starting points: behavioral, constructive and holistic (Babić, 2007) emphasize the tendency toward a constructive approach to competence which is particularly clear in the elaboration of the individual and social nature of competence, where the social nature of studying and instruction confirm the importance of social interaction in which an individual constructs his reality made up of competence, or knowledge, capacity and skills. Poole et al. (1998) imply under the concept of competence a combination of knowledge, skills, attitudes, motivations and personal characteristics that enable the individual to act actively and effectively in a specific and determined situation.

effective preparation for the work market. The application of this paradigm in the European Union countries has become one of the main tasks of the Bologna Process. One of the essential projects that have influenced the elaboration of the curriculum model directed towards competence development is the Tuning Project (*Tuning educational structures in Europe*) started in the year 2000 with the support of the European Commission whose basic aim is directed toward the building of a general approach to the Bologna Process application in higher education in different academic areas.

Within the framework of the project the points of reference have been developed, and they express studying results as a level of competence that has to be achieved by the person studying. Based on the presumption that besides the development of specific knowledge and academic skills, a curriculum basis is of great importance and need for the development of general competence and transferable skills needed to prepare the student for his future role in society, and within the framework of the project attention is directed towards three types of generic competences: *instrumental, interpersonal and system* competences. In the system competence group, the capacity of producing new ideas, or *creativity*, holds a significant place, which represents the future reference framework for considering the importance of creativity stimulation in higher school teaching, but creativity as a significant professional competence (Bedeković i Zrilić, 2009b) of the higher school teachers. In this context, creativity stimulation, as a significant competence of the higher school teacher, represents an essential precondition for the beginning of changes in creative higher school teaching.

The changed environmental conditions in contemporary society directed towards knowledge, and among which Croatia surely holds a place, have substantially influenced the changing and expanding of the professional role of the higher school teacher. In this context, expectations, among other things, refer to stimulation of self-regulated studying, to the acquiring of multiple competences, as well as the acquisition of communication and social skills. Considering the dependence on human creativity as one of the basic presumptions for success in any human activity, this has a particular significance for life in this world caught by continual and un stoppable changes, expectations connected to the stimulation of releasing creative potentials in students surely represents an important professional challenge for higher school teachers. (Bedeković , 2009).

It is, therefore, necessary to direct higher school teaching towards changes that, among other things, imply the transformation of traditional lecture-directed teaching directed teaching towards active and creative student-directed teaching, while the solution to the problem discrepancies between acquiring theoretical knowledge and practical skill development directed towards acquiring different competences in the traditional studying program discerns in the elaboration of a competence approach model and a curriculum based on the results of studying that are closely connected to establishing qualification frameworks that determine knowledge, understanding and the possibility of creating a student based on the given qualifications. Considering the fact that studying results and qualification frameworks are essential not only for the recognition of acquired qualifications in the national and international area, but also for study program realization and design (Šoljan, 2008), it is to be expected that the question of shaping new and reshaped existing study programs in Croatian higher school institutions will become a first-class task not only for the academic community but also for other interested participants, particularly those that create the demands and needs of the contemporary work market

3. Towards a Conclusion

Increased interest in higher education started coming into the Croatian area at the turn of the 20th into the 21st century, the time when the Bologna Process authors were already directed towards the year 2010 as a given deadline where European leaders have obliged themselves to shape the European higher education area. In the period from the year 2000 until today, the changes in the Croatian higher education system have become part of the education policy, while the Bologna Process impressions[17] range from complete denial to (un)critical advocating. Šoljan (2008) points out that the European academic public has, in recent years, been dealing mostly with issues connected to the building of a new architectural system of higher education with the aim of being harmonized according to the model 3+2+3, creating presumptions for student and higher school teacher mobility and introducing instruments

[17] The Republic of Croatia signed the Bologna Declaration at the Chancellors' Conference held in 2001 in Prague, after which the Bologna Process became obligatory in Croatian undergraduate, graduate and postgraduate expert and university studies.

that will facilitate the mobility of students through the ECTS system where the student academic development should be identified on the basis of studying results connected with establishing qualification frameworks that determine the knowledge level, understanding and activity based on the given qualifications.

Along with the consideration of the mentioned advantages and the problems on the difficulties in applying single Bologna issues into practice, it is considered necessary to point out the lack of taking into consideration pedagogical, didactical and methodical issues in the Bologna Process application. Creating problems over this issue is firstly referred to the qualification level of higher school teachers in applying contemporary methods of instruction directed towards the transformation of traditionally directed higher school teaching, as well as its adaptation to the needs of contemporary society which confronts educational systems with new paradigm challenges for the traditional higher school teaching to hardly manage. In this context, it is, nevertheless, encouraging that the Bologna Process points out that the pedagogical-didactical-methodical approach questions from the very bottom the traditional higher school education, and it is teaching directed towards the students. Therefore, traditional higher school teaching that was teacher directed (and unfortunately still is) should have been substituted by student directed teaching which changes substantially the role of the higher education teacher, as well as the role of the student. In these terms the role of the teacher is no longer measured with the transfer of knowledge through the classical aspect of lectures, while the student stops being the passive receiver of the teacher's notions and becomes an active participant of his own development, participating in active, cooperative, critically oriented and creative teaching. Taking into consideration the fact that the human creativity phenomenon has still been insufficiently researched from the pedagogical aspect (Bedeković and Zrilić, 2009a), particularly when we are generally dealing with creativity stimulation in higher school teaching and its influence on student creativity and with the results of its implications on student academic development, the issue of standard where higher school teaching is oriented on the student and becoming a reality in Croatian higher school institutions can be considered as a key issue of discussion on the possibilities and perspectives of creativity stimulation in higher school teaching. p

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A fast image processing based kin recognition method in a robot swarm

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Abstract

In this paper we develop a reliable and fast visual recognition algorithm to detect kin object in a robot swarm, where every robot is equipped with a zebra pattern. Our idea is based on Fast Fourier Transform (FFT), which is sensible for this kind of pattern and has a relatively low complexity. We sampled the camera images of the robot by a vertical sampling method, and the sampled one dimensional vectors were the inputs of the FFT. The basic idea of the pattern localization is that there is a distinguishable peak in the FFT spectrum if the sample went through the horizontal zebra pattern. If this peak is larger than an empirically determined threshold value the algorithm finds the location of a kin robot. To test our idea more experiments were accomplished with Surveyor SRV1 robots, which have on-board camera system. The captured pictures of the observer robot were sent to and processed in a PC using MATLAB program.

Keywords: mobile robots, visual tracking, kin recognition

1. Introduction

In the last few decades a considerable development achieved in the field of swarm intelligence and multi-robot cooperation and due to this now there is a wide variety of problems that can be solved efficiently by a group of autonomous robot workers. The most investigated tasks are, for example, the exploration of an unknown area [1, 2, 3] and the realization of some collective movement patterns such as gathering or chain formation [4].

In most of the cases the mobile robot has to navigate in a space populated by different objects and obstacles. Provided that the robots are equipped with on board or outer camera, it is a crucial task, based on the pictures of the camera, to distinguish the team members from the indifferent objects and, moreover, the team members from each other. If this so called visual kin recognition ability is granted then much more advanced swarm intelligence algorithms can be realised. Note that this visual identification of the robots means also localization, since the approximate coordinates of the robots can be recovered from the camera picture. A number of works investigated the possibility of such a camera based recognition and localization system using various image processing and shape or colour extraction algorithms [5, 6, 7]. However, all of these applied methods consisted of algorithms with a complexity of the order of at least n^2 (where n is the linear size of the camera image in pixels). This can be a problem in the case when it is not possible to send the pictures to an outer work-station but the pictures of the on-board camera have to be processed by the mobile robot itself. (Actually, this is the case, when we have a real autonomous robot swarm.) The computational resources of a small mobile robot can be very limited even compared to an ordinary PC, therefore a less complex and fast solution for the problem is of high importance.

In the present work a fast visual kin recognition and localization algorithm with the complexity of the order of $n \cdot \log(n)$ is proposed and tested. The method is based on masquerading of the robots by a zebra pattern and searching for this pattern in the camera picture by Fast Fourier Transform (FFT). The complexity of the FFT, which is $n \cdot \log(n)$ for a row of n elements, gives the complexity of the whole algorithm. The proposed method is tested with the help of the Surveyor SRV-1 robot, which is equipped a proper camera and picture capturing system. At the present phase of our work the image processing part is implemented in an outer work-station using MATLAB, and the implementation for the robot's microcontroller is left to a future work.

In the next section the mathematical details of the proposed method are given. In Section 3 the test of the method is introduced, and in the last section we conclude our results.

2. The visual kin recognition method

As it was mentioned in the introduction the basic idea of the visual kin recognition is that a zebra pattern is searched in the picture captured by the robot camera. To understand the details of our visual kin recognition algorithm, first let us give brief description about the basic notions used in the image procession.

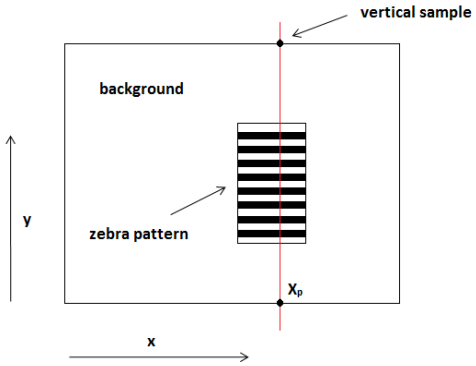

Fig. 1. Digital image vertical sampling for FFT

2.1. Digital image

A digital gray image is represented by a two-dimensional array of size ($M \times N$) or interpreted as two dimensional spatial function ($f(x,y)$). If we use gray images each pixel corresponds to a value from 0 to 255:

$$P_{xy} : (x,y) \to [0,255], \quad (1)$$

where P_{xy} denotes the pixel value at the coordinates of (x,y).

Each coordinate pair determines a pixel location, where x ($x \in [1,N]$) is the column and y ($y \in [1,M]$) is the row index. Let us introduce the notion of vertical sampling, which has a high importance in our method. It is assumed that a zebra pattern is located somewhere in the captured digital image of the robot. In order to determinate the horizontal location of the kin robot i.e. locate the zebra pattern, we have to take sample-columns of width one pixel and of length *M* pixels from the digital image. This method called vertical sampling. A sampled column represented as a set of pixel values, and can be given as:

$$\bar{S}_{x_0} = \left\{ P_{x_0 y_i} \mid 0 < i \le M \right\}. \quad (2)$$

In this case the parameter *x* is fixed and the parameter *y* changes from 0 to *M*.

2.2. Pattern recognition

The basics of our idea are shown in Figure 1. Each team member (robot) got a zebra pattern, since this kind of pattern could be easily detected by the FFT analysis. The captured digital image is sampled by the vertical sampling technique, thus the input of the FFT is only a one dimensional signal, which is a column of the captured image. If the sample-column contained the zebra pattern then this results in a distinct peak in the FFT spectrum.

The FFT spectrum can be computed easily in MATLAB with the help of the following formula:

$$C(f) = \left| F(H(\bar{S}_{x_0})) \right| \quad (3)$$

where $C(f)$ is the frequency dependent Fourier coefficient function of the sample-column, H is the Hilbert transform (interpreted by the means of the MATLAB system) and F stands for the Fourier transform. The F and H functions correspond to the `fft` and `hilbert` functions in MATLAB.

Regarding the details of these transforms see for example Ref. [8]. The Fourier transform can be accomplished by FFT, which has the complexity of $M \log(M)$.

Figure 2 demonstrates three vertical samples and their FFT spectrums. Figure 2/a shows the original image, the b, c and d show the FFT spectra obtained from the samples marked on the original image. In the former two there are no distinct peaks in the spectrum in the region of interest, however, d contains a unique peak, as the selected column goes throw the zebra pattern.

Since the coefficients in the low frequency region of the spectrum are much higher than the peak value of the pattern, it necessary to appoint a "searching window" in the frequency domain around f_p i.e. the maximum place of the of peak and restrict the search of the peak to this window. Let denote this window as:

$$\bar{W} = [f_{\min}, f_{\max}]. \quad (4)$$

This method provides an efficient way to find the peak location, which generated by the pattern.

When the FFT spectrum of a certain sample is obtained we have to determine if the sample goes through the zebra pattern or not. In order to decide this, the maximum value (denoted by A_p) of the spectrum in the $\bar{W}$ window is calculated, and then this maximum value is compared to a $T(f_p)$ threshold. This is a well known method in the decision-making procedure. Actually the threshold value will be the stopping condition of the kin recognition algorithm. More precisely, the decision process above can be given as:

- take the sample $\bar{S}_{x_0}$ at position x_0;
- calculate $C(f)$;

- find the maximum value (A_p) of $C(f)$ inside the window $\overline{W}$;
- if $A_p > T(f_p)$ then stop further search;
- if $A_p \leq T(f_p)$ continue searching, i.e. go to step first and repeat the algorithm with another x_0 value.

The $T(f_p)$ threshold function can be established in an empirical way (see the next section).

2.3. Heuristic searching in the digital image

By now the zebra pattern recognition method is specified. The problem is how we could find the location of pattern in the image plane. Implicitly the easiest solution for the problem is to scan the image column by column. However, with this exhaustive search the algorithm complexity grows to $N \cdot M \log(M)$. Thus it is necessary to define a heuristic and much faster searching method to find the location of the zebra pattern in the image plane. An efficient answer for this issue is a tree-like heuristic searching. Figure 3 shows this heuristic method, that establishes the searching order by the binary tree breadth-first traversal. As it is shown by the figure this searching process quickly reduces the largest width of the undiscovered column-streaks in the image.

The searching order, which gives the order of the x_0 sample positions, will be the following (if we have a 320x240 resolution image):

x_0 =160, 80, 240, 40, 120, 200, 280, 20, 60…

This searching procedure does not stop until find the zebra pattern.

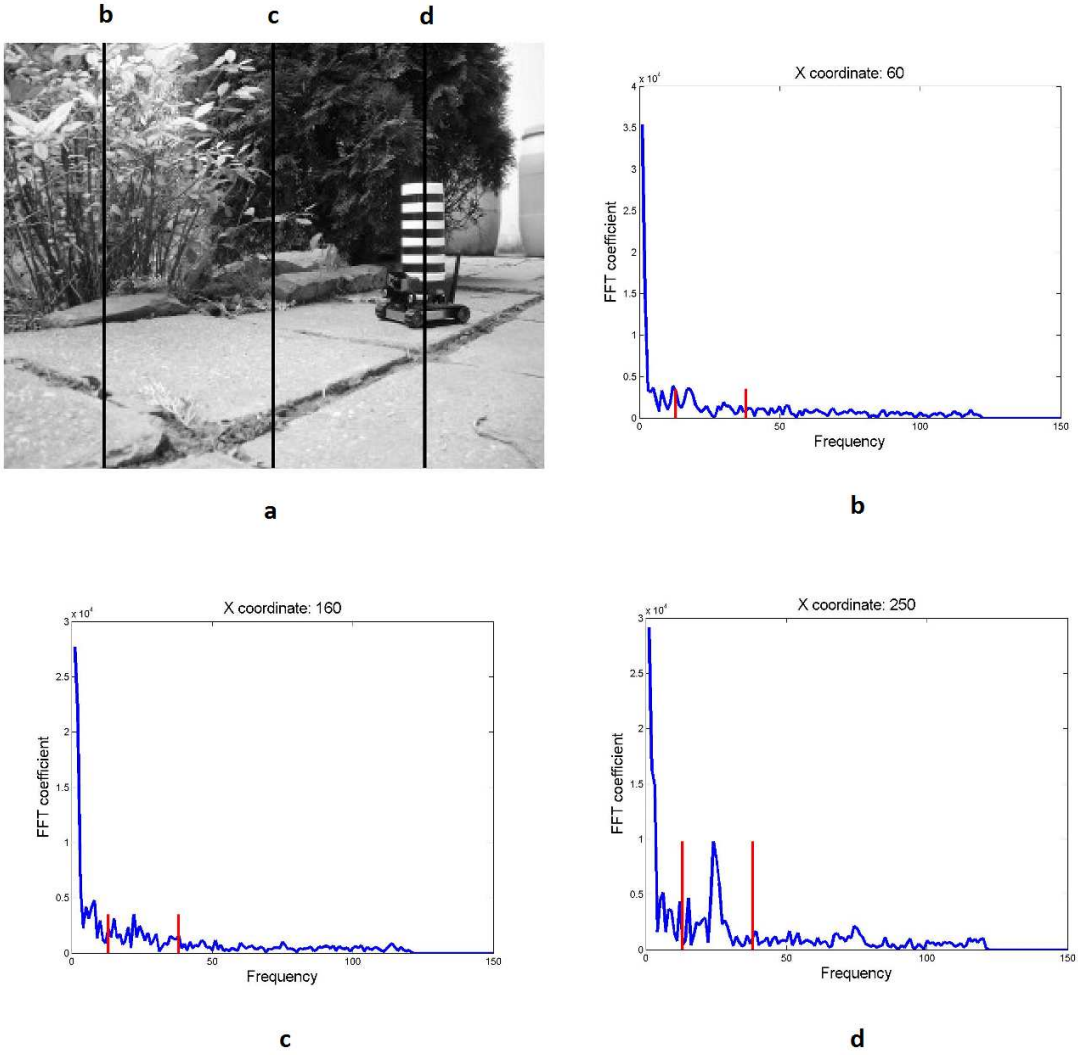

Fig. 2. FFT spectra of three different vertical samples

The camera system of the robot captures images (frames) continuously and passes them to the algorithm for procession. Every single image needs the search window $\overline{W}$ and threshold function $T(f_p)$ to detect the zebra pattern. The search window of a certain picture can be determined with the help of the previous (and processed) image, because the frequency of the peak cannot change abruptly. This means that the frequency variations refer to a continuous function. So the window $\overline{W_i}$ of the *i*-th image is chosen as:

$$\overline{W_i} = \left[\frac{f_{p_{i-1}}}{2}, \frac{3 f_{p_{i-1}}}{2} \right], \quad (5)$$

where $f_{p_{i-1}}$ is the maximum place of the frequency peak (caused by the pattern) in the (*i-1)*-th image.

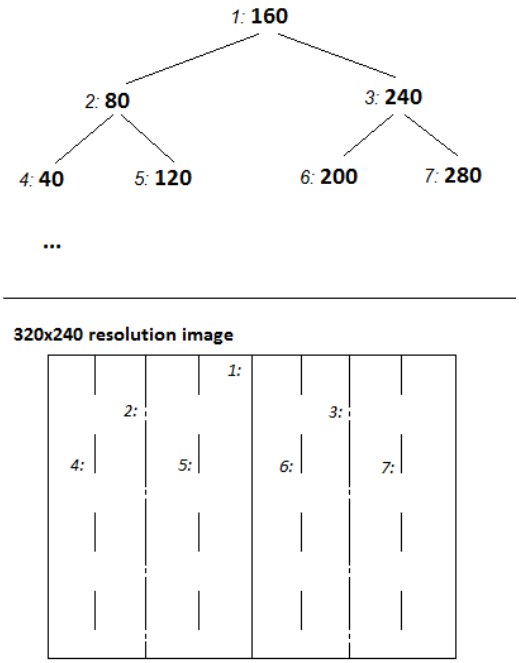

Fig. 3. Solution for the vertical sampling order

3. Experiments and results

The method detailed in Section 2 was tested by a relatively simple experiment with the help of the Surveyor SRV1 robot system.

3.1. The Surveyor-SRV1 robot

The Surveyor-SRV1 (see Figure 4) robot is designed for research, education and exploration. It employs the SRV1 Blackfin Camera Board with a 500MHz Analog Devices Blackfin BF537 processor. The video camera has resolutions from 160x128 to 1280x1024 pixels, and the robot also has two laser pointers to distance measurement. The robot is capable to communicate with a PC or another kin Surveyor robot using its wireless interface.

The software of the Surveyor robots includes a linux operating system and a preinstalled framework. This framework also contains a Pico C interpreter to execute on-board programs. This language provides the possibility to create a self-navigating autonomous robot.

Fig. 4. Surveyor SRV1 robot with the zebra pattern

In order to masquerade the robot with the zebra pattern a simple plastic cylinder was used with alternating horizontal black and white streaks on it. This cylinder shows the same visage from any angle of view. Briefly the cylinder provides a simple, movement invariant solution for the kin recognition method.

3.2. The experiment

In the experiment there were only two robots involved: an observer robot, which is equipped with a camera, and a moving kin robot, which should be localized in the camera picture. The task of the observer robot is to capture images and implement image processing, which was detailed in the previous section.

Figure 5 shows the experimental setup. The observer is immobile and sends the captured frames to a PC for processing. Furthermore, the visual system of the observer always sees the moving robot. The task of the moving robot is to follow a zigzag path gradually distanced from the observer.

The observer has 5 frames/second image capturing rate at 320x240 resolution. These images are sent to the PC as inputs of the image processing using MATLAB.

When the distance is gradually increases the observed frequency of the zebra pattern increases too. Thus a relationship can be established between the distance and the detected frequency. Beyond a certain

distance the processing method becomes unreliable, because the resolution of the camera is too small and the pixels cannot determine the pattern efficiently. The theoretical limit of this distance is when the width of the streaks of the zebra pattern is only one pixel, that is the frequency value of f_p is equal to the Nyquist frequency. By the means of our experiments this distance is approximately *5* meters.

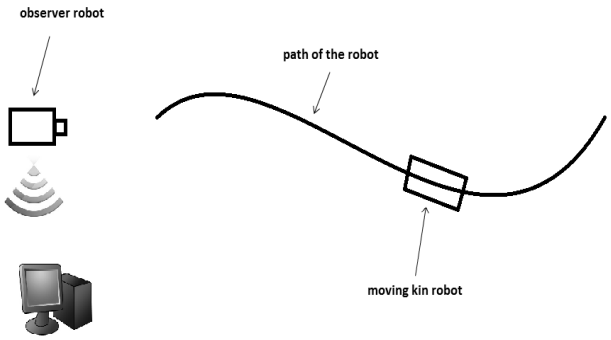

Fig. 5. The experimental setup

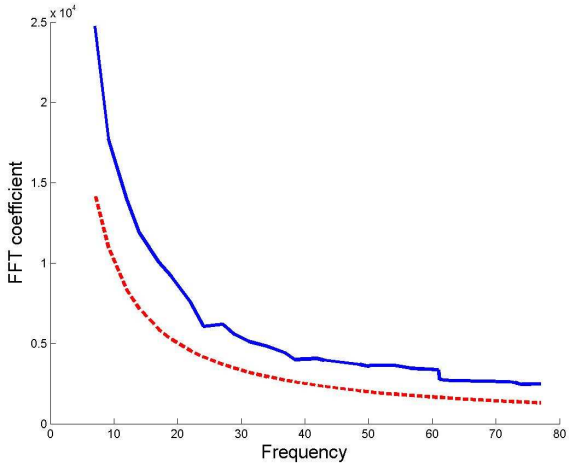

Fig. 6. Distance measurement and the proposed threshold function denoted by continuous and dashed lines, respectively

The threshold function $T(f_p)$, as it was mentioned in the previous section, was determined empirically. Images were captured at different distances (from 20cm to 300cm) about the cylinder with the zebra pattern. The values of the frequency peaks caused by the pattern were recorded for each distance value. The results are shown in Figure 6.

It can be seen that the peak value versus distance curve resembles a power function with negative power. Therefore the threshold function here is chosen as:

$$T(f) = 10^5 \cdot \frac{1}{f_p} \qquad (6)$$

The coefficient of the function was approximated by the experimental curve. The approximated curve is also shown in Figure 6.

Note that it is also possible to estimate distance between observer and moving robot with the help of the detected f_p frequency value based on the relationship between frequency and distance.

3.2. The results

In this subsection we exhibit the results of the above mentioned experiment. Figure 7 shows 3 processed input images and their FFT spectra. The images contain a vertical line to sign the found vertical sample which corresponds to the stopping conditions. Each line has some details next to it, such as *x* coordinate, frequency and FFT coefficient. Axes of the FFT spectrums show the found peak and the searching windows. The dependence between distance and frequency values can be seen clearly in these picture-pairs.

4. Conclusions

Finally we summarize the results of our visual kin recognition algorithm:

- the proposed location method is reliable in various environments;
- complexity of the proposed algorithm is lower than the used visual kin recognition methods till now;
- our method is capable to estimate the robot-robot distance by the frequency value of the maximum peak;

In the future we are planning to develop this method for more kin robot recognition. This can be based on an additional vertical zebra pattern, the frequency of which is a certain multiple of the frequency given by the horizontal pattern. Thus the expanded patterns provide a reliable method to not only detect but also identify each kin object in the image plane of robots.

Furthermore we are planning to program the Surveyor SRV1 robots on-board using only the provided hardware capability of the robots.

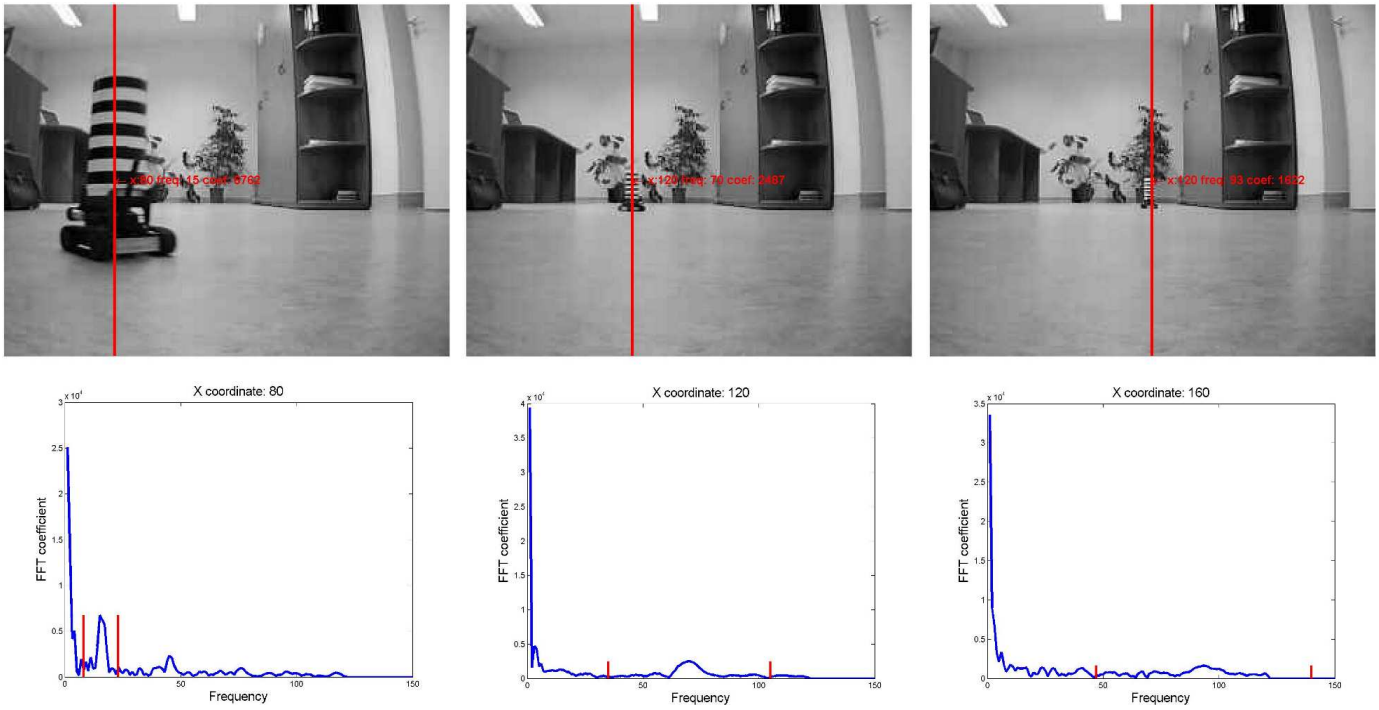

Fig. 7. Three images from the series taken by the camera of the observer and the FFT spectra of the three vertical samples indicated in the images by the solid lines. The searching windows are denoted in the spectra by vertical segments

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Enhanced Control Interface for Alcohol Refinery

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Abstract

In this paper, development of process control system for an alcohol fermentation plant with acid dilution subsystem is presented. Interface to system is designed as operator application executed on personal computer with capability of monitoring work variables in current and historical manner, manipulate actuators, available controls and change sequences. Proposed enhanced process control interface model is outlined with human oriented design approach. Former conventional control and new enhanced model are compared where new model is shown as superior in process representation and control. Control and interface systems are extended with conventional proportional-integral-derivative algorithm and fuzzy control algorithm. Further optimisation of control parameters for different work regimes (start-up, normal, disturbances) is made as offline particle swarm optimisation for minimization of overall production time and resources usage.

Keywords: fermentation, control interface model, fuzzy logic

1. Introduction

Keeping operation variables stable was previously only objective of a given process control. New objectives put in front of process industry as result of variable working conditions ask for reliable control and monitoring system for supervision [1]. Final solution has to be modular, time and cost effective in deployment and maintenance. Two main tasks in this example needed to be satisfied: one is to preserve self-sufficiency of control and monitoring system for fermentation plant and enable connection with other present systems in refinery and factory. In recent period, ethanol alcohol as alternative fuel product draws progressive attention. New ways of production, new sources of feedstock and control are presented recently [2, 3]. New control paradigms and strategies are tested and deployed, like ones in evaluated literature where fuzzy logic [4, 5, 6], neural networks [7] and genetic algorithms for process identification and control [8] were used. Process industry supervision and control is considered complex doe to high integration [1, 5, 9]. This all makes more difficult to preserve safety, process and maintenance demands at local and consequently global factory level. An advanced control system should provide displays which are oriented toward the total process rather than towards only individual parameters [1,10] furthermore it could stand for every supervision and control system generally speaking.

2. Alcohol Rafinery

Sugar beet molasses, as by-product of sugar production, is commonly used as substrate for ethanol and yeast biomass production. Ethanol usage is as technical alcohol, in alcoholic beverages production and as alternative fuel. Fig. 1. presents general scheme of alcohol refinement from sugar molasses. Main focus in this paper is on fermenters and preparation of constituents for batch-feed fermentation supervision and control in refinery as central unit in alcohol production. Molasses preparation, and latter distillation and rectification are not covered in this paper, only as information interchanges between these systems in function.

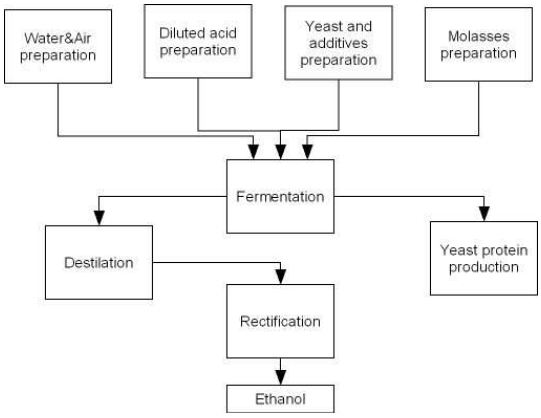


Fig. 1. General configuration of Alcohol Refinery Plant

3. Fermentation Plant Interface Design

A properly designed plant interface system should provide displays and interfaces, which operator can use to supervise and control all available process activity. The interaction is dual: active in controlling the process or passive in monitoring the system and process behaviour [10]. Input data from other systems are: status of molasses preparation system, concentration of molasses, flows; status of distillation and rectification columns, main flows, temperatures and concentrations; general supply status; general communication status of relevant systems. System must maintain self-sufficiency even if other control systems fail (working on last known set points until operator declare otherwise).

Process control interface is the means by which the operators, site supervisors, maintenance engineers and system administrators interact with the system. Process operators need to know present and past process data, trends and alarms and be able to control process in the desired way. Supervisor need to check historical trends and give direction for operators accordingly. A maintenance engineer has to have entrance for equipment usage, its parameters and all other relevant data [10]. System administrator has local and remote access for database administration and system health control, setup and configuration screens for controllers parameters and system behavioural configuration. All of these functions needed to be taken in to the consideration in process control interface design and deployment. Design considerations have to be taken by human oriented approach in goal of realization better integration of procedures, control and alarm system [3, 11, 12]. New setup configuration consists of one process controller and one central personal computer with two monitors (one for process control operations and other for alarms and messages) for process control interface. Figure 2. illustrates detail of main process control operations screen as it is seen by process operators. Operators usually keep this screen active for most of the time in normal operation of system.

4. Results and achievements

4.1 Acid dilution

Acid dilution is one of safety critical from maintenance and control point of view because of aggressive media used. Sulphuric acid is strong mineral acid and its dilution in water is highly exothermic reaction. Industrial concentrated sulphuric acid is stored in outside monthly tanks and mixed with molasses after dilution. Because of water, relative lower density it tends to float on acid and process needs to be closely monitored and controlled to avoid dangerous splatter and boiling if water is accidentally added in acid. Main supervisory for operators and alarming value is temperature in mixing tank. Former control cabinet was kept for security reasons and alternative manual control (Figure 3). New control screen for acid dilution control and supervision is shown in Figure 4. Mixing goal concentration of acid is 10% dilution (in mass concentration). Diluted acid is added to yeast milk and mixed in mixing vessel. This mixture is than mixed with prepared molasses, water and nutrition salts mixture in pre-fermenter (Figure 2.).

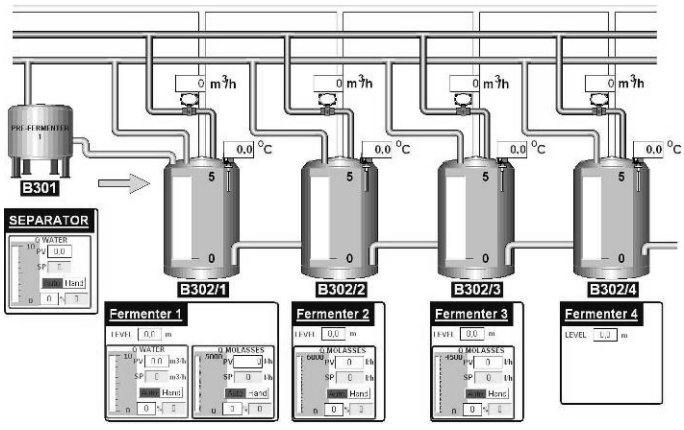


Fig. 2. Fermenters supervision and control screen (detail adopted from [13])

4.2 Process Supervision and Control

Supervision and control of fermenters is in main concern of operators beside control of quality of product by means of sample extraction and bio-chemical analysis (in present time manual). Main process control is modular programmable logic controller (PLC) based with Profibus and Industrial Ethernet communication connections to other systems [13]. Control of continues variables is by means of standard and advanced software fuzzy proportional integral derivable algorithm (PID and fuzzy-PID). Parameters optimization can be made on-line for different work regimes (start-up, normal, disturbances, shut-down) for mixture of water, diluted acid, molasses, additives and temperature control in pre-fermenter and standard for air, water and molasses flows in fermenters for error and error rate. Operator can select between remote (automatic and manual) and local modes of work. In automatic remote mode sequence of mixing is automatically started with defined mixture ratio. Mixing ratio is variable and can be recalibrated if needed in case of disturbances.

Fig. 3. Acid dilution supervision and control cabinet

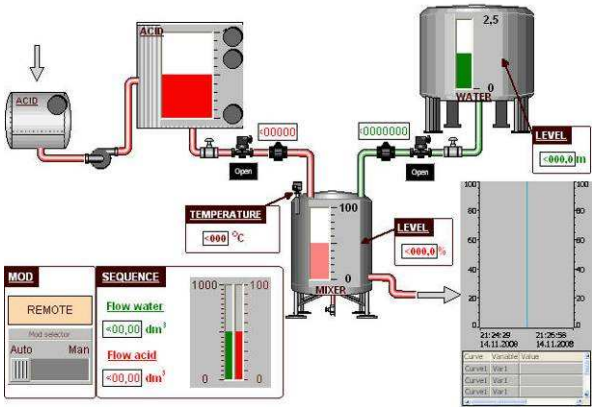


Fig. 4. Acid dilution supervision and control screen (detail adopted from [13])

Alarms control have been divided in two screens, distinguishing acid dilution and fermenters control alarms and all other alarms; where others include approximately 100 valves, pumps and electrical drives status values. Relevant information for maintenance division is prepared in form of graphic signalization for operators (Figure 5.) and text alarms and messages interchange for maintenance division.

This screen replaces ten meters of conventional lamp driven control cabinet with blind schema. Part of it is shown on Figure 6 – pictures a) utility preparation and b) yeast protein production.

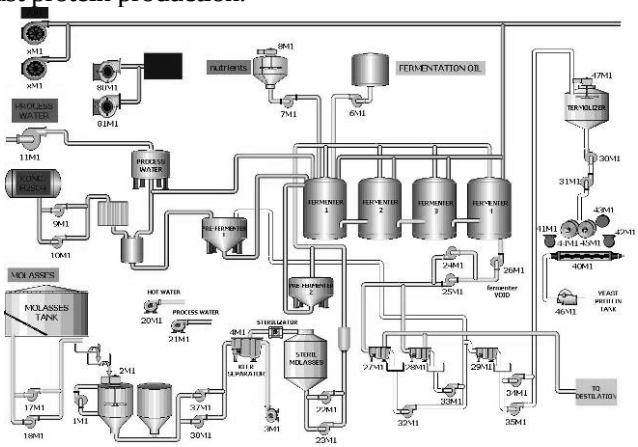
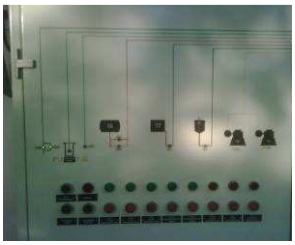
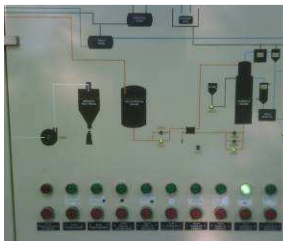


Fig. 5. Plant drives supervision and control screen 1 (detail adopted from [13])



a) utility preparation



b) Yeast protein

Fig. 6. Plant drives control control cabinet

For current and historical view of measured data appropriate screens are designed for all needed data: one screen for acid dilution (level, temperature, acid and water utilization), and one screen for fermenters (level, air flow, water flow, molasses flow, …), example is Figure 7. illustrates historical data measurement of vessels level in meters (upper graph) and flow of air in fermenters in m^3 in hour (lower graph) for period of five hours.

Fig. 7. Measurement historical data representation for vessels levels in meters (upper graph) and flow of air in fermenters in m^3 in hour (lower graph) (color inverted)

Screen controls enable users to change time scale, zoom in, go back in previous segment. All measurements and control actions of operators are collected and preserved in database systems on local computers second backup hard drive.

User's remarks after first period of usage was taken in to the consideration, evaluated and implemented for this years campaign start.

5. Conclusion

The process control system presented in this paper uses adopted computer based interface as a replacement of former conventional interface. Implementation of new control system based on software algorithms was successful and replaced old conventional. Users have all relevant information on one place; and maintenance staff now can historically view and act preventively.

• Sample extraction and bio-chemical analysis for molasses needs to be fully automated and integrated in process control system to enable more autonomy in optimisation of control parameters.

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Image correction for network applications

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Abstract

In the work of image correction, example white balance correction to study the peculiarities of digital photography, which has in the past few years, much simplified and modernized the process of photography. We know that photography completely depends on light but what is interesting is that the light looks always the same to human visual system although it can have endless variation. As our visual system reacts different than photographic film or digital chip, white balance depends on condition where picture has been taken. If there is a case with unbalanced white color we can correct white balance with program that is made in this work and integrated in network applications like world wide web browsers for correctiong images on networks.

Keywords: Digital photography, light, white balance, protocols, web browsers.

1. Introduction

As much as the man was ready to learn, explore and study, the technology goes further in its development. In order to stop a little short, but very important segment of the technology we have explored, studied, compared and brought a new vision regarding the development of digital photography as an integral part of any web sites or web pages. The aim of this paper is to present a theoretical point of view, to study the properties of digital photography and to use the methods by which programming language was created for the principle of correction of the white balance for digital photography as part of the website, but first of all, the emphasis is on practical and exploring part of that related to the development of the previously mentioned programs. As well as each work has to bring something new, original, which is the reason why it occurs, it also has to be based on already seen or researched theoretical principles that will make him a solid base and be an impetus for further, independent research.

The first part of this study refers to the properties of digital photography. In brief, but clear enough points we have presented the properties of digital photography where the emphasis is put on the full dependence on the light, as the centre of our interest. In this chapter, we meet up with the concept of apparent colour which brings us to the table where colour temperature of some light sources is submitted, plus one is warned of the key issues when it comes to digital photography, and is moved from the comparison of man and technology. It is also noted that our visual system reacts completely different to the temperature of the light than the camera. This problem is proven by simple but impressive example of a sheet of paper. Also, there is the comparison between shooting with colour film and photography taken with a digital camera when shooting under ordinary light bulbs. Digital Cameras provide a greater choice when shooting, which also applies to the whole range of options while shooting in different temperatures of light. However, in spite of so many options, sometimes there is uneven photography white balance. On such a photo, one can make a correction by using certain computer program which will be discussed in the following sections of this study. In the second part of this study we have described an algorithm, or the way running white balance correction and its implementation in a programming language known as programming language C #. Given that the Internet is a global network it provides the communication infrastructure to access different contents on the Internet and thus a variety of digital photographs that are on web sites. Results can be viewed using the client programs, called browsers

(web browsers), and the goal of this work is to implement the white balance algorithm to the Internet site in order to improve the display of digital photos.

2. Properties of digital photography

People who have entered the world of photography after the digital revolution are not even aware of the fact how certain segments of the digital technology have simplified the process of photographing, but at the same time the same process has become significantly more complicated, because when there are more options to choose you have to have lots of knowledge to choose properly. Photography is completely dependent on light and light can have an almost infinite number of different variations. One of the characteristics of light that has a whole range of possibilities is the temperature of light (Tab. 2.1.). The term is used to explain the spectral characteristics of light, and its apparent colour. Why do we say the apparent colour? It is because light appears to us more or less always the same, in most cases we do not even notice that the light has a colour. The unit for measuring the colour of temperature is in Kelvin degrees. Source with higher temperature has a „more" blue light from the source with lower temperature.

Table 1st ***Colour temperature of some light sources.***

Light source	**Temperature in K**
Clear blue sky	10000 – 15000
Cloudy skies	6000 – 8000
Sunny, average	5400 – 6000
Electrical flash	5400 – 6000
Domestic lighting	25000 – 3000
Light pipe 200 Watts	2980
Light pipe 100 Watts	2900
Light pipe 75 Watts	2820
Light pipe 60 Watts	2800
Light pipe 40 Watts	2650
Candle flame	1200 - 1500

One of the problems is that our visual system reacts completely different to the temperature of the light than the camera. We will see a sheet of paper in white colour, even though all three components of light (red, green and blue) are not represented equally, but no photographic film or chip will react like that. If we read a book under ordinary light bulbs we will see the site in white colour, but if we make a photograph of the same book under the same light, the site will have a light orange - red colour. If white balance is not well adapted the image can be seen as bluish in Figure 1, or if something to photograph the light and high temperature device is not configured for these conditions.

Fig. 1st Incorrect white balance

This discrepancy may be predicted so that the camera control functions use the white balance (white balance Eng.). What does this function actually work? It allows the camera to adjust to a different distribution of three basic components of light, and the camera establishes a new balance between these three components in a way that the white paper again becomes white. That's why this function is called white balance. When you establish a balance on a white surface, all the other areas on the image will be displayed in correct colors (Figure 2)

Fig. 2nd The correct white balance

If you have a picture in digital form with the incorrect white balance, you can make a correction by using certain computer program. The user must specify the area in gray colour, brightness is not important to determine a starting point. Correction is performed according to the algorithm described in the following chapter.

3. Algorithm for the correction of the white balance in digital photography

Each image in digital form includes component parts which are called pixels. Each pixel is a discrete point on the screen. Typically, images contain thousands of pixels. Visual perception image is achieved by colouring each pixel individually. Each pixel is uniquely determined with three different colour components: red, green and blue. By mixing the three primary colours we get certain colour. To perform white balance correction it is necessary to determine a reference point. For each image user has to select the area of the image that is in gray colour, brightness is not important. The area is selected by clicking on the image by checking a single pixel. Then he takes the environment and point the width and height of 11 pixels to get a total of 121 pixels. In this area, it is necessary to find the middle value of all component colours (red, green and blue). Then find the equivalent gray colour of the selected area by adding the average values of all three colour components and dividing the sum by three. Thus the preparation is finished and it is possible to transform each pixel image in a way that the numerical value of each component multiplied by the resulting equivalent gray selected area and share with the mean value of these components obtained from selected areas.

Pseudo code:

- load point, the user should select the area you know that the gray colour, brightness is not important
- area restricted to an area of 121 pixels
- find the average value of RGB colour components: sR, sG, sB
- find an equivalent gray colour of the selected area

$$gray = \frac{sR + sG + sB}{3} \tag{1}$$

- for each point of the whole image to make the transformation

$$\begin{aligned} R' &= R \cdot \frac{grey}{sR} \\ G' &= G \cdot \frac{grey}{sG} \\ B' &= B \cdot \frac{grey}{sB} \end{aligned} \tag{2}$$

In the C # programming language, images are usually displayed as a Bitmap object. With this kind of object, manipulation of images is very simple. But such object does not allow direct access to the data images, but used methods GetPixel and SetPixel to get or set the value of individual pixel images at a particular position. These methods use the conventional white balance correction, where are i and j coordinates of pixels in the image. Inside the Colour object there are the values of all three components of colour.

```
Color originalColor = original.GetPixel(i,j);
```

When user selects the area that is in gray colour, it is taken the surrounding of that point of the eleven times eleven o'clock pixel counts and is counted the sum of the value of individual colour components required for high value

```
Rsum = Rsum + originalColor.R;
Gsum = Gsum + originalColor.G;
```

```
Bsum = Bsum + originalColor.B;
```

where *originalColor.R* is red component, *originalColor.G* green component and *originalColor.B* blue component colours and *Rsum*, *Gsum* i *Bsum* their sum. Mean values of individual components and the equivalent gray colours are calculated according to

```
sR = Rsum / 121;
sG = Gsum / 121;
sB = Bsum / 121;
grey = (sR + sG + sB) / 3;
```

After that, we make a picture or a blank Bitmap object that we will later be used to save the changes of the original image. The size must be the same as the original image.

```
Bitmap newBitmap = new Bitmap(original.Width, original.Height);
```

Since we use the indicators (pointers) that point to a specific position in the memory, image is required to be stored in memory before use, or set bits fixed addresses that can not move in memory. It is necessary to make the original image and the blank image we created in the beginning.

```
BitmapData originalData = original.LockBits(new Rectangle(0, 0,original.Width,original.Height),
ImageLockMode.ReadOnly, PixelFormat.Format24bppRgb);
BitmapData newData = newBitmap.LockBits(new Rectangle(0, 0, original.Width, original.Height),
ImageLockMode.WriteOnly, PixelFormat.Format24bppRgb);
```

PixelSize number indicates the number of bytes per pixel. For jpeg images 24 bits per pixel is needed, each component of 8 bits, a total of 3 bytes. This means that each colour component can have a numeric value from 0 to 255 decimal.

```
int pixelSize = 3;
```

We read pixel data from the image row by row within a loop that goes from 0 to the end of the picture height and place them in one-dimensional field or row. *Scan0* gives the address of the first bits of each row following the current row we get by multiplying the total number of bits in a row. *Stride* gives the number of bits in a row.

```
byte* origRow = (byte*)originalData.Scan0 + (i * originalData.Stride);
byte* newRow = (byte*)newData.Scan0+ (i * newData.Stride);
```

So we get lines with the data shown in Figure 3 that approach as well as a number from memory. With these data we perform the operation for the correction of the white balance to pseudo code.

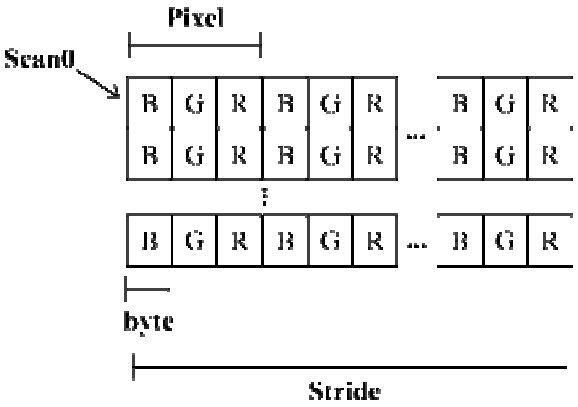

Fig. 3rd The resulting data rows

Byte at position *j * pixelSize* denotes blue component colours, *j * pixelSize + 1* green and *j * pixelSize + 2* red. By correction we get the new numeric values for each component which have to be limited to values between 0 and 255. If the value of individual components is greater than the maximum value of 255, we take the value of 255.

```
int pom_b = origRow[j * pixelSize] * grey / sB;
    if (pom_b > 255) pom_b = 255;
    int pom_g = origRow[j * pixelSize + 1] * grey / sG;
    if (pom_g > 255) pom_g = 255;
    int pom_r = origRow[j * pixelSize + 2] * grey / sR;
    if (pom_r > 255) pom_r = 255;
    byte newColorB = (byte)pom_b;
```

```
byte newColorG = (byte)pom_g;
byte newColorR = (byte)pom_r;
```

Obtained values are stored back to a blank image in memory in a similar way.

```
newRow[j * pixelSize] = newColorB;
newRow[j * pixelSize + 1] = newColorG;
newRow[j * pixelSize + 2] = newColorR;
```

In the end it is necessary to unlock bits of memory.

```
newBitmap.UnlockBits(newData);
original.UnlockBits(originalData);
```

4. Protocol stack

Algorithm described in previous chapter can be used in two ways: off-line, for processing of picture files downloaded from specific web sites, or on-line for processing of currently transmitting pictures, before those become visible to user. Since transmission is typically done using HyperText Transfer Protocol, algorithm should act between transport layer and final application at application layer [2].

Position of algorithm in TCP/IP reference model is shown on figure 3:

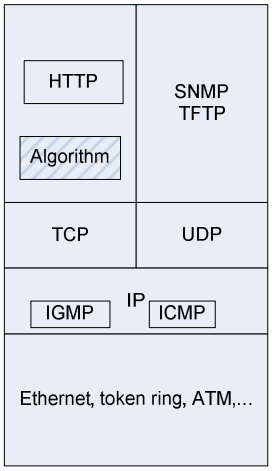

Fig. 4th Reference model

Instead establishing connection to web server directly, web browser (e.g. Internet explorer) should communicate to proxy server, that will transmit all connection data to web server. Proxy should act as »sniffer«, recognizing transmission of picture data. During transmission, picture data should be buffered at proxy level, where algorithm will perform its actions in order to modify pictures in desired way shown in Figure 5 [1]:

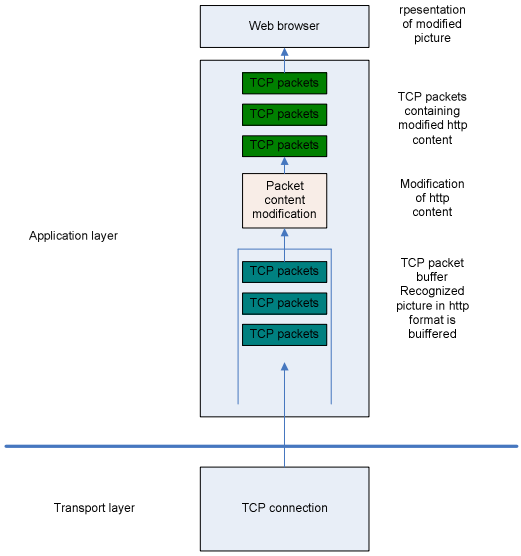

Fig. 5th Packets

Implemenation of such algorithm can be done in terms of plug-ins integrated with web browser, or stand-alone proxy servers used by web browsers.

5. Conclusions

In this work, entitled Image correction for network applications, theme is processed through three in-depth, independent, but coherent chapters. First we specify some basic properties of digital photos. We concluded that the photos entirely depends on the light and as such can be displayed in a variety of different forms dependent on light. The second part shows the correction algorithm for white balance as one of the possible algorithms for the correction of digital images implemented in C #. At the end implemenation of such algorithm can be done in terms of plug-ins integrated with web browser, or stand-alone proxy servers used by web browsers. Since transmission on network is typically done using HyperText Transfer Protocol, algorithm should act between transport layer and final application at application layer.

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The importance of education in primary school for ecological development in the global technical environment

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Abstract

Work shows how students of different faculties and students of primary schools from the area of Slavonski Brod and its surroundings are familiar with certain concepts in the field of ecology. Through surveys we have explored their opinions, attitudes, accountability and a way of solving certain problems. The research results showed that it is necessary to organize more courses to students which are more familiar with environmental issues among students because there is still insufficient awareness and education of these problems. Therefore, it is necessary to increase and raise the quality of life as one constant process of realization and promotion of human and institutional values

Keywords: environment, sustainable development, education, education, students.

1. Introduction

Ecology is called "comprehensive science of everything" because it helps to understand the rules under which it takes what we like to call "balance in nature." Ecology is now recognized by science. When defining the concept of ecology started with a study of the environment of individual species to man, and later studied the relationships in nature. Subject of study of ecology is the relationship of living things according to his environment, their mutual relationship and influence of environment on them. [1] Protection and improvement of environment as one of the most important requirements of survival and development of the human species implies a reasonable use of natural resources and protection and the formation of the biosphere. [1] With his actions man is greatly damaged our environment. The causes that led to these damages are industrialization, urbanization, use of new technologies, increased noise, pollution and the large number of other causes. Society in its industrial development affects the aggressive nature and the environment, gradually conquering and destroying it, while causing an environmental crisis. Environmental problems today are engaged in many sciences, although many believe that ecology should remain, according to tradition, in the biological sciences. As environmental problems are increasingly affecting society and the interests and representation of certain disciplines leads to greater expression. One of the many sciences that deal with this issue is pedagogy. It starts from the practical effects of teachers on students in environmental protection, but also in terms of theoretical reflections on the advancement of practical action. Uzelac [2] indicates that studies in the UK showed that more subjects in school that study environmental education are no guarantee that environmental education will be "better". But on the contrary, problems arise such as:

- lack of readiness of all educational - educational structures in schools,
- lack of sufficient time in the schedule of work,
- lack of equipment and various materials,
- too many children in the classes, which makes it difficult for creative activities in the field of education for the environment. [2]

From this we see clearly that it is necessary to include education about the environment in the curricula of all schools. Although the biggest problem that arises here is the education of teachers, and the main question is: "How will teachers, who themselves are not environmentally educated, able for environmental education for children?"

2. Education and education for sustainable development

Interest in ecology, nature protection and environment is in constant increase. The name of "ecological" is often all you can hear in everyday speech. We write and speak about environmental products, organic food, environmental awareness, environmental associations. "Environmental" and "eco" associated with something that is healthy, natural, harmless and as environmentally friendly. In this way the "ecology" unintentional, but erroneously identified with environmental protection. [2] Education for sustainable development is defined as a process that is increasingly facing the environment in an integrated manner, considering the important cultural, social, economic and biological diversity. Oriented to the environmental problems that depend on the conflict between different human goals, including the wider economic and cultural goals, requesting and listening to what is called the motivation for involvement in environmental activities, according to general rules of good practice, and to increase the competence in the development of criteria and stimulating public participation in decision making. [3] Education and formation of students' positive views toward the environment, habits and behavior in nature, acquired through education and widespread introduction of nature and its value. It is important to accompany the knowledge of the feelings, and encourage students' activity to explore and understand nature. [4] It is equally important to build respect for the nature of the personal scale of values of each individual. It is necessary to encourage adoption of healthy lifestyle and encourage and practice behaviors that will contribute to nature conservation and improvement of working and living in nature. [2] The modern approach to education for the environment in the educational process of school planning involves different ways of learning in a regular election and continue to extracurricular activities: practical work, research and teaching classes outside the classroom, open (project) days of integrated classes, panels, roundtables, debate, including schools in the GLOBE program, or ECO - school. Education for Sustainable Development carry out the task of creating a new generation of young people through the love of nature to create a constant need to go into it, develop the correct attitude towards nature and personal scientific creativity. [2] The main and permanent goal is educations of students - educators. The best results are achieved and easily teach the youngest generation, although the curriculum for primary schools has very little subjects where we can find direct links to ecology, because of that a special place belongs to biology. [2] At the same time, younger generations are those who will acquired knowledges and apply it and transmit to others. It is known from developed countries that have introduced the concepts of environmental protection to the general public through education in the workplace and school children through their parents. [6] Even in kindergarten children develop a sense of responsibility towards their environment. And the schools are occasional events mark the dates related to the protection of nature and important for our blue planet Earth. Are well known and traditional ecological and other activities such as students on the occasion of International Day for the protection of swamp and wetlands (February, 2.), the World Day of Water (March, 22.), Earth Day (April, 22.), the World Day of Biodiversity and On the nature protection in Croatia (May, 22.), World Environment Day (June, 5.), International Protection of the Ozone Layer (September, 16.) and the International Day of clean mountain (September, 26.). As the ecology, is now recognized science and environmental problems have become problems of the world scale, it is necessary to mention that the schools are not the only one who deal with this issue, but also many government and international organizations deal with this. Just to mention some of the adopted protocols - the Montreal Protocol, the Kyoto Protocol, Vienna Convention, the British code, Barcelona Convention, Center for Regional activities - Blue plan, program CARDS and many others.

3. Research

The study was conducted exclusively for this work to see how many students Faculty of Teacher Education, Dislocated study in Slavonski Brod and students of Institution of higher education familiar with the concepts and issues related to sustainable development and protecting and preserving the environment. Also has conducted research among students of primary school, which is also supposed to show how many students are environmentally awere. For this study, as an instrument of research, we select a poll. It should be noted that students of the Faculty of Teacher Education, Dislocated study in Slavonski Brod and students of Institution of higher education had the same poll, while primary school pupils had a survey with questions adapted to their age. Questions were made not to produce fatigue and indifference of respondents. In a survey of students was 13 questions

with one additional question for students of the Faculty of Teacher Education, Dislocated study in Slavonski Brod. Questions are generally answered the questions with YES or NO, and a couple of questions with multiple responses offered. While primary school pupils have had a survey with 14 questions to which were also answered with YES or NO. The sample consists of 100 respondents Faculty of Teacher Education, Dislocated study in Slavonski Brod, 23 subjects of Institution of higher education and 30 primary school subjects.

3.1. Research results

Students of the Faculty of Teacher Education, Dislocated study in Slavonski Brod and University of Applied sciences of Slavonski Brod

The initial question in a survey for students was: Are you familiar with the concept of sustainable development?

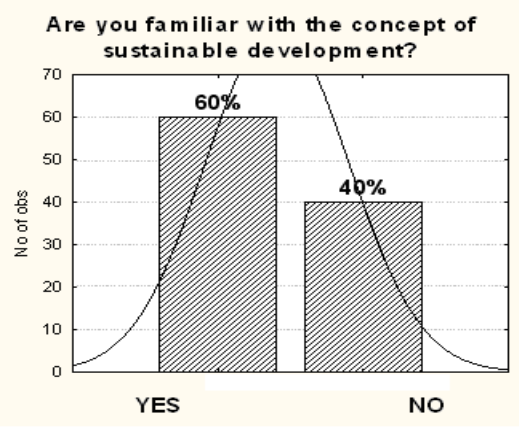

Fig. 1. Faculty of Teacher Education

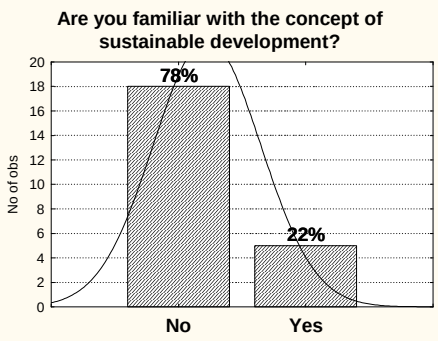

Fig 2.University of Applied Sciences of Sl. Brod

The survey showed that 60% of students of the Faculty of Teacher Education heard the term sustainable development, while the students of the University of Applied Sciences of Sl. Brod for the same term heard only 20% of them. From this we can conclude that the question of the concept of Faculty of Teacher Education students better informed, which is in the normal manner and for the future teachers who must be aware of the environmental issues. On the question of "Pollution problems can be solved only by the rapid technological development?" students are almost equally responded with a difference of 1%

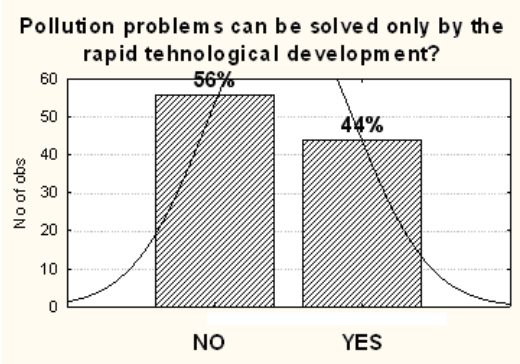

Fig. 3. Faculty of Teacher Education

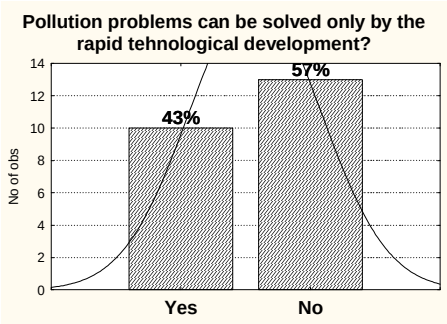

Fig.4.University of Applied Sciences of Sl. Brod

Here we see that the level of awareness, regardless of the university, is very good. Students believe that this aspect is not enough that we resolve the existing problems. Finally students were asked: No matter what man polluting nature, it will never cause a catastrophe of such proportions that killed all life on Earth?

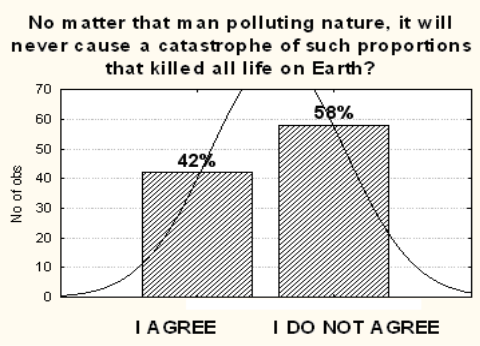

Fig. 5. Faculty of Teacher Education

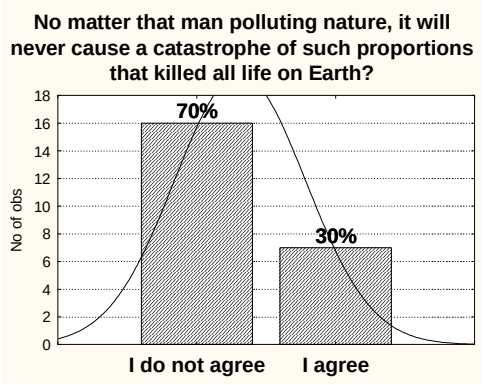

Fig.6.University of Applied Sciences of Sl. Brod

Primary school students

The first question in the survey for students was "How do you know about the problems that happen in nature?"

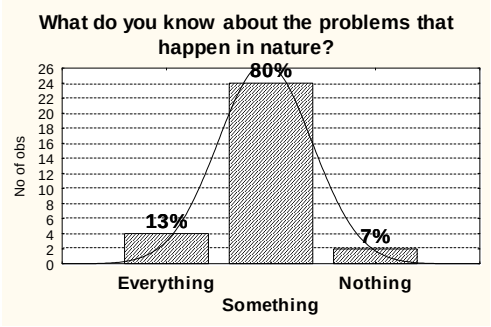

Fig. 7. Primary school

The results are satisfactory due to the fact that the subjects in which we study about environmental problems is very little represented in the curriculum. We see that 80% of the students know the basic facts about the problems of the environment. Are very devastating results that we get to the question "Have you ever participated in a quiz related to environmental problems?" As we see even 93% of students responded that they never participated in a quiz where the themes are related to environmental problems. The reason why teachers do not prepare this type of teaching is so far unknown.

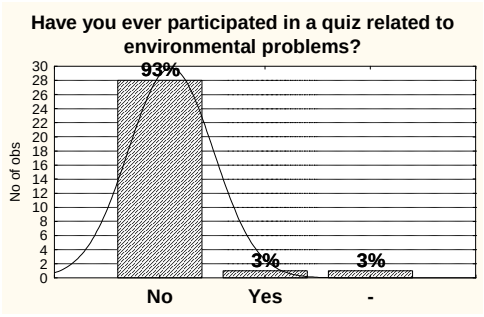

Fig. 8. Primary school

The question "How many are included in the environmental action planning organized school?" Is very poorly rated.

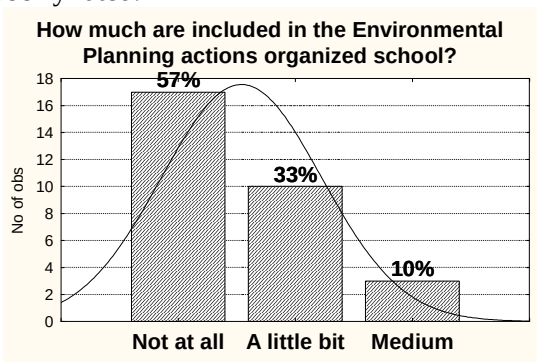

Fig. 9. Primary school

It is very bad that even 57% of students do not participate in school activities planning because as we already know in the more established eco-school, where children need to be educated and familiar not only with environmental problems but also opportunities to preserve the environment. Questions regarding specific concepts such as recycling, pollution and the recognition of certain containers for waste students are mostly well-recognized and opted for an answer that is satisfactory. At the end we asked students "to talk with their peers about environmental problems"

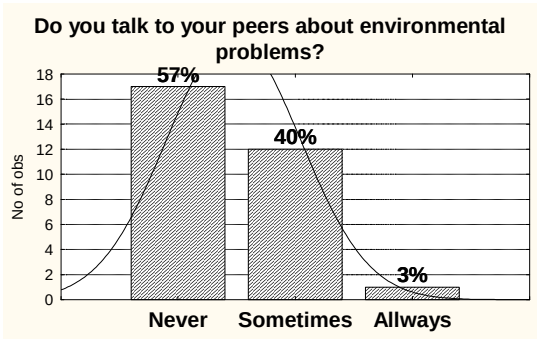

Fig. 10. Primary school

Here we see that even 57% of students never talk to their peers about the problems of the environment, and only 3% were still talking about it. This is very bad, but we can look at it as they are still too young to be understood these issues seriously.

4. Conclusions

Seventies of last century in the minds of the people there was the knowledge that our planet Earth blue-green becomes less blue, green, sunny and pleasant life. The long neglect industrial and consumer-oriented civilization has led to the danger all the living world. Pessimistic scientists have

warned of the consequences of pollution of air, water and soil: the disappearance of the natural environment becomes a threat to the survival of humanity. A man, Homo sapiens, the only rational creature on earth! Environmental protection is a social or political movement that aims to educate the public about the problems of environmental pollution and encourage the resolution of these problems. Life in urban areas away from the children's contact with nature. Everything around them is not pristine nature, parks or even pets. Education for the environment carry out the task of creating a new generation of young people through the love of nature to create a constant need to go into it, develop the correct attitude towards nature and personal scientific creativity. Contemporary thinking on education exceptional attention to environmental issues and sustainable development. When it is questionable whether we need education for the environment, but how to implement that would be effective. A real foundation for change is personal change. Once aware of themselves and the need for change, we will be able to raise and educate others.

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Development of creativity through practical work in methodics of technical culture

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Abstract

The aim of this research is to show how pupils in primary school at Technical culture classes can increase their creativity in learning about mechanisms through practical work with different kinds of tasks and usage of models of mechanisms. The main methods used for the research are: interviewing, action research, group work, assessing and judging. In the action research conducted with fifth grade pupils on the subject of increasing creativity, there was an attempt to creatively adopt unit called „The ways in which mechanisms operate". The method of interviewing was used to determine pupils opinion of what they consider valuable for evaluation. Group work was carried out with students using portable models of mechanisms. A questionnaire was implemented for assessment and deliberation in order to collect data on student opinion about their satisfaction with these methods of work and ways of gaining knowledge of Technical culture. A video of the lesson was made. These methods of collecting and processing information led to the conclusion that by application of creative techniques, teaching aimed at results and active teaching methods is actually possible to develop pupils creativity in Technical culture in fifth grade of primary school.

Keywords: creativity, technical culture, practical work, mechanisms, transmission

1. Introduction

"Definition of creativity:

The word creativity is the result of the Latin word create what means to product things which did not exist before or to create. Based on this word, the Word to create today's result is a modern word which refers creativity on the power of creation, detecting new things or production, artistic creation and participation in something useful or valuable (constructive, meaningful). Creativity is the process of thinking and responding to connects our previous experience, responses to stimulation (objects, symbols, ideas, people, situations) and creating at least one unique combinations[1]. Today is the study of creativity dominant in the service of education where the school as a place of systematic development is considered one of the basic predisposition for the development of creativity from the creative potential of the individual. Teaching in the classes at school is a unique and not repeatable process. Each class (and each student) makes the system itself with all their specific and individual needs which the teacher must adapt to. The teachers adaptation to these needs can be done only by a teacher who is aware of the positive results that follow for him and for students, and even then it is not enough for good development of creativity. Teacher first and foremost must become aware of how to develop pupils abilities and resources necessary means first to develop his own abilities. Motivation for work basic starting point from which it is possible in their work to obtain the necessary knowledge to develop us and others to teach[3]. What is the function of the teacher in modern education and what it can do to realized the needs of society? In modern education's function becomes teaching and collaborating with students. The modern teacher is facing with the rapid progress of technology that makes access to information easier. Young pupils minds are bombarded the large quantity of various multimedia content, which makes large challenge for teachers. Teacher needs to fight for the pupils

attention which has much higher expectations and to achieve it must apply equally diverse and new attractive approaches in accordance with pupils interests. Questions that teachers can set to themselves to evaluate their work are the following: "What knowledge do I want my students to gain? What values will my students receive? What do I expect during their learning? Which answers and feedback do I expect from them? What methods shell I use? Which materials shell I use to approach to my students and explained matter to them in the best possible way? How will I evaluate their work? What do the other teachers do in their teaching practice that I can use? In what areas do I need to improve my skills and knowledge? What other sources of knowledge I know and can use them in class? "12 questions are certainly superfluous if the teacher does not have the necessary motivation to work. Motivation for an activity depends on two factors: the attractiveness of rewards that individual offers for the result or effect of certain activities and depends on the individual differences, it is a subjective understanding of attractiveness and correlation between ones efforts and expected rewards. Teacher will be most creative when he is motivated from inside or if he looks at the whole task while working and at the sense of satisfaction that his job offers vs. Motivation from the outside, when the work is focused on the goal, that is the reward[2]. Creativity of teachers as an important competency teaching profession. Concern about creativity in terms of school is one of the most important tasks of modern school which must be based primarily on the needs of the child, but also the needs of modern society where creativity is the primary lever of development. In schools where nurture creativity 1st school staff strives to reduce stress and anxiety in children and in themselves, 2nd process is valued more than the product, 3rd removes the time limit from the activities in which children participate, 4th establishing a free and open atmosphere, and self-expression are encouraged and appreciated, 5th Children are encouraged to exchange ideas not only with the teacher, but between themselves and 6th competition and remuneration are trying to use less. [1] Meeting the previous conditions can be achieved by psychological safety. It depends primarily on safe environment. Children feel secure when most of the other people accept that the child has unconditional value, when there is no external evaluation and when a child behaves in emphatic way.

Psychological freedom is internal. It streams from the child. When children play freely symbols and use symbols for self-expression, they develop the internal state of psychological freedom [1].

2. Goals

The goal is to continue to build a culture of technical active, creative, entrepreneurial and technical-technological way of thinking and enable students to identify and apply technical formation in living environment.[4]

2.2. Mode and content

Common technical task of teaching culture is to give students first all application of knowledge in engineering and technology development and general technical culture which make knowledge and action. Individual tasks are:

- Acquaint students with the types of living environment, their properties and technical task;
- Explain the concept of techniques, technologies, technological and business processes;
- Enable students to express knowledge of the meaning of technical drawings and the development of elementary skills of reading ability and knowledge of simple drawings (eg, architectural layout of buildings, city map, offering control and creation of technical drawings);
- Familiar types, properties, processing and application procedures building most important material for making technical invention;
- Provide students knowledge of force, work and energy, and uses of energy to perform work in different sectors;
- Know the basic types of technical creation, to know their use and be able to recognize them in the environment;
- To develop basic writing skills with the help of computer, send messages and search notices on the Internet;
- Get the habit of using technological algorithms work, which includes all the constituent elements of the technical and technological content, the performance of tasks in the working examples of technical exercises creation;
- Identify possible careers in technical and technological activities of different areas;
- Enable pupils with special educational needs (damaged) vision, hearing, difficulties in voice

communication, physical damage, the easier mental disorders, with behaviour disorders) participation in work practices and success in selected technical and technological facilities of education and work;

- Enable students to get to know the contents of the proposed electoral program to satisfy their individual interests.

The process of achieving individual tasks to consistently emphasize standardized, planned action: step by step, and the practical value of what it is. This creates a continuous "technical atmosphere" and ensure the achievement of the stated goals of education in the EU[4].

3. Development of creativity through the unit "How mechanisms operate"

3.1. Pupils made evaluation criteria

Knowing all the facts mentioned above in this paper, I decided to conduct the Action Research in the subject I teach – Technical culture. I wanted to increase pupils creativity within Technical culture. I found hard to present the unit called „The ways in which mechanisms operate" in a creative way so I decided to take the following steps according to that particular unit within my action research: My lesson plan for the 6th of March, 2009. First, I wanted to examine the pupils opinion about teachers evaluation of their work. I asked pupils a question:"What do you consider important in your work on the class for teacher to evaluate your work by? I gave each pupil a sheet of paper where they put their suggestions of what to be evaluated on the class. Here are three examples of pupils work. All together there were 20 pupils on that class.

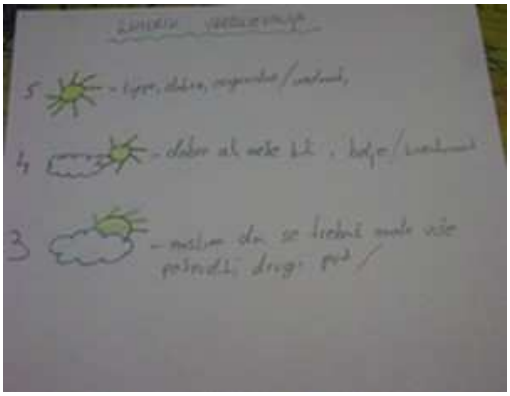

Fig. 1. 1st example of pupils-made evaluation criteria

Fig. 2. 2nd example of pupils-made evaluation criteria

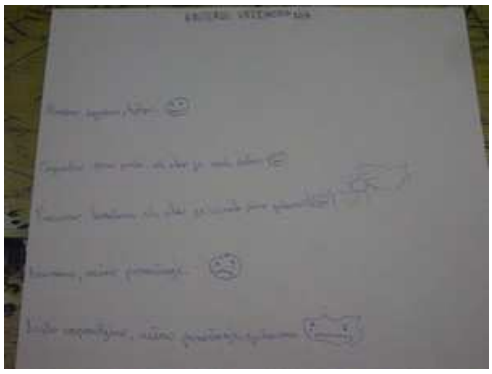

Fig. 3. 3rd example of pupils-made evaluation criteria

From 20 pupils on the lesson the results of what they considered the evaluation criteria should be are:

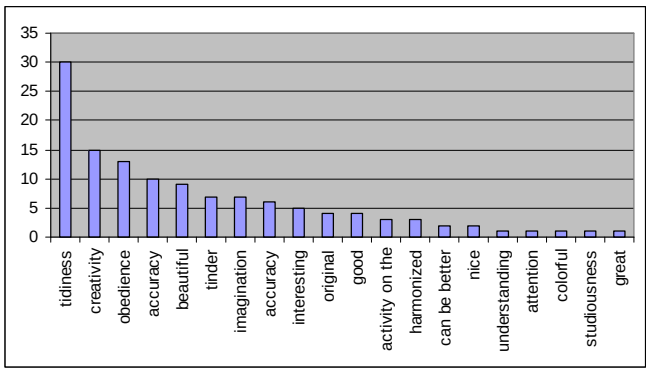

Fig. 4. Frequency of occurrence of pupils evaluation criteria

3.2. Learning "How mechanisms operate" through practical work

There are five types of mechanisms and I planed to have five groups of pupils. Each group had to study one type and to prepare presentation of the groups work to the rest of the class (other five groups). To give them an idea of what mechanisms and motion are I showed a power point presentation and movies about operation of mechanisms. After seeing the presentation pupils started to work in groups. Each member of a group had a special task which refer to the specific mechanism. This was the creative part, where pupils put together, measured, identified a causal connection consequential.

Each group had a wooden made model – an example of each specific type of mechanism. I planed a specific task for each member of each group.

Tasks were to:

1st member of a group:

Find movable and stationary part of mechanism.

2nd Member of a group:

Find the way that prosecuted member of the mechanism acts in relation to the operating member.

3rd Member of a group:

Measure and write down values**:**

n_1 = number of turns of the operating member

n_2= number of turns of the prosecuted member

Z1= teeth number of the operating wheel

Z2= teeth number of the prosecuted wheel

4th Member of a group: calculate value of the expression by the default equations.

5th Member of a group: Prepare short presentation for the rest of the class. After pupils made all the tasks and measurements they found a presenter of a group. That pupil explained to all the other groups what was done in their group. In the end I gave them survey on satisfaction with the work done on the lesson. The results were following:[5]

Table 1: Results obtained satisfaction survey of students (conducted on a sample of 20 students)

During the classes I feel relaxed	
Do not agree	0
Disagree	0
Partially agree	1
I agree	7
I fully agree	12

Tablica 2. Results obtained satisfaction survey of students (conducted on a sample of 20 students)

How active I was on the class?	
No	0
Very little	0
Little	0
Quite	6
Fully	14

Acknowledgements

I acknowledge to my dear pupils for showing interest, creativity and love and to their parents who allowed us to perform the action research.

4. Conclusions

By application of creative techniques, teaching aimed at results and active teaching methods it is actually possible to develop pupils creativity in Technical culture in fifth grade of primary school. It is shown on the unit called „The ways in which mechanisms operate". In the last question of the questionnaire on pupils satisfaction pupils answers are showing following:

On the question: What didn't you know but you learned today? The Answers were:

1. I didn't know the mechanisms but I learned today. - 99% of pupils.
2. I learned the types of mechanisms. - 89% of pupils
3. I learned that prosecuted member is a part of the mechanism on which the motion is transmitted. Performs forced motion. – 75% of pupils
4. I learned that the drive member is a part of mechanism that transmits motion. – 75% of pupils.

Therefore I can conclude that the used methods of development of pupils creativity through practical work in methodology of technical culture in a fifth grade of primary can actually develop pupils creativity. I could say that the final results of pupils understanding can show that used methods have actually developed pupils creativity

and pleasure of learning in the particular lesson of technical culture.

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Design and functionality parameters of cycloidal curves

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Abstract

The main objective of this work and research to construct cycloidal curve from the default equation. Equations are written in polar coordinates, or the default parameter. Cycliodal curves are curves that were obtained as a solid point trajectories associated with the circle which is rolling without slipping on the second circle. Main object the cycloid as other cycloidal curves shared the main features and characteristics. Cycloidal curves can be transcendental and algebraic. Transcedental curves are those curves whose equations are written in a rectangular coordinate system are algebraic. We demonstrated in excerpts equation cycloid, and we can also demonstrate to other cikloidne curve. The default equation are specific to certain intervals through various functions in Microsoft Office Excel draw any planar curve.

Keywords: cycloid, cycloidal curves, design, functionality, cycloidal gear, computer technologies

1. Introduction

In this paper we talk about the quartic curve. These are algebraic curves, which give interesting shapes. Among them include the famous curves such as cardioid, astroid, Steiner's curve or deltoid, etc.

The classification curve is large and extensive, so that this work will be all processed.

The paper defines each individual cycloidal curve. Are given its functional features and graphics processed in several different programs. For graphical display curves using software packages such as Mathematica 6, Graph, Microsoft Office Excel 2007, and a dynamic geometry program The Geometer's Sketchpad.

In cycloidal formation curve, the point which describes them away from the center of the circle to the beginning of a certain size. Days are representations of cycloid at which point on the circle of rotation.

So derived curves are divided into epicycloid hypocycloidal and, depending on whether the is rotary circle's outside or the inside of the fixed circle.

Epicycloid hipocikloide shape and is determined in each case the size of the module *m*.

2. Cycloid

The cycloid is the locus of a point on the rim of a circle of radius rolling along a straight line.

A equation of cycloid is done in Cartesian rectangular coordinate system. Take the circle with radius a and let it roll in a straight line. A straight line p is x axis coordinate system and a point O is point on the circle k. Intersection between the circle and line is a starting point O in the initial position coordinate system[2].

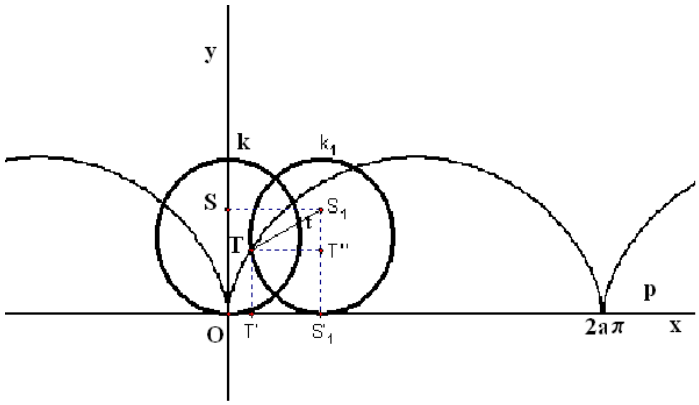

Fig. 1. Cycloid

Let the curve which it describes the point O. When the circle rotated for angle t (in radian), then point O come to point T. The position in which the circle came is k_1, then angle t is

$$t = \measuredangle(TS_1S_1')$$

(1).

Since it is rolling without slipping, it's known $|OS_1'| = \overset{\frown}{S_1'T}$, where it is $\overset{\frown}{S_1'T}$ arc length of the circle. On Fig. 1. can be seen that is

$$|OT'| = |OS_1'| - |T'S_1'| = |OS_1'| - |TT''|$$

(2).

Because of $|OS_1'| = \overset{\frown}{S_1'T}$ then $|OS_1'| = at$. Let's $T = (x, y)$. From the right triangle $\Delta\, TT''S_1$ below $|TT''| = a \sin t$ and it can be written in the form

$$x = a(t - \sin t) \qquad (3).$$

Next, we have $|TT'| = |S_1'T''| = |S_1S_1'| - |S_1T''|$

and $|S_1S_1'| = a$, but from the same right triangle belowe

$$|S_1T''| = a \cos t \qquad (4),$$

and it can be written in the form

$$y = a(1 - \cos t) \qquad (5).$$

Its parametric equation of cycloid is

$$x = a(t - \sin t)\,, \quad y = a(1 - \cos t) \qquad (6)$$

.

Eliminating t in the above equations gives the Cartesian equation

$$x = a\left(\arccos\frac{a-y}{a} - \sqrt{1 - \left(\frac{a-y}{a}\right)^2}\right) \qquad (7)$$

where is

$$t = \arccos\frac{a-y}{a} \qquad (8)$$

from second equation. And thus we have shown that the cycloid is transcendental curve. (Q.E.D) [2].

Basic properties of the curve:

If we use the parametric equations of the form[1]:

$$x = a(t - \lambda \sin t) \text{ i } y = a(1 - \lambda \cos t) \quad (9)$$

where is a radius of circle and parameter $\lambda = TS_1$.

If is $\lambda > 1$ then the curve described with point which lies outside the circle and it is rolling along a straight line. So the resulting curve is called rolate cycloid.

(In Figure is used $a = 1$ i $\lambda = 2$)

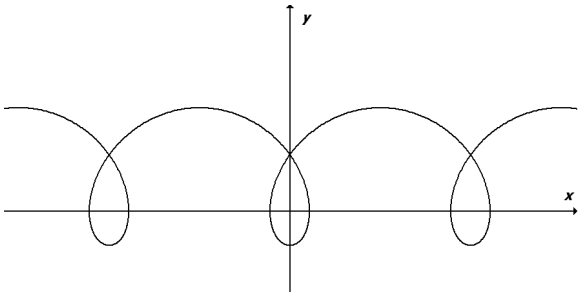

Fig.2. Prolate Cycloid [4]

If is $\lambda < 1$ $\lambda > 1$ then the curve described with point which lies inside the circle and it is rolling along a straight line. So the resulting curve is called curtate cycloid.

(In Figure is used $a = 1$ i $\lambda = 0.5$)

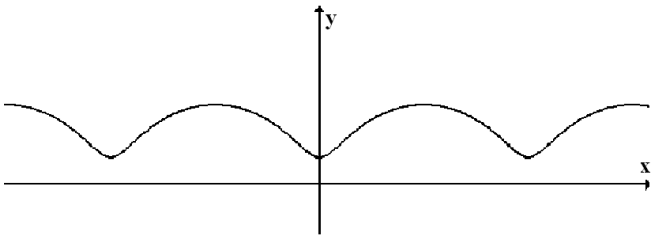

Fig. 3. Curtate Cycloid [4]

3. Cardioid

The cardioid can be achieved as trajectory point of the rolling circle radius r that by fixed circle the same radius[3]. This curve is epicycloid with parameter $m = 1$.

This allows us to write a cardioid parametric equations

so a parameter m in epicycloid parametric equations replace with one and we get [1]:

$$x = 2r\cos t - r\cos 2t \quad (10)$$

$$y = 2r\sin t - r\sin 2t \quad (11)\ .$$

To obtain the cardioid polar equation we use a point A as a polar point and x axis is polar axis. Since it is quadrangle AOO_1M and isosceles trapezoid then the polar angle of point M is the same parameter t for rolling the circle. Then in second equation we replace y with $\rho\sin t$. The cardioid given by the polar equation

$$\rho = 2r(1 - \cos\varphi) \quad (12)\ .$$

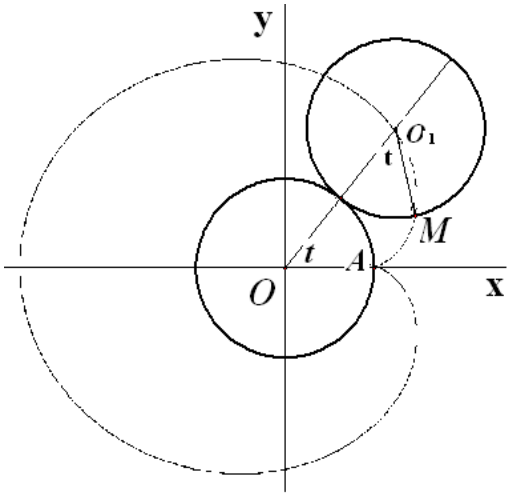

Fig.4. Cardioid

The cardioid is a degenerate case of the limaçon[3].

Basic properties of the curve:

- The radius of curvature any selected point of cardioid given by

$$R_K = \frac{8r}{3}\sin\frac{\varphi}{2} \quad (13).$$

- The arc length is

$$S = 16r\sin^2\frac{\varphi}{4} \quad (14)$$

- The perimeter of cardioid is $S = 16r$ and area of the curve is $U = 6\pi r^2$.

The softwear Excel drew a cardioid as function the parametric equations of the form

$$x = 2r\cos t - r\cos 2t \quad (15),$$

$$y = 2r\sin t - r\sin 2t \quad (16)\ ,$$

where is $r = 1{,}5$ and parameter $t \in \langle 0, 2\pi \rangle$.

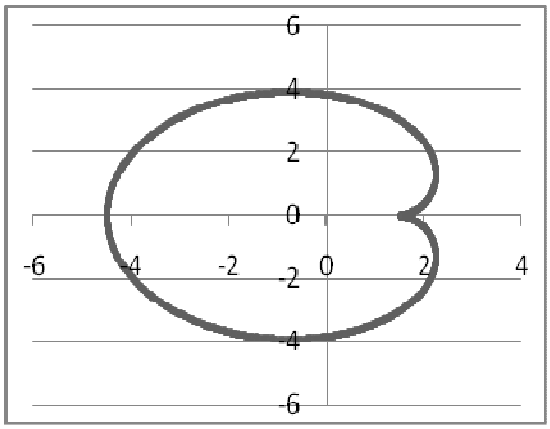

Fig.5. Cardioid in Excel

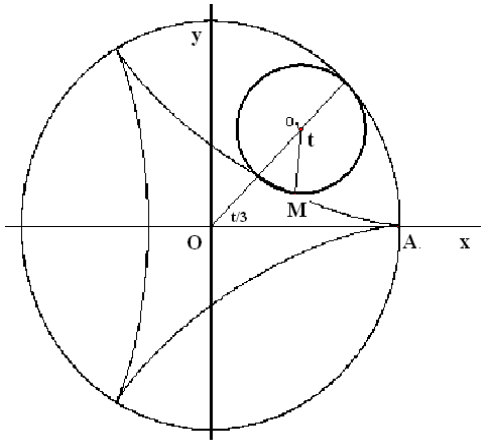

Fig.6. Deltoid

4. Deltoid

A hypocycloid with parameter $m = \frac{1}{3}$ called a deltoid. The equation of the deltoid is obtained by setting $r = \frac{1}{3}R$, where R is the radius of the large fixed circle and r is the radius of the small rolling circle.

The parametric equations of the form [1]

$$x = 2r\cos\frac{t}{3} + r\cos\frac{2t}{3} \qquad (17)$$

$$y = 2r\sin\frac{t}{3} - r\sin\frac{2t}{3} \qquad (18)$$

where t is angle of rotation of the rolling circle.

Eliminating t in the above equations gives

$$(x^2+y^2)^2 + 8rx(3y^2-x^2) + 18r^2(x^2+y^2) - 27r^4 = 0 \qquad (19)$$

A general form of deltoid shown in Fig.6.

Basic properties of the curve:

- The radius of curvature any selected point of deltoid given by [1]

$$R_K = 8r\sin\frac{t}{2}$$

(20).

- The arc length is

$$S = \frac{16}{3}r\sin^2\frac{t}{4}$$

(21)

- The arc length is

$$S = \frac{16}{3}r\sin^2\frac{t}{4}$$

(22),

where $\frac{16}{3}r$ is lenght of one ray of curve but the perimeter is $16r$.

- The area is given by $2\pi r^2$.

The software Excel writen parametric equations of the form

$$x = 2r\cos\frac{t}{3} + r\cos\frac{2t}{3}$$

(23)

$$y = 2r\sin\frac{t}{3} - r\sin\frac{2t}{3}$$

(24)

where is $r = 0{,}5$.

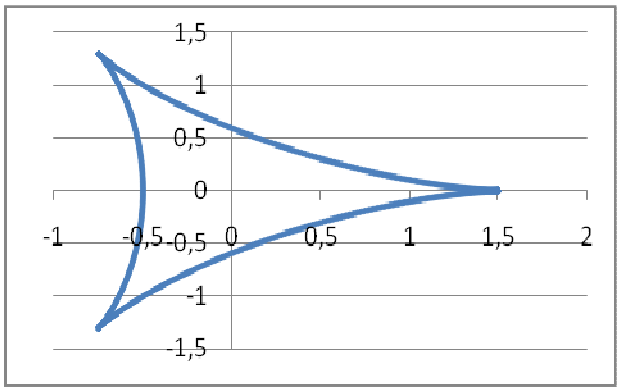

Fig. 7. Deltoid in Excel

The Steiner's curve or deltoid is the envelope of the Simson lines of a triangle.

The deltoid is very interesting because deltoid pedal curve.

A main equation is

$$(x^2+y^2)^2+[(a+3r)y^2+(a-r)x^2]x=0$$

(24)

or in the polar equation given by

$$\rho = 4r\cos^3\varphi-(a+3r)\cos\varphi$$

(25).

These are some forms of

1) If $a=0$ then the equation in polar coordinates given by

$$\rho = r\cos 3\varphi$$

(26)

and called a trifolium.

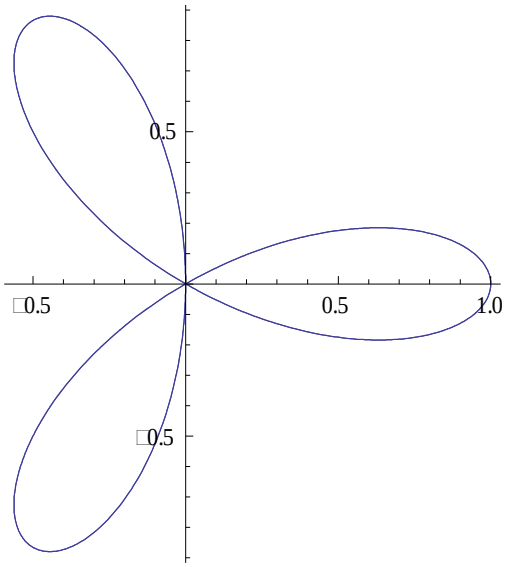

Fig.8. Trifolium

2) If $a=r$ then the equation in polar coordinates given by

$$\rho = -4r\cos\varphi\sin^2\varphi$$

(26)

and called a bifolium[4].

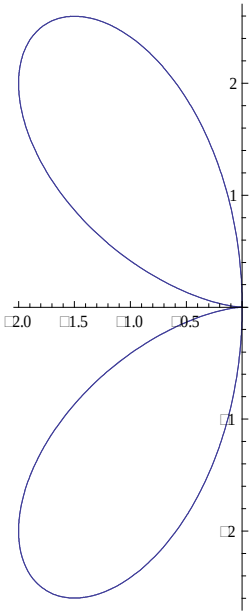

Fig.9. Bifolium

3) If $a=-r$ then the equation in polar coordinates given by

$$\rho = 2r\cos\varphi\cos 2\varphi$$

(27)

and called trefoil curve[4].

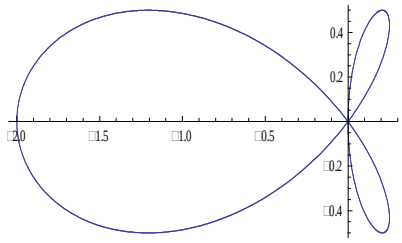

Fig.10. Trefoli curve

4) If $a = -3r$ then the equation in polar coordinates given by

$$\rho = 4r\cos^3\varphi \tag{28}$$

and called a folium[4].

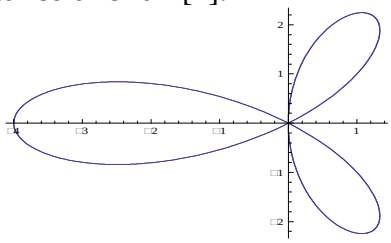

Fig.11. Folium

In practice, you can often find such cycloidal curve at the cycloidal gear tooth. With a touch of gear teeth flanks is achieved on certain points cycloid.

When cycloidal tooth to achieve favorable terms, if the radius of the surgery circles.

$$\rho = \left(\frac{1}{3} \div \frac{2}{3}\right) \cdot r \tag{29}$$

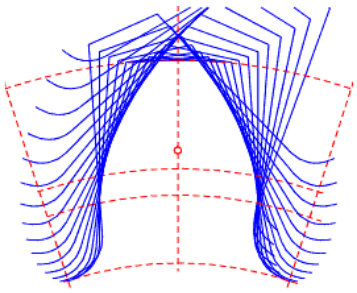

Fig.12. Contact cycloidal teeth gear [5]

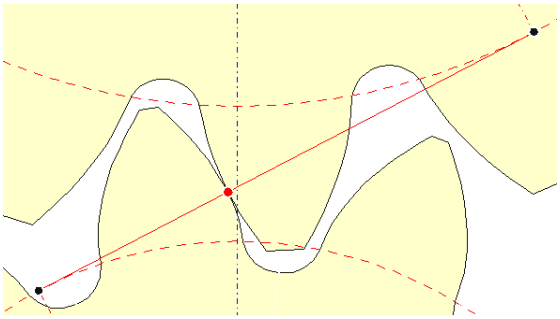

Fig.13. Example of contact line teeth gear

5. Conclusions

Based on the research plane curve quartic curve or cycloidal curve, we come to the conclusion that changing only one parameter in the default parametric or polar equation, we get a completely new kind of curves that can be epicycloid or hipocikloida.

The procedure of design of functional design features of the curve of the fourth order can accelerate a variety of software solutions.

At the same time is an important application of these curves in the other branches of mechanical engineering and technology.

In this paper, the practicality of a wider readership used a simple Excel program for family formation curve of the fourth order, based on the set of equations and the change interval and / or parameters for the design of the new curve.

The work day and view access Steinerovog shaping pedal curve with the corresponding equations.

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Application of Models in Development of utilization of Space Image in Primary School Education

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Abstract

In this article, it is shown an observation of cameras and arietta of photography which deposits the importance of the camera as expressive media in the lecturing. The paper refers to contemporary didactic strategies for work with children. It is also shown the school's photography affects, how does it affects on the students and on what she encourages them. In the work can also be found some examples how to work with photography in class. The empirically contents part two parts. First part shows how photography can help to make a model. Second part of the research was the observation of photography where it was wanted to see how the students have developed the visual perception.

Keywords: knowledge transfer, development of functional skills, practical teaching, creativity, photography

1. Introduction

The man was in ancient times felt the need for a permanent record of events, movements and forms of what we witnessed drawings found in caves throughout the world. ”Photography, like any other art form, media interpretation, which is characterized by peculiar significance. The camera is just a tool of the photographer expresses creative abilities.” [Hedgecoe, 1976., P.7.]. Photography is a branch of the art with which it is often encountered in life because it is all around us (press, posters). Photography is interesting because of the universal language spoken image, which always reveals and brings something new and moving along with life and technical progress. It is "about our time," everywhere present and everywhere welcome. [Fizi, 1982., P.6.]

Two main expressive means of the relationship between images of light and shadow and design, and observation and they should pay attention.

The relationship of light and shadow is an important quantity, type and quality of lighting, and design is a clear or unclear. At first we begin by considering the overall impression and then investigate other properties and their mutual relationship and attitude toward the whole. The most important quality of photography is the creativity that can be understood as a combination of many qualities such as inventiveness, imagination, inspiration and power of observation. Creativity is learned and constantly evolving. To make a good photo, it is necessary to know all of her influences such as time of day, light, viewing angle and determined the time needed to press the trigger.

2. The role and significance cameras and Photography as expressive resources in teaching

2.1. Modern didactic strategy

Although the force entered the CNES, in most of our schools still carried the traditional teaching. Since most schools have options, they should use modern methods of using the methods, procedures and materials appropriate for children under school age. Application of modern teaching strategy leads students to new situations and roles. They also enable communication between students and cooperative and interactive learning in a comfortable classroom atmosphere where students through didactic games and the expression and detection of adopting new knowledge and skills and learning without fear. Students in teaching subjects, not just persons who need special protection, and they therefore in the educational process should enable the activity, cooperation and freedom of expression. Exactly

contemporary didactic strategies allow the child to become an active participant in the educational process, not just a passive observer and listener. Teacher is no longer just a trainer, organizer, but by teaching and creating. Teacher is teaching in the modern manager and creator of the methodological scenarios. For all of this takes time, material resources and continuous inclusion of human resources through the whole-life education. Because of the above and say that the CNES in the implementation of a system that required a time adjustment, and as such part of the process the events of a strategic plan (in this case, the CNES).

2.2. Photo School

To work with pictures in the school must create the appropriate requirements, such as didactic and methodological basis. Students must be aware of the goals of this work must be clearly set is detailed tasks divided into units adapted to the age of students. Photo encourages students to actively explore and discover the open world around them. Students can use it to systematize and expand basic knowledge such as the nature, develop environmental awareness, foster patriotism, manage the area, acquire knowledge of traffic and much more. Students who are not aware of their personalities, often like to show off their skills before the camera, and therefore the camera can have great use in school and not only for learning but also to increase students' confidence as they freely before him and in that way can see what they really can know what you are and how these talents can develop.

Students more easily understood as a continuous change if they can every day to photograph and after some time and look at pictures again to recall how it progressed. Photography can also help in processing the contents of which often can not meet the direct observation of such second place, customs, history and much more. Such examples can be found very much. The choice of content that will be processed using the picture or where it can help us depends on the creativity and inventiveness of teachers. It is very useful in the selection to include children because they may be much better than us, see where their photos can help. This increases the awareness and activity of students and makes it work better and more useful for children. The school usually prevails verbal way of expressing the content of thought, and ignores the form of visual thinking. Photographs or visual stimulus allows us far greater speed of receiving information, compared with the word. When we see an image, even briefly, we see much more detail and learn lots of information and impressions in such a short time while we make the verbal description of the same image should be a lot more time. Viewing photos must have some clear goals, purpose and tasks are clear to all students. For starters, they should learn to look to know see the elements of which an image is created, its basic drawing, lines, tones, and their accommodation in the surface image. When considering photography students must analyze (parse) and synthesize (reconnect) photo. Also, teach them to judge the value meaning of individual elements and their mutual relationship. It is important to teach them to take a valuable noticement motives because students often difficult to cope in a variety of information and difficult to differentiate significantly from unimportant. Art and content side of it is necessary to give priority, to photos not in the eyes of young people has become one way, the technical-chemical process, but serves the general art education and a better understanding of its meaning, which in his view, is transferred to the people who look at the picture. [Fizi, 1982., Pp. 339.] In getting acquainted with the beginnings of photography should go some order to the students the importance of gradually familiar images. For this initial work is not necessary to have equipment that is because the cameras are students first familiarize themselves with the expressive means camera - photography. The first step was to collect a variety of photographs from newspapers, journals, postcards, photographs of some of his family and talk about their meaning and application. This is followed selection and sort photos into groups by themes that show and create thematic maps that complement their own students later in their preferences for specific topics. The next step is to talk about these pictures. Viewing, students analyze the value of their individual views and content warning on the shortcomings of such election themes, ambiguities in the presentation and contents of which are slowly preparing for their photography. To understand the forms that appear in the photos, after talks on the photos, crossing out of them. Photo placed on transparent paper and crossing out the basic shapes. Step further in considering the description of what students see in the picture. So we see what their observations might be because each of them to see the same picture in different ways. The next step is a creative work in which students can create photo collage combining various parts of the image in the same paper. Each picture comes with the description of what the students wanted to show. This is actually the simplest form of photomontage, where students from many parts of the work its unique work. Evident creativity of students and the work of the students are approaching the real photography as keep an eye on the

composition, motives. After the analysis of results, we can set the best board. Only after the children met with all these, we can begin preliminary for photographing such as copying, drafting and drawing photogram's developers. Only then starts photographing. Gradual implementation of the photos is important for students because it will adopt all that is important for photography in a simple and interesting way.

3 Empirical studies part

3.1. Starting value

The elementary school students with the technical culture, that is, its contents, or meet directly correlated with the subjects of class instruction in the first grade, although the subject introduces the technical culture only in the fifth grade. Students today are familiar with the technical achievements and before starting primary school andn classroom instructional time is needed to use to develop the principles of technical culture and thus develop their creativity.

In order to determine the roles and importance of the camera as a technical system in a technical culture in the younger school age have been carried out this research. Wanted to determine how the use and benefit of the use of cameras in elementary school.

3.2. The aim of the research

This study wanted to determine the impact and usefulness of photography as an expressive use of media in teaching students with younger school-age children.

3.3. Hypotheses

Photographs can help students in making models for easier work detail, better relations and the observed depth and space. Also, students might have a good perception of detail.

3.4. Research Tasks

Determine whether the photographs to help students in making models easier to work details, the better identify and relate the depth and space. Determine whether students have a good power of observation details. Determine whether it helps you in learning photography and repeat content in the classroom.

3.5. Variables

Dependent variable: use of camera, creativity, inventiveness, knowledge of the camera, expressing feelings Independent variables: gender, age, class.

3.6. Research Methods

The paper used research methods based on comparison of visual perception and memory. In fact, research has focused on analyzing the application of photography to create models in the teaching domain processing threads homeland.

The concept was designed by visual perception of object perception and detail through the technique of memory is another application of the photographs in the analysis of three-dimensional object and its transfer to the appearance of 3D models as models of spatial perception.

3.7. Sample Research

The study was conducted in elementary school, „Ivane Brlić Mažuranić",District School Milanovac in Virovitica in a time of 20 to 21 October 2008. year. The research has investigated a total of 26 students of fourth grade teacher Ivana Lončar. The class is 17 boys and 9 girls.

3.8. Context of research

Elementary School „Ivane Brlić Mažuranić", began working 1974th under the name "Braće Ribar". Of 1992. changes its name has remained until today. Elementary School „Ivane Brlić Mažuranić",associated with regional schools, and four regional schools: Milanovac, Rezovac, Rezovačke Krčevine and Čemernica. Central School has 287 students from 1 to 4 grade and 564 students from 5 to 8 grade. Regional schools have 195 students. The whole school has a total of 1046 students. It also has 63 teachers. With the arrival of the CNES, a school is equipped with 9 laptops, LCD projector, 12, 14 cameras and 1 camera.

4. Research results

Data obtained from observation of models and photos of students who took the fourth grade Regional School Milanovac. The contributions of 26 students, were statistically analyzed and are grouped (Fig. 1-Fig.7.) for easy inspection of the table and histograms.

Fig. 1. Photo that was used to help create models

Fig. 2. The model 1G that was created by viewing pictures - front view

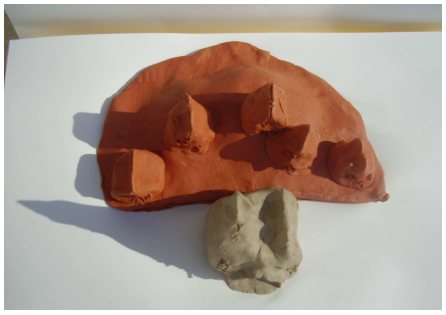

Fig. 3.The model 1G which was created by viewing photographs - view from above

Fig. 4. The model 1P (material: paper, handy glue, scissors), which was created by viewing pictures - front view

Fig. 5. The model 1P (material: paper, handy glue, scissors), which was created by viewing photos of the view from above

Fig. 6. The model 2G (material: clay), which was created by viewing photographs - view from above

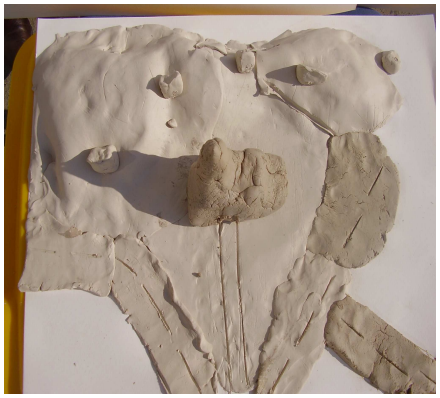

Fig. 7. The model 2G which was created by viewing photographs - view from above

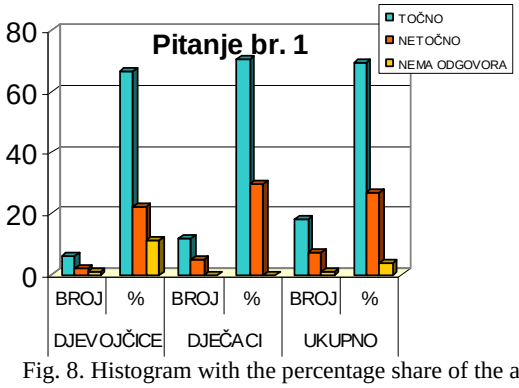

Fig. 8. Histogram with the percentage share of the answer to thequestion:"How much has the spiral cypress in the picture?"

The observation of pictures even 70.59% 66.67% boys and girls perceive details in a short viewing the photos, which shows a high degree of experience and observation details.

The observation of images 52.94% 66.67% boys and girls perceive the exact number of persons, which is a good result, because the duration of observation is crucial to the accuracy of counting people in the photo. Only well trained observer has learned the ability of these tests, which can be significant for some other services.

Table 1. Frequency and the arithmetic mean analysis of responses to the question: "How much has the spiral cypress in the picture?"

	GIRLS, $\sum N_{Ž}^{20} = 9$		BOYS, $\sum N_{M}^{20} = 17$		TOTAL, $\sum N_{U/20}^{M+Ž} = 26$	
	$N_{Ž}^{20}$	$\overline{X}_{Ž}^{20}$ %	N_{M}^{20}	$\overline{X}_{M}^{20}$,%	$N_{U/20}^{M+Ž}$	$\overline{X}_{U}^{20}$,%
RIGHT	6	66,67	12	70,59	18	69,23
WRONG	2	22,22	5	29,41	7	26,92
NO ANSWER	1	11,11	0	0	1	3,85

Table 2. Frequency analysis and the arithmetic mean answers thequestion:"How many people have in the picture? "

	GIRLS, $\sum N_{Ž}^{21} = 9$		BOYS, $\sum N_{M}^{21} = 17$		TOTAL, $\sum N_{U/21}^{M+Ž} = 26$	
	$N_{Ž}^{21}$	$\overline{X}_{Ž}^{21}$,%	N_{M}^{21}	$\overline{X}_{M}^{21}$,%	$N_{U/21}^{M+Ž}$	$\overline{X}_{U}^{21}$, %
RIGHT	6	66,67	9	52,94	15	57,67
WRONG	2	22,22	8	47,06	10	38,46
NO ANSWER	1	11,11	0	0	1	3,85

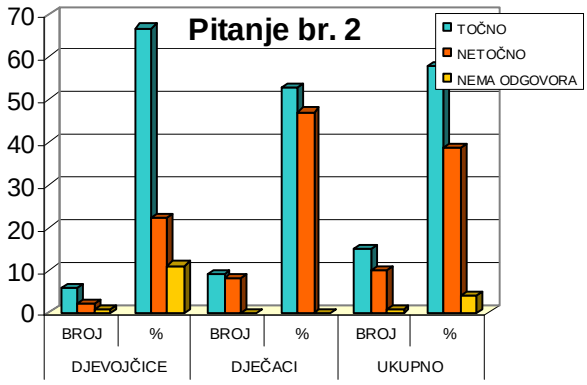

Fig. 9. Histogram with the percentage share of the answer to the question:"How many people have in the picture?"

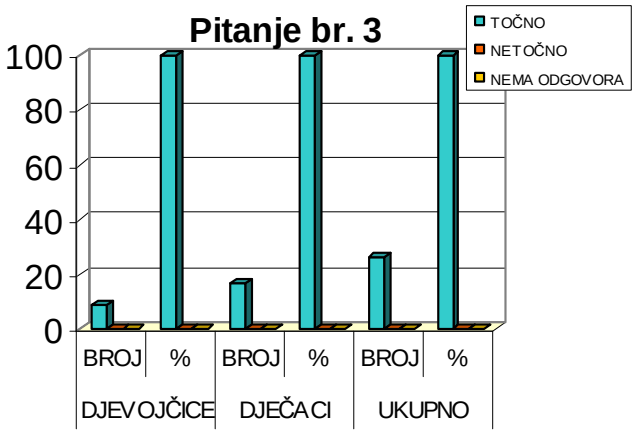

Fig. 10. Histogram with the percentage share of the answer to thequestion:"What color is the car in the picture? "

Table 3. Frequency and the arithmetic mean analysis of responses tothe question:"What color is the car in the picture?"

	GIRLS, $\sum N_{Ž}^{22} = 9$		BOYS, $\sum N_{M}^{22} = 17$		TOTAL, $\sum N_{U/22}^{M+Ž} = 26$	
	$N_{Ž}^{22}$	$\overline{X}_{Ž}^{22}$,%	N_{M}^{22}	$\overline{X}_{M}^{22}$,%	$N_{U/22}^{M+Ž}$	$\overline{X}_{U}^{22}$, %
RIGHT	9	100	17	100	26	100
WRONG	0	0	0	0	0	0
NO ANSWER	0	0	0	0	0	0

Recognizing the colours in a photograph with a share of 100% boy and 100% girl simply is an excellent result in the perception and medical sense. These issues with a combination of detail, color and position and ascore of correct answers from 64.71% in boys and 88.89% for girls isthe result of remarkable and encouraging practical sense to continue working with students in the use of photographic equipment and photography in the classroom.

When this question is evident that the girls responded correctly in 55.56% of the boys in 17.65%, which represents a statistically significant difference in the sense that girls perceive more clearly the details of this set questions and details on location photography. For clearer conclusions should conduct additional research.

Table 4. Frequency and the arithmetic mean analysis of responses tothe question:"What color are the leaves in the right corner of theimage?"

	GIRLS, $\sum N_{\check{Z}}^{23} = 9$		BOYS, $\sum N_{M}^{23} = 17$		TOTAL, $\sum N_{U/23}^{M+\check{Z}} = 26$	
	$N_{\check{Z}}^{23}$	$\overline{X}_{\check{Z}}^{23}$,%	N_{M}^{23}	$\overline{X}_{M}^{23}$,%	$N_{U/23}^{M+\check{Z}}$	$\overline{X}_{U}^{23}$, %
RIGHT	8	88,89	11	64,71	19	73,08
WRONG	1	11,11	6	35,29	7	26,92
NO ANSWER	0	0	0	0	0	0

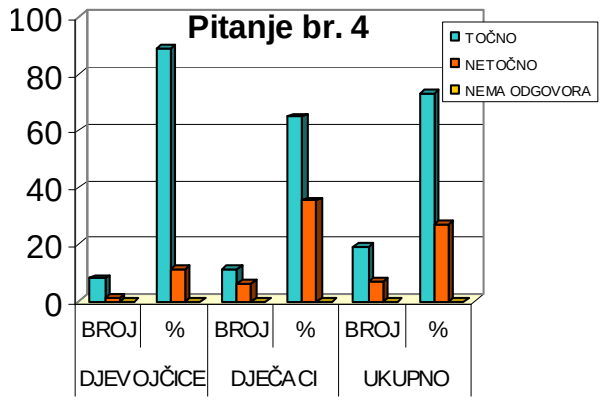

Fig. 11. Histogram with the percentage share of the answer to the question:"What color are the leaves in the right corner of the image?"

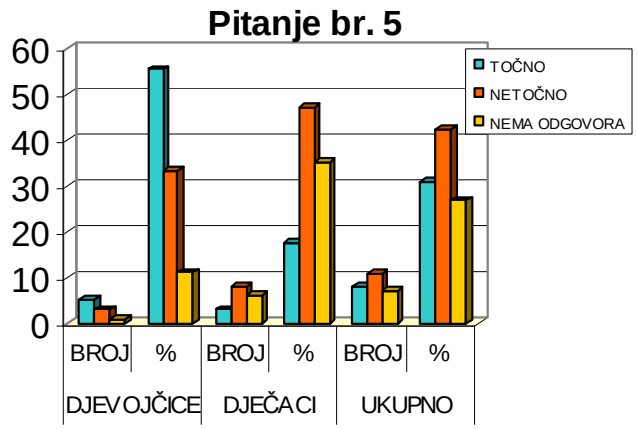

Fig. 12. Histogram with the percentage share of the answer to the question: "What lies beneath the evergreen tree?"

Table 5. Frequency and the arithmetic mean analysis of responses tothe question:"What lies beneath the evergreen tree?"

	GIRLS, $\sum N_{\check{Z}}^{24} = 9$		BOYS, $\sum N_{M}^{24} = 17$		TOTAL, $\sum N_{U/24}^{M+\check{Z}} = 26$	
	$N_{\check{Z}}^{24}$	$\overline{X}_{\check{Z}}^{24}$,%	N_{M}^{24}	$\overline{X}_{M}^{24}$,%	$N_{U/24}^{M+\check{Z}}$	$\overline{X}_{U}^{24}$,%
RIGHT	5	55,56	3	17,65	8	30,77
WRONG	3	33,3	8	47,06	11	42,31
NO ANSWER	1	11,11	6	35,29	7	26,92

5. Interpretation of research

In order to determine the set objectives of research in elementary school, „Ivane Brlić Mazuranić" Milanovac branch school in Virovitica, fourth grade students made the models and observed the picture and answered questions about it.

In this way, meant to determine how many photos can help in achieving the plan and program, as used in the classroom, how many students know about it, what helps them to read (in this case specifically in the development of models), and whether the students developed visual perception.

The study included a total of 26 fourth grade students.

The students first made a model, modelling clay and half of the board. Half of them worked in the photography and the other half went to see the church from the same point of view of the photography that they would not have any differences regarding views.

Bread-boarding wanted to see whether the photo to help students when developing models. The second day of answering the questions related to visual observation.

The students looked at picture 15 seconds after that, he turned and answered questions. When the students made models, half of them had a picture when they worked while the other half of the model were made after the observation.

Although all the works were successful, more details have been recognized and make disciples who had a photo in front of them during construction. This was expected because students are always able to look at the photo.

Next stage was watching the pictures and answering questions about it. Wanted to investigate how the visual perception of students. The observation of pictures even 70.59% 66.67% boys and girls perceive details in a short viewing the photos, which shows a high degree of experience and observation details.

The observation of images 52.94% 66.67% boys and girls perceive the exact number of persons, which is a good result, because the duration of observation is crucial to the accuracy of counting people in the photo.

Only well trained observer has learned the ability of these tests, which can be significant for some other services. Recognizing the colours in a photograph with a share of 100% and 100% boys and girls simply is an excellent result in the perception and medical sense.

Question with a combination of detail, colour and position and a score of correct answers from 64.71% in boys and 88.89% for girls is the result of remarkable and encouraging practical sense to continue working with students in the use of photographic equipment and photography in the classroom.

With this issue, which concerns the observation of detail, evident that the girls responded correctly in 55.56% of the boys in 17.65%, which represents a statistically significant difference in the sense that girls perceive more clearly the details of this set issues and positions detail in the photo. For clearer conclusions should conduct additional research. There are significant differences between boys and girls. Boys, according to the study showed significantly less clarity and clarity visual perception in relation to girls.

6. Conclusion

Although the camera is now accessible to all, and the most of schools have it, its usage in teaching is still not satisfactory high.

When the cameras and photographs get more in use in teaching of students, the true value of the camera as well as technical aids in teaching, their visual perception would be better and learn better observe details will be understand.

Working with the camera allows direct participation of students in the teaching process, a greater interest in the material that is processed and greater socialization.

Although the technology and its components present all around us, often we use it the wrong way. It is necessary to understand the true purpose and content of a technical supplies such a complex system, not to use them only for fun.

How it all can learn quite a bit of technical integration of culture in teaching all subjects of class because it does not exist as an independent subject.

In the future, and considering the intense technical progress, the content of the technical culture is justified with its content in classroom teaching and

correlation with other subjects in order to multidisciplinary education students in the 21 century.

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Survey on Practical Applications of Fuzzy Rule Interpolation

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Abstract

In the last thirty years fuzzy logic became very popular. One can find solutions based on it in several fields from industrial systems to house appliances. Recently a new category of fuzzy systems gained more attention, the so called fuzzy rule interpolation (FRI) based systems. Owing to the low complexity of their rule bases, i.e. they can infer as well when only the relevant rules are known, they can be applied successfully even in cases when a traditional fuzzy system could not give an interpretable result in lack of the full coverage of the rule base.

In this paper, after doing a survey on FRI methods we present several successful practical applications organized in three main areas, namely fuzzy control, function approximation and expert systems.

Keywords: fuzzy rule interpolation; sparse rule bases; application examples; function approximation; rule based control

1. Introduction

Traditional fuzzy reasoning methods (e.g. the Zadeh-Mamdani type compositional rule of inference) demand complete (covering) rule bases, and therefore the construction of a corresponding rule base requires a special care in order to create all the possible rules. Covering rule bases are characterized by a high number of rules that grow exponentially with the number of antecedent dimensions and the number of linguistic terms. In order to solve the complexity problem sparse (not covering) rule bases and inference methods based on rule interpolation can be applied 0. A fuzzy rule bases is sparse if for one or more possible input values it does not contain any matching rules.

A sparse fuzzy rule base can arise in two ways. The first one starts from a completely covering rule base and reduces the number of the rules excluding the non relevant rules or merging the similar ones. The methods following the second way produce a sparse rule base directly. Usually they apply one of the following approaches:

1. Try to identify the so-called optimal fuzzy rules (e.g. 0).
2. Extend the rule base by applying the concept of Rule Base Extension (e.g. 0).
3. Create the starting rules base on fuzzy clustering 000).
4. Apply evolutionary algorithms (e.g. 00).

Having a sparse rule base one may use an approximate inference technique for fuzzy reasoning. In most of the cases the procedure developed for this purpose determines the conclusion using a fuzzy rule interpolation (FRI) method. FRI methods can be divided into two groups depending on whether

1. they produce the conclusion directly or (one-step FRI methods),
2. first they interpolate an auxiliary rule and they calculate the consequent by using that rule (two-step FRI methods).

Traditional fuzzy logic based systems have been successfully used in fields of control (e.g. 000), fuzzy modeling (e.g. 0) and expert systems (e.g. 0). FRI methods became popular since the second half of the 1990s owing to their applicability in cases with reduced amount of information (sparse rule base). Several successful applications have been reported in the literature in different fields. In this paper, we give a survey on some of them emphasizing the typical application areas.

The rest of the paper is organized as follows. Section 2 gives a short introduction on the FRI techniques. Section 3 presents the practical applications organizing them in three main groups.

2. Survey on Fuzzy Rule Interpolation Methods

2.1. One-step Fuzzy Rule Interpolation Methods

The techniques belonging into the first group of FRI methods produce the conclusion directly based on the observation and two or more neighboring rules. The base method of this art is the KH interpolation, which initiated the FRI research. There are numerous descendants, which overcame the delimitations of the first linear rule interpolation technique and improved as well as completed the base method.

The key idea of the **linear rule interpolation** proposed by Kóczy and Hirota (KH method) 0 is that the approximated conclusion divides the distance between the consequents of the two nearest rules in the same ratio as the observation divides the distance between the antecedent sets of the same rules. This solution is called Fundamental Equation of the fuzzy Rule Interpolation (FERI). The method is α-cut based, and the above mentioned ratio is calculated in case of every cut separately for the lower and upper distances. The applied function is (1):

$$d(A^*, A_1) : d(A^*, A_2) = d(B^*, B_1) : d(B^*, B_2). \quad (1)$$

The KH method was developed originally for Single Input Single Output (SISO) fuzzy systems, but it was extended for the case of Multiple Input Single Output (MISO) fuzzy systems as well by using Minkowski type distances.

The **Modified α-Cut based Interpolation** (MACI) was published by Tikk and Baranyi 0. It applies a vector representation of the fuzzy sets and transforms the calculations into a vector space where the possibility of the abnormal consequent sets is eliminated.

The MACI method describes every fuzzy set by the help of two vectors, which contain the abscissa values of the left (bottom) and right (upper) flanks of the set. In case of smooth membership functions the endpoints of the α-cuts form the vectors.

An advantage of the method is that always results valid fuzzy sets, and it can be extended for MISO systems as well. Besides, the generalized version of MACI 0 can handle non-convex fuzzy sets, too. As a drawback one can mention that MACI does not preserve the piecewise linearity. However, the deviation is smaller than in the case of the KH method gives 0.

The **Fuzzy Interpolation in the Vague Environment** (FIVE) method developed by Kovács and Kóczy 00 and extended by Kovács 0 applies a new approach by placing the task of fuzzy rule interpolation into a virtual space, the so-called vague environment. The concept of the vague environment is based on the similarity and indistinguishability of the objects. In the vague environment the similarity of two fuzzy sets is described by their weighted distance, where the so-called scale function is the weighting factor. The scale function describes the shapes of the fuzzy sets of a fuzzy partition. The method does not preserve the piecewise linearity.

The application of the method is restricted by the need on an exact or approximate universal scale function for each dimension, which describes the whole partition even if the partition is not of Ruspini type. After defining the vague environment of the antecedent and consequent universes each rule will be represented by a point in the vague environment of the rule base and the position of the conclusion can be calculated by a linear interpolation.

The vague environments for the antecedent and the consequent sides can be produced beforehand. This speeds up the method, because in course of the inference only the interpolation needs to be done.

The method is applicable in MISO cases as well. FIVE is application-oriented, because it is fast and easy, thus it can be embedded into direct robot control, too.

2.2. Two-step Fuzzy Rule Interpolation Methods

The two-step fuzzy rule interpolation methods follow the concept of the **Generalized Methodology of fuzzy rule interpolation** (GM) suggested by Baranyi, Kóczy and Gedeon (e.g. in 0). GM characterizes the position of fuzzy sets by reference points. In its first step it interpolates a new rule in the same location as the position with the observation. Thus the reference point of each antecedent linguistic term of the new rule overlaps the reference point of the observation set in the correspondent dimension. The first step consists of three sub-steps:

- Determine the antecedent set shapes of the interpolated rule by the help of set interpolation.

- Determine the location of the consequent sets by the help of crisp interpolation/extrapolation method.
- Determine the consequent set shapes of the interpolated rule using the same set interpolation technique.

The approximated rule is considered as part of the rule base in the second step. The conclusion corresponding to the observation is produced by the help of this rule. As the antecedent part of the estimated rule generally does not fit perfectly to the observation, therefore some kind of special single rule reasoning is needed. Several techniques are suggested in 0 for this task (e.g. FPL, SRM-I, SRM-II). As a precondition for all of these methods, it should be mentioned that the support of the antecedent set has to coincide with the support of the observation. Generally this is not fulfilled. In such cases the fuzzy relation (rule) obtained in the previous step is transformed first, in order to meet this condition.

The **Fuzzy Rule Interpolation based on POlar Cuts** (FRIPOC) The Fuzzy Rule Interpolation based on POlar Cuts 0 solves the task of fuzzy reasoning in two steps conform to the GM. First a new rule is interpolated whose antecedent part is in the same position as the observation in each antecedent dimension. The expression "same position" means that in each partition the reference point of the observation and the reference point of the rule antecedent set are identical. FRIPOC uses the centre of the core as reference point.

The new rule is determined in three stages. First the shapes of the antecedent sets are calculated using the set interpolation technique FEAT-p separately in each antecedent dimension. Its main idea is that all sets of the partition are shifted horizontally into the interpolation point (reference point of the observation), i.e. their reference points will be identical with the interpolation point. Next the shape of the new set is calculated by its polar cuts. For each polar level the polar distance is determined as a weighted average of the corresponding polar distances of the overlapped known sets. The position of the consequent sets is calculated in the second stage using an adapted version of the Shepard interpolation 0. Next (stage 3) one calculates the shape of the consequent sets by FEAT-p in an identical way as seen in case of the antecedent sets (stage 1).

The second step of FRIPOC determines the conclusion from the observation and the previously generated auxiliary rule using the method SURE-p. The Single rUle Reasoning based on polar cuts calculates the differences between the polar distances corresponding to the observation and the antecedent of the interpolated rule in each antecedent dimension and for each polar level. Next an average difference is determined for each polar level. One calculates the conclusion by modifying the consequent of the interpolated rule by the average differences followed by a control and correction algorithm in order to ensure the validity of the new fuzzy set.

The method **LEast Squares based Fuzzy Rule Interpolation** (LESFRI) 0 was developed by Johanyák and Kovács. It also belongs to the group of two-step fuzzy rule interpolation techniques. It uses FEAT-LS as set interpolation technique. FEAT-LS was developed especially for the case when all sets of a partition belong to the same shape type and the characteristic (break) points are also situated at the same α-levels. In such cases it seems to be a natural condition on the new linguistic term created in the interpolation point to suit this regularity as well. As a first step all the sets of the partition are shifted horizontally in order to reach the coincidence between their reference points and the interpolation point. Next, the characteristic points of the new set's shape are determined by the method of weighted least squares taking into consideration the corresponding characteristic points of the overlapped sets. The weighting expresses that the sets situated originally in closer neighborhood of the interpolation point should exercise a higher influence than those situated originally in farther regions of the partition.

LESFRI uses SURE-LS as single rule reasoning method in its second step. SURE-LS applies an α-cut based approach for this task. It uses a set of α-levels compiled together by taking into consideration the break-point levels of all antecedent dimensions and the current consequent partition. The calculations are done separately for the left and right flanks. On each side for each level it calculates the weighted average of the distances between the endpoints of the α-cuts of the rule antecedent and the observation set. The weighting makes possible to take into consideration the different antecedent dimensions (input state variables) with different influence.

The basic idea of the method is the conservation of the weighted average differences measured on the antecedent side. Applying these modifications on the consequent side usually results in a set of characteristic points that do not fit the default set shape type of the partition. Therefore the method of Least Squares is used in order to find the break-points of an acceptable conclusion.

3. Practical Applications

Fuzzy rule interpolation technologies became increasingly important for automatic identification of sparse fuzzy rule-bases from sample data. There are three main application areas of FRI based fuzzy systems: fuzzy control, fuzzy modeling (function approximation applications), and expert systems.

Further on we introduce 3-3 sparse rule-base based applications belonging to the first two groups, and one application representing the third group.

3.1. Fuzzy Control

Kovács and Kóczy reported in 0 the preparation of a complex application. They applied rule-interpolation based fuzzy reasoning for the simulation of an **automated guided vehicle**. Their main goal was the path tracking and the collision avoidance without losing the designated path. The used approximate fuzzy reasoning method was FIVE.

The obstacle avoidance strategy leaned on three measurements of ultrasonic sensors. The system was simulated on a test path and obstacle-configuration. The applied planning (modification and test) can be very useful for controlling of unknown or partly known systems. The generated fuzzy system had two outputs, the speed and the steering, which was achieved by creating two rule bases. Altogether 12 rules were needed for controlling of steering and 5 for speed. The vague environment of antecedent and consequent universes (scale functions) were generated in a training process, which based on data collected from human experts. In order to get the shortest docking distance on the test path the training process was optimized for the core positions of the linguistic terms and the values of the scale functions (see in figure 1).

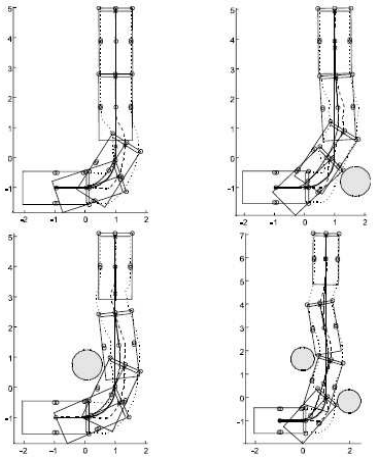

Fig. 1. Some simulated outcomes of AGV 0

Vincze and Kovács in 0 introduced an **automata mobile robot room surveillance navigation control** with FIVE fuzzy reasoning method. The robot navigated with help of waypoints and it avoided the collisions with the obstacles and walls. If something blocked the way of the robot, it turned around and headed towards the opposite of the last direction. The test configuration had 4 waypoints in fixed order, which were joined to the four corners of the room. The room was oblong and had 4:3 side-ratio (see in figure 2). The navigation control was built from three components, these choose the next waypoint to approach, the avoidance of the walls and the obstacles as well as the changing of the direction.

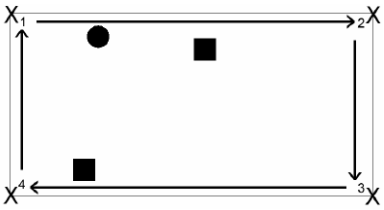

Fig. 2. The room, where the robot (the round object) navigates with the waypoints (in the corners) and the obstacles (the two squares) 0

The first step of the control was the waypoint choosing, and then the result-vector was added to the actual position of the robot. With this new position was calculated the distance from the walls and the obstacles. Then the rule base of the wall and the obstacle avoiding were evaluated. These results were summed with the actual position and this would be the next valid location of the robot. If needed to modify the moving direction of the robot, the waypoint variation was inverted. If one repeats the procedure in

loop, gets the model of surveillance navigation controlling and collision avoiding.

If one would build a full covering rule base with the same strategies and 4 waypoints it would need $2^{(2n+2)}$+8+4+4 rules, that are 1040 rules. The solution based on a sparse rule base required only n*(6+n)+3+4+4 rules, that is 51 rules. This rule base can be implemented easy even in embedded FRI fuzzy logical controller in case of high number of input dimensions.

Kovács and Kóczy suggested the application of **an interpolation-based fuzzy reasoning method for behavior-based control structures** in 0. The solution can be implemented easily and fast enough to fit to the structure of the behavior-based control in real time direct fuzzy logic control systems. In case of pure behavior-based control structures every main task of the control – the behavior control, the behavior fusion and the behaviors ourselves – is implemented in fuzzy controllers.

The main task of the behavior-coordination is to choose the most needed behavior from the known behavior patterns in order to handle the actual situation. The proposed solution estimates the similarities of the preconditions of the actual situation and the known behaviors. This is named symptom evaluation (see figure 3).

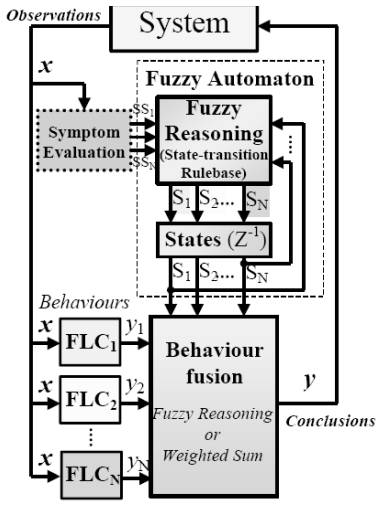

Fig. 3. The proposed behavior-based control structure 0

The user is handled adaptively with the existing (offline collected) human opinions (user models) combinations. The new state values are given based on the observations (inputs) the conclusion of the user feedback (the evaluation of the symptom in the state transition i into every conceivable state of SS_i $\forall i \in [1, N]$) and the previous S_i state values.

For example if the system has already found a satisfied model (S_i), and the user feedback (SS_i) comes out for it yet, the system keeps it even if the user feedback starts to come out for other models. The goal of the heuristic is to reach a relative fast convergence, which can be important for numerous application areas, for example for introduction of an online user adaptive choosing system, where the feedback information are limited for the state variables.

If the strategy introduced in 0 would be used for the classical fuzzy reasoning, the covering rule bases would need 16 rules because of two state case (as the observing universe has four dimensions: S_1, SS_1, S_2, SS_2) and each has two fuzzy sets (zero, one). Applying a sparse rule base only 7 rules are needed. The disadvantage of the proposed method is that the result of the reasoning is a singleton fuzzy set. This has not influence in applications where the result is defuzzified.

3.2. Function Approximation Type Applications

Wong and Gedeon [6] reported the generation of fuzzy models for petrophysical properties prediction. One of the key tasks in course of the analysis of petroleum well log data is the prediction of petrophysical properties corresponding to specific input data, i.e. depth values different from the original ones used by the experiments. Such properties are the porosity, permeability and volume of clay [6]. The expensive and time consuming character of the data collection from boreholes increases the significance of the prediction. The predicted values help taking decisions on rentability of the exploration of a specific region. The aim of the research was to establish a low complexity fuzzy model taking into consideration three input variables: the gamma ray, the deep induction resistivity and the sonic travel time. The models have one output parameter. The training sample data set had 71 data rows, and the test data set had 51 data rows. The data were preprocessed, and each variable was normalized to the unit interval.

The applied FRI method was MACI. The prescribed output and the results produced by the model were compared by the correlation factor. The results can be seen in table 1. The generated system was based on 36 rules.

Table 1. Values of correlation factor [6]

Applied method	Correlation factor	
	Training data	Test data
MACI	0.917	0.865

Fuzzy models can adapt to diversified system configurations and operation conditions well. Johanyák, Parthiban and Sekaran [7] introduced models which were prepared based on laboratory experiments for **anaerobic tapered fluidized bed reactor**. The task of the system was anaerobic digestion of synthetic wastewater derived from the starch processing industries.

The model had four input (Flow rate, Chemical Oxygen Demand [COD], pH, Biological Oxygen Demand [BOD]) and 5 output (COD, Biogas, Volatile Fatty Acids, Alkalinity, BOD) values. The sample data set consisted of 78 data rows. The lower and upper limits of the input and output base sets were prescribed values. There were prepared four fuzzy models using the Automatic fuzzy system generation based on fuzzy Clustering and Projection (ACP) algorithm and the FRIPOC rule interpolation based reasoning method. The models were evaluated using relative value of the root mean square error (RMSEP).

Table 2. The results of the tuning process [7]

	RMSE	RMSEP%
COD	27.7827	4.11
Biogas	0.8012	2.46
VFA	18.2828	7.75
Alkalinity	76.0786	9.67
BOD	88.4201	9.96

Table 2 presents the results of the system evaluations. In case of COD the result is relative good, the deviation was significant only in case of few measured-computed values. The best result had the system, which modeled the correspondence between the Biogas and input. In case of VFA and Alkalinity the results were medium, but it is possible it is opened to improvement with another rules and the improvement of the tuning algorithm. The output parameters predicted by the tuned system were very close to the corresponding experimental results. The model was validated with repeated tests.

The **proper selection of cutting parameters for machining operations** has determinant role in achieving the expected economical and quality goals. Therefore, several models have been developed aiming the reliable prediction of tool life, which is in close relation with the modeling of the functional relationship between the tool life and its main influential factors. Such factors are the cutting speed and the feed rate.

Relevant models are the exponential [8], the Taylor [8], the corrected Taylor [8], the Gilbert [9], and the Kronenberg [10] model. Their parameters can be estimated from experimental tests using some optimization methods but the approximation accuracy decreases when the cutting speed or the feed rate increases. The fuzzy model applying RBE-SI+FRIPOC [11] ensured the better results.

In course of the modeling DA20 and DA25 carbid insert types were examined based on milling experiments. The author developed two separate models for the two carbide insert types. Both models had two input and one output dimensions. They were created using the Sparse Fuzzy Model Identification (SFMI) Matlab ToolBox [12]. The crisp output values were calculated with Centre Of Area (COA) defuzzification, and they used RMSEP as a performance index and calculated the performance index with the Fuzzy Rule Interpolation (FRI) Matlab Toolbox [13].

Table 3. The performance indexes (RMSEP) of the models of the tool life [11]

	Exp.	Taylor	T. corr	RBE-SI+ FRIPOC
DA20	1.12 23%	2.88 16%	4.7 610%	0.014 6 %
DA25	0.70 45%	3.94 86%	7.2 525%	0.000 5 %

Table 3 compares the performance (RMSEP) of the three traditional models and the fuzzy model applying fuzzy rule interpolation

3.2. Fuzzy Expert System

In several cases when a fully automated student scoring is not possible (e.g. narrative responses, software development) the **evaluation of the students' academic performance** can result in quite significant deviation between the marks given by different evaluators or at different occasions. This problem partly can be traced back to the vagueness in the opinion of the evaluator that hardly can be fitted in the one-value-based traditional evaluation model. Student Evaluation based on Fuzzy Rule Interpolation (SEFRI) [14] aims the support of the evaluator by allowing the scoring of each question by fuzzy

numbers and by calculating the total score using fuzzy inference.

In course of the rating the evaluator takes into consideration three aspects, namely the accuracy of the response, the time necessary for answering the questions, and the correct use of the technical terms. In course of the preparation the 100 achievable marks are divided between the questions. They are the weights associated to the questions.

In case of the second aspect one works with the total time necessary for answering all of the questions, which is determined automatically and reported to the allowed total response time. The resulting relative time is fuzzified (TR) using singleton type fuzzification.

The characteristics "the accuracy of the response" (AC), and "the correct use of the technical terms" (CU) are measured by the evaluator with separate fuzzy marks (fuzzy numbers) for each question. The scoring scale is in both cases the unit interval. After assigning the two fuzzy marks for each question one calculates an average AC and CU value ($\overline{AC}$ and $\overline{CU}$) for the student as a weighted average of the individual values.

Next one determines from the three fuzzy values ($\overline{AC}$, TR, and $\overline{CU}$) the general evaluation of the student using fuzzy inference. In order to reduce the complexity of the rule base the LESFRI fuzzy rule interpolation based reasoning method is used. Thus the underlying rule base requires only 64 rules in contrast with the 125 rules of the dense rule base owing to the fact that each input dimension contains five fuzzy sets.

The fuzzy inference results the general fuzzy evaluation of the student (GFE) that is defuzzified using Center Of Area method in order to get the total score (TS). Finally the grade of the student is determined using the standardized mapping of the university.

4. Conclusions

Fuzzy rule interpolation based inference is an emerging field of fuzzy set theory allowing the reasoning even in cases when not all the possible rules are known or the rule base is intentionally sparse in order to ensure a low system complexity. A wide number of practical applications demonstrate that FRI is not only of theoretical interest. Although originally it was developed for fuzzy systems with high number of input dimensions and partitions with high resolution it also can be used successfully in other cases. The known practical applications form three main groups conform the tasks they are used for: fuzzy control, function approximation and expert systems.

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Adaptive MMSE equalization of SIMO channels

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Abstract

In this paper a novel channel equalizer algorithm will be introduced for wireless communication systems to combat channel distortions resulting from multipath propagation. Recently, regarding the mobile telecommunication systems, SIMO (Single Input Multiple Output) systems came to the fore. Hence, an adaptive Minimum Mean Square Error (MMSE) equalizer to the SIMO case has been derived. From the performance analysis one can infer that the new algorithm has significant benefit in contrast to the single output case, and as a result, it can contribute to maintaining QoS communication over very bad channels.

Keywords: Knowledge Transfer, Channel equalization, Signal processing

1 Introduction

Nowadays, the main challenge of mobile systems is QoS (Quality of Service) communication at a high data rate. The new services must be carried out over narrowband radio channels which are highly limited and consecutively expensive [1]. One of the most effective solution to improve the quality of communication without increasing the required bandwith is spatial diversity [3]. This solution is based on multiple transmitter and/or receiver antennas, using the same radio channel. In the case of mobile uplink channels (i.e. the mobile transmits data to the base station) the transmit power is highly limited because the mobile is powered by accumulators. This implies that diversity can be applied only at the base station, i.e. at the receiver side, where power limitations are not so strict. The benefit of the diversity depends on the spatial distance of the receiver antennas, where this distance must be comparable to the wavelenght of the carrier. In this case the channels between transmitter and the given receiver are independent, which results in a higher chance that at least one of the channels do not suffer under the restrictive effect of multipath propagation. This scenario results mathematically in a Single Input Multiple Output channel model.

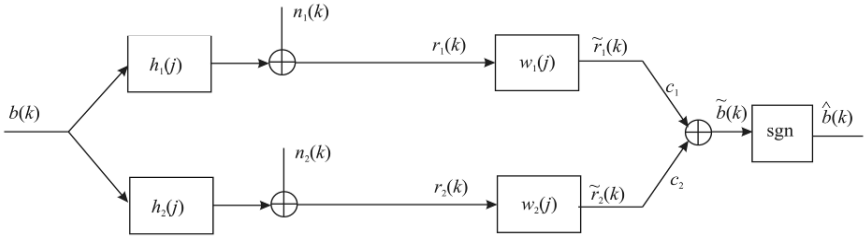

Figure 1: A modell

2 The model

Our model is depicted in Fig. 1, where $b(k)$ denotes the transmitted bit in the kth time slot. In this paper we consider two-state modulation scheme for mathematical convenience. The input symbols are assumed to be independent and equally probable:

$$b(k) \in \{-1, +1\}; \quad \mathbb{P}\{b(k) = -1\} = \mathbb{P}\{b(k) = +1\} = 0.5$$

We consider two receiver antennas, i.e. two parallel channels, which can be of different lengths. The channels introduce linear distortion and white Gaussian noise:

$$h_1(k) \qquad k = 0, ..., M_1 \tag{1}$$

$$h_2(k) \qquad k = 0, ..., M_2 \tag{2}$$

where sub indices refer to the number of the given propagation path while k is the discrete time. For convenience vector denotion will be introduced as follows:

$$\begin{aligned}
\mathbf{b}(k) &= [b(k), b(k-1), ..., b(k-M)]^T && (3)\\
\mathbf{h}_1 &= [h_1(0), h_1(1), ..., h_1(M_1)]^T && (4)\\
\mathbf{h}_2 &= [h_2(0), h_2(1), ..., h_2(M_2)]^T && (5)\\
\mathbf{w}_1 &= [w_1(0), w_1(1), ..., w_1(J)]^T && (6)\\
\mathbf{w}_2 &= [w_2(0), w_2(1), ..., w_2(J)]^T && (7)\\
\mathbf{w} &= \left[\mathbf{w}_1^T, \mathbf{w}_2^T\right]^T && (8)\\
\mathbf{r}_1(k) &= [r_1(k), r_1(k-1), ..., r_1(k-J)]^T && (9)\\
\mathbf{r}_2(k) &= [r_2(k), r_2(k-1), ..., r_2(k-J)]^T && (10)\\
\mathbf{n}_1(k) &= [n_1(k), n_1(k-1), ..., n_1(k-J)]^T && (11)\\
\mathbf{n}_2(k) &= [n_2(k), n_2(k-1), ..., n_2(k-J)]^T && (12)
\end{aligned}$$

Further denotions:

$$\begin{aligned}
r_1(k) &= \sum_{j=0}^{M_1} h_1(j)\, b(k-j) + n_1(k) && (13)\\
r_2(k) &= \sum_{j=0}^{M_2} h_2(j)\, b(k-j) + n_2(k) && (14)\\
\tilde{r}_1(k) &= \sum_{j=0}^{J} w_1(j)\, r_1(k-j) && (15)\\
\tilde{r}_2(k) &= \sum_{j=0}^{J} w_2(j)\, r_2(k-j) && (16)\\
\tilde{b}(k) &= c_1 \tilde{r}_1(k+D_1) + c_2 \tilde{r}_2(k+D_2) && (17)\\
\hat{b}(k) &= \operatorname{sgn}\left\{\tilde{b}(k)\right\} && (18)
\end{aligned}$$

Here r refers to received signals, which are applied to Finite Impulse Response (FIR) equalizers w of the same length J. The output of the equalizers are denoted by $\tilde{r}$. The decision variable, which is a linear combination of the output of the equalizers denoted by $\tilde{b}$ from which the decision $\hat{b}$ is carried out by simple threshold detection. In (17) D_1 and D_2 model the delay of the different channels. Using vector notation we conclude to a more compact description as

$$\begin{aligned}
r_1(k) &= \mathbf{h}_1^T \mathbf{b}(k) + n_1(k) && (19)\\
r_2(k) &= \mathbf{h}_2^T \mathbf{b}(k) + n_2(k) && (20)\\
\tilde{r}_1(k) &= \mathbf{r}_1^T(k)\, \mathbf{w}_1 && (21)\\
\tilde{r}_2(k) &= \mathbf{r}_2^T(k)\, \mathbf{w}_2 && (22)\\
& && (23)
\end{aligned}$$

and

$$\begin{aligned}
\mathbf{r}_1(k) &= \mathbf{H}_1 \mathbf{b}(k) + \mathbf{n}_1(k) && (24)\\
\mathbf{r}_2(k) &= \mathbf{H}_2 \mathbf{b}(k) + \mathbf{n}_2(k) && (25)\\
& && (26)
\end{aligned}$$

where

$$\mathbf{H}_i = \begin{bmatrix}
h_i(0) & h_i(1) & \cdots & h_i(M) & 0 & 0 & 0\\
0 & h_i(0) & h_i(1) & \cdots & h_i(M) & 0 & 0\\
0 & 0 & \ddots & \ddots & \ddots & \ddots & 0\\
0 & 0 & 0 & h_i(0) & h_i(1) & \cdots & h_i(M)
\end{bmatrix} \tag{27}$$

Let us use the following denotion for the statistics of the transmitted and received signal (for further details see [2]):

$$\begin{aligned}
\mathbf{p}_1 &= \mathbb{E}\{b(k-D_1)\, \mathbf{r}_1(k)\} = \mathbf{H}_1 \mathbf{e}_{D_1+1} && (28)\\
\mathbf{p}_2 &= \mathbb{E}\{b(k-D_2)\, \mathbf{r}_2(k)\} = \mathbf{H}_2 \mathbf{e}_{D_2+1} && (29)\\
\mathbf{R}_1 &= \mathbb{E}\left\{\mathbf{r}_1(k)\, \mathbf{r}_1^T(k)\right\} = \mathbf{H}_1 \mathbf{H}_1^T + N_{01}\mathbf{I} && (30)\\
\mathbf{R}_2 &= \mathbb{E}\left\{\mathbf{r}_2(k)\, \mathbf{r}_2^T(k)\right\} = \mathbf{H}_2 \mathbf{H}_2^T + N_{02}\mathbf{I} && (31)\\
\mathbf{R}_{12} &= \mathbb{E}\left\{\mathbf{r}_1(k+D_1)\, \mathbf{r}_2^T(k+D_2)\right\} = && (32)\\
&= \begin{cases} \mathbf{H}_1 \mathbf{H}_{2D}^T & \text{if} \quad D_1 \geq D_2 \\ \mathbf{H}_{1D} \mathbf{H}_2^T & \text{if} \quad D_2 > D_1 \end{cases} && (33)
\end{aligned}$$

where N_0 is the spectral density of the additive noise, $\mathbf{I}$ is the identity matrix and $\mathbf{e}_j$ is the jth unitvector, $D = D_1 - D_2$ and the definition of $\mathbf{H}_{iD}$ is

$$\mathbf{H}_{iD} = \begin{bmatrix} \mathbf{0} & \tilde{\mathbf{H}}_\mathbf{i} \end{bmatrix} \tag{34}$$

where the zeromatrix has D columns and $\tilde{\mathbf{H}}_\mathbf{i}$ stands for the first $M + J + 1 - D$ columns of $\mathbf{H}_i$. Note, that $\mathbf{R}_1$ and $\mathbf{R}_2$ are symmetrical and Toeplitz-type, while $\mathbf{R}_{12}$ is Toeplitz but not symmetrical.

We assume that the noises of the given channels and the input signals are independent:

$$\begin{aligned}
\mathbb{E}\{n_1(k) n_2(k-i)\} &= 0 \quad \forall i\\
\mathbb{E}\{b(k) h_i(k-j)\} &= 0 \quad \forall i, j\\
\mathbb{E}\left\{\mathbf{n}_1(k) \mathbf{n}_1^T(k)\right\} &= N_{01}\mathbf{I}\\
\mathbb{E}\left\{\mathbf{n}_2(k) \mathbf{n}_2^T(k)\right\} &= N_{02}\mathbf{I}
\end{aligned}$$

3 The MMSE cost function

The goal of this section to derive the optimal equalizers in the sense of the MSE (Means Squared Error) criterion. Note that the novelty of the following derivation is the joint optimization of the equalizers, as follows

$$\begin{aligned}
J(\mathbf{w}) &= \mathbb{E}\left\{\left(b(k) - \tilde{b}(k)\right)^2\right\}\\
&= \mathbb{E}\left\{\left[b(k) - c_1 \tilde{r}_1(k+D_1) - c_2 \tilde{r}_2(k+D_2)\right]^2\right\} =\\
&= 1 - 2c_1 \mathbf{p}_1^T \mathbf{w}_1 - 2c_2 \mathbf{p}_2^T \mathbf{w}_2 + c_1^2 \mathbf{w}_1^T \mathbf{R}_1 \mathbf{w}_1 +\\
&\quad + 2c_1 c_2 \mathbf{w}_1^T \mathbf{R}_{12} \mathbf{w}_2 + c_2^2 \mathbf{w}_2^T \mathbf{R}_2 \mathbf{w}_2
\end{aligned}$$

Quadratic cost functions have the benefit of having one global minimum, which can be found by making the gradient equal to zero:

$$\begin{aligned}
\nabla_{\mathbf{w}_1} J(\mathbf{w}) &= 2c_1^2 \mathbf{R}_1 \mathbf{w}_1 - 2c_1 \mathbf{p}_1 + 2c_1 c_2 \mathbf{R}_{12} \mathbf{w}_2 = 0\\
\nabla_{\mathbf{w}_2} J(\mathbf{w}) &= 2c_2^2 \mathbf{R}_2 \mathbf{w}_2 - 2c_2 \mathbf{p}_2 + 2c_1 c_2 \mathbf{R}_{12}^T \mathbf{w}_1 = 0
\end{aligned}$$

from which

$$\mathbf{R}\mathbf{w}_{opt} = \mathbf{p} \tag{35}$$

follows, where

$$\mathbf{R} = \begin{bmatrix} c_1^2\mathbf{R}_1 & c_1c_2\mathbf{R}_{12} \\ c_1c_2\mathbf{R}_{12}^T & c_2^2\mathbf{R}_2 \end{bmatrix}$$

and

$$\mathbf{p} = \begin{bmatrix} c_1\mathbf{p}_1 \\ c_2\mathbf{p}_2 \end{bmatrix}.$$

4 Optimization of the weighting coefficients

The optimal values of the weighting coefficients c_i, which define the weight by which the given path must be incorporated into the decision variable can be carried out by calculating the gradient of the cost function (48) regarding coefficients c_i:

$$\begin{aligned} \nabla_{c_1} J(\mathbf{w}) &= -2\mathbf{p}_1^T\mathbf{w}_1 + 2c_1\mathbf{w}_1^T\mathbf{R}_1\mathbf{w}_1 + 2c_2\mathbf{w}_1^T\mathbf{R}_{12}\mathbf{w}_2 \\ &= 0 \\ \nabla_{c_2} J(\mathbf{w}) &= -2\mathbf{p}_2^T\mathbf{w}_2 + 2c_2\mathbf{w}_2^T\mathbf{R}_2\mathbf{w}_2 + 2c_1\mathbf{w}_1^T\mathbf{R}_{12}\mathbf{w}_2 \\ &= 0 \end{aligned}$$

Hence, the optimal solution to $\mathbf{c} = [c_1, c_2]^T$ is

$$\mathbf{c}_{opt} = \begin{bmatrix} \mathbf{w}_1^T\mathbf{R}_1\mathbf{w}_1 & \mathbf{w}_1^T\mathbf{R}_{12}\mathbf{w}_2 \\ \mathbf{w}_1^T\mathbf{R}_{12}\mathbf{w}_2 & \mathbf{w}_2^T\mathbf{R}_2\mathbf{w}_2 \end{bmatrix}^{-1} \begin{bmatrix} \mathbf{p}_1^T\mathbf{w}_1 \\ \mathbf{p}_2^T\mathbf{w}_2 \end{bmatrix} \tag{36}$$

Since the optimal value of $\mathbf{c}$ depends on the equalizer coefficients, this optimization can be carried out only by an iterative process:

1. $\mathbf{c}(0) := [0.5; 0.5]^T$;
2. calculate $\mathbf{w}_{opt}$ using (35);
3. calculate $\mathbf{c}$ using (36);
4. GOTO 2.

5 Adaptive equalizer

Since radio channels change rapidly, an adaptive solution must be found in order to carry out real-time equalization. Using the steepest descent method, the following adaptive algorithm can be derived:

$$\begin{aligned} \mathbf{w}_1(n+1) &= \mathbf{w}_1(n) - \Delta\{c_1^2\mathbf{R}_1\mathbf{w}_1 + c_1c_2\mathbf{R}_{12}\mathbf{w}_2 - c_1\mathbf{p}_1\} \\ \mathbf{w}_2(n+1) &= \mathbf{w}_2(n) - \Delta\{c_2^2\mathbf{R}_2\mathbf{w}_2 + c_1c_2\mathbf{R}_{12}^T\mathbf{w}_1 - c_2\mathbf{p}_2\} \end{aligned}$$

where Δ is a sufficiently small step size. It can be easily seen that the equilibrium ($\mathbf{w}_i(n+1) = \mathbf{w}_i(n)$) of this iterative algorithm is the same as the optimal solution defined in (35). Unfortunately, the statistics of the received signal is not known at the receiver, hence they must be replaced by the instantaneous estimates:

$$\begin{aligned} \mathbf{w}_1(n+1) &= \mathbf{w}_1(n) - \Delta\{c_1^2\hat{\mathbf{R}}_1\mathbf{w}_1 + c_1c_2\hat{\mathbf{R}}_{12}\mathbf{w}_2 - c_1\hat{\mathbf{p}}_1\} \\ \mathbf{w}_2(n+1) &= \mathbf{w}_2(n) - \Delta\{c_2^2\hat{\mathbf{R}}_2\mathbf{w}_2 + c_1c_2\hat{\mathbf{R}}_{12}^T\mathbf{w}_1 - c_2\hat{\mathbf{p}}_2\} \end{aligned}$$

where

$$\begin{aligned} \hat{\mathbf{p}}_1 &= b(k)\,\mathbf{r}_1(k+D_1) \\ \hat{\mathbf{p}}_2 &= b(k)\,\mathbf{r}_2(k+D_2) \\ \hat{\mathbf{R}}_1 &= \mathbf{r}_1(k+D_1)\,\mathbf{r}_1^T(k+D_1) \\ \hat{\mathbf{R}}_2 &= \mathbf{r}_2(k+D_2)\,\mathbf{r}_2^T(k+D_2) \\ \hat{\mathbf{R}}_{12} &= \mathbf{r}_1(k+D_1)\,\mathbf{r}_2^T(k+D_2) \\ \hat{\mathbf{R}}_{12}^T &= \mathbf{r}_2(k+D_2)\,\mathbf{r}_1^T(k+D_1) \end{aligned}$$

using this instantaneous estimates and after some standard calculations we arrive at

$$\begin{aligned} \mathbf{w}_1(n+1) &= \mathbf{w}_1(n) - \Delta c_1\mathbf{r}_1(k+D_1)\cdot \\ &\quad \cdot\{c_1\mathbf{r}_1^T(k+D_1)\,\mathbf{w}_1 + c_2\mathbf{r}_2^T(k+D_2)\,\mathbf{w}_2 - b(k)\} \\ \mathbf{w}_2(n+1) &= \mathbf{w}_2(n) - \Delta c_2\mathbf{r}_2(k+D_2) \\ &\quad \cdot\{c_2\mathbf{r}_2^T(k+D_2)\,\mathbf{w}_2 + c_1\mathbf{r}_1^T(k+D_1)\,\mathbf{w}_1 - b(k)\}. \end{aligned}$$

Applying (17)

$$\begin{aligned} \mathbf{w}_1(n+1) &= \mathbf{w}_1(n) - \Delta c_1\mathbf{r}_1(k+D_1)\{\tilde{b}(k) - b(k)\} \\ \mathbf{w}_2(n+1) &= \mathbf{w}_2(n) - \Delta c_2\mathbf{r}_2(k+D_2)\{\tilde{b}(k) - b(k)\}. \end{aligned}$$

Introducing $e(k) = \tilde{b}(k) - b(k)$ simplifies to

$$\mathbf{w}_1(n+1) = \mathbf{w}_1(n) - \Delta c_1\mathbf{r}_1(k+D_1)\,e(k) \tag{37}$$

$$\mathbf{w}_2(n+1) = \mathbf{w}_2(n) - \Delta c_2\mathbf{r}_2(k+D_2)\,e(k). \tag{38}$$

Defining the concatenated equalizer coefficient vector $\mathbf{w} = [\mathbf{w}_1^T, \mathbf{w}_2 T]$ one can conclude to

$$\mathbf{w}(n+1) = \mathbf{w}(n) - \Delta\mathbf{r}(k)\,e(k) \tag{39}$$

where $\mathbf{r}(k) = \left[c_1\mathbf{r}_1^T(k+D_1), c_2\mathbf{r}_2^T(k+D_2)\right]^T$.

5.1 Adaptation of the weighting coefficients

Applying the same steps as in section 5 the adaptation rule can be derived for the weighting coefficients, which is described in details in Appendix B. The adaptation of $\mathbf{c}$ must be calculated parallel with the adaptation of $\mathbf{w}(n)$.

6 Simulation results

In this section we numerically investigate BER with respect to SNR. The simulations were made in the case of four different channel models representing multipath propagation in different practical scenarios. The corresponding channel characteristics are given by their impulse response as follows: $\mathbf{h}^{(1)} = [1; 0.6; -0.3]^T$, $\mathbf{h}^{(2)} = [1; 0.6; 0.3]^T$, $\mathbf{h}^{(3)} = [1; 0.9; 0.5]^T$ and

$\mathbf{h}^{(4)} = [1; -0.7; -0.755]^T$.

In Figure 2 the BER versus SNR performance of the classical and the new algorithms are depicted. The abbreviations used in the figure are as follows:

- Threshold – Simple signum detection without equalizer;
- div(hx,hy) – SIMO channel model, the signal propagation is parallel over channels hx and hy;
- MMSE – Minimum Mean Square Error;

The equalizer length were set to 5 in the case of MMSE without diversity, and to 2×5 in the case of diversity. We used an artificial scenario for reference as well, namely the same channel was assumed for both propagation paths, and a diversity equalizer was applied, which equivalent to a repetition of the same signal. (The benefit comes from the fact that the noise which jams the signal is not the same in the two channels).

One can note a significant increase in BER performance caused by the diversity algorithms. Even in the case of nonminimum-phase channels (such as $h^{(3)}$ and h^4) good performance can be achieved. However the ranking of the algorithms depends on the channel coefficients, (e.g. channel h^4 seems to be unequalizable, using the information gathering from this path can be increase the overall performance – see curve 'MMSE div(h3,h4)' and 'MMSE divh3'), MMSE equalization for the diversity scenario always outperforms the classical methods.

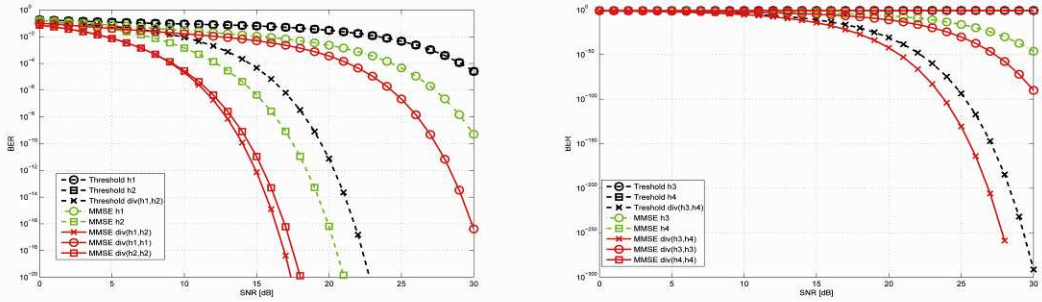

Figure 2: BER-SNR curves for channel h1 and h2 (left side) and h3,h4 (right side)

7 Conclusion and further work

In this paper an adaptive method has been derived for the MMSE equalization of SIMO channels. By the new method lower Bit Error Rate can be reached while the used radio channel does not require a larger bandwidth. In the future the following issues will be addressed:

1. It can be proven that under given circumstances lower bit error rate equalization can be reached by a given number of coefficients in a diversity fashion than by the same length equalizer without diversity (SISO)?
2. An adaptive equalizer algorithm which can optimize the SIMO equalizer coefficients based on the Minimum Bit Error Rate cost function [6, 5, 7] should be derived.

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Appendix A

The derivation of the cost function:

$$J(\mathbf{w}) = \mathbb{E}\left\{\left(b(k)-\tilde{b}(k)\right)^2\right\} = \mathbb{E}\left\{\left[b(k)-c_1\tilde{r}_1(k+D_1)-c_2\tilde{r}_2(k+D_2)\right]^2\right\} = \tag{40}$$

$$= \mathbb{E}\left\{\left(b(k)-c_1\sum_j w_1(j)\,r_1(k+D_1-j)-c_2\sum_j w_2(j)\,r_2(k+D_2-j)\right)^2\right\} = \tag{41}$$

$$= \mathbb{E}\left\{b^2(k)\right\}-2\mathbb{E}\left\{c_1\sum_j w_1(j)\,r_1(k+D_1-j)\,b(k)+c_2\sum_j w_2(j)\,r_2(k+D_2-j)\,b(k)\right\}+ \tag{42}$$

$$+\mathbb{E}\left\{\left(c_1\sum_j w_1(j)\,r_1(k+D_1-j)+c_2\sum_j w_2(j)\,r_2(k+D_2-j)\right)^2\right\} = \tag{43}$$

$$= 1-2c_1\sum_j w_1(j)\,\mathbb{E}\left\{b(k)\,r_1(k+D_1-j)\right\}-2c_2\sum_j w_2(j)\,\mathbb{E}\left\{b(k)\,r_2(k+D_2-j)\right\}+ \tag{44}$$

$$+c_1^2\sum_i\sum_j w_1(i)\,w_1(j)\,\mathbb{E}\left\{r_1(k+D_1-i)\,r_1(k+D_1-j)\right\}+ \tag{45}$$

$$+2c_1c_2\sum_i\sum_j w_1(i)\,w_2(j)\,\mathbb{E}\left\{r_1(k+D_1-i)\,r_2(k+D_2-j)\right\}+ \tag{46}$$

$$+c_2^2\sum_i\sum_j w_2(i)\,w_2(j)\,\mathbb{E}\left\{r_2(k+D_2-i)\,r_2(k+D_2-j)\right\} \tag{47}$$

Using (28)-(33) we conclude

$$J(\mathbf{w}) = 1-2c_1\mathbf{p}_1^T\mathbf{w}_1-2c_2\mathbf{p}_2^T\mathbf{w}_2+c_1^2\mathbf{w}_1^T\mathbf{R}_1\mathbf{w}_1+2c_1c_2\mathbf{w}_1^T\mathbf{R}_{12}\mathbf{w}_2+c_2^2\mathbf{w}_2^T\mathbf{R}_2\mathbf{w}_2 \tag{48}$$

Appendix B

The adaptation rule for the weighting coefficients:

$$\mathbf{c}(n+1) = \mathbf{c}(n)-\Gamma\left\{\begin{bmatrix}\mathbf{w}_1^T\mathbf{r}_1(k+D_1)\,\mathbf{r}_1^T(k+D_1)\,\mathbf{w}_1 & \mathbf{w}_1^T\mathbf{r}_1(k+D_1)\,\mathbf{r}_2^T(k+D_2)\,\mathbf{w}_2\\ \mathbf{w}_1^T\mathbf{r}_1(k+D_1)\,\mathbf{r}_2^T(k+D_2)\,\mathbf{w}_2 & \mathbf{w}_2^T\mathbf{r}_2(k+D_2)\,\mathbf{r}_2^T(k+D_2)\,\mathbf{w}_2\end{bmatrix}\mathbf{c}(k)+\right. \tag{49}$$

$$\left.-\begin{bmatrix}b(k)\,\mathbf{r}_1^T(k+D_1)\,\mathbf{w}_1\\ b(k)\,\mathbf{r}_2^T(k+D_2)\,\mathbf{w}_2\end{bmatrix}\right\} \tag{50}$$

where Γ is the step size. Applying definition (22)

$$\mathbf{c}(n+1) = \mathbf{c}(n)-\Gamma\left\{\begin{bmatrix}\tilde{\mathbf{r}}_1^2(k+D_1) & \tilde{\mathbf{r}}_1(k+D_1)\,\tilde{\mathbf{r}}_2(k+D_2)\\ \tilde{\mathbf{r}}_1(k+D_1)\,\tilde{\mathbf{r}}_2(k+D_2) & \tilde{\mathbf{r}}_2^2(k+D_2)\end{bmatrix}\mathbf{c}(k)+\right. \tag{51}$$

$$\left.-\begin{bmatrix}b(k)\,\tilde{\mathbf{r}}_1(k+D_1)\\ b(k)\,\tilde{\mathbf{r}}_2(k+D_2)\end{bmatrix}\right\} \tag{52}$$

Bluetooth communication networks for a mobile robot swarm

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Abstract

In this work the possible communication schemes of an autonomous robot swarm via Bluetooth radio is investigated. One of the presented solutions is a conventional Bluetooth scatternet. In the other solution, however, an autonomous unit was equipped with two independent Bluetooth radios. It was clearly shown that the latter scheme far outperforms the former one regarding the communication speed. Besides, the use of Bluetooth technology makes possible to directly involve cell phones in the communication network.

Keywords: Bluetooth scatternet, mobile robots

1. Introduction

In the last few decades the various swarm intelligence algorithms are tested or implemented by not only computer simulations but real mobile robots. In these swarm intelligence applications the communication capability in the swarm is often supposed to be granted, however, the realization of a stable wireless communication system is not a trivial task. In most of the cases the mobile robots at hand are equipped with Wi-Fi (IEEE 802.11), Zig-Bee (IEEE 802.15.4) or Bluetooth (IEEE 802.15.1) radio system, since they render cheap and yet satisfactory solutions for the communication between the mobile robots.

The Bluetooth radio system, which is the subject of the present work, is a cheap solution and compared to its relatively high data rate it is economic on power. Due to these advantages the Bluetooth technology is the most commonly used on small mobile devices, and therefore it is a good candidate also in the case of mobile robots. More detailed pros and cons on Bluetooth communication in mobile robotics can be read in [1] or [2]. The most serious limitation of a Bluetooth network is that it is not scalable, since a Bluetooth piconet can consists of a master and at most seven slaves [3]. In order to overcome this limitation the so called Bluetooth scatternet is invented shortly after the appearance of the original Bluetooth standard [4, 5]. The basic idea of forming a scatternet is that a slave disconnects from its master and becomes only a passive member (park or hold mode) in its original piconet, and then asks for and gets admission into another piconet as a slave or a master. Thus there can be communication between the two piconets through this, so called, bridge unit: if there is a packet or a message directed to the other piconet the bridge takes it, changes piconet and passes the packet towards its destination. However, each of these bridging actions causes some delay and acts as a bottleneck. In addition to this, the position of the bridge unit is more restricted than the others, since it must be in the radio coverage in both piconets. Due to this shortcomings this bridge based scatternet, although arbitrary scalable from theoretical point of view, is limited to not to big networks and low data rates in practice.

Sohrabi et al. [6] and later Leopold et al. [7] proposed a novel and simple solution that employed two independent Bluetooth radios in single autonomous host to form a large scale wireless sensor network. In this scheme the two Bluetooth radios are parts of two different piconets so that the host passes the information between its two radios. It is easy to see that this solution is free from the limitations of the former bridge based scatternet, although it has higher cost.

In the present work we employed both a conventional and a dual-radio scatternet scheme described above to form scalable communication networks of mobile robots and, besides, our second implementation also involves Bluetooth equipped cell phones as parts of the network. In order to test our scheme in reality we used the microcontroller based NXT robot assembling set produced by LEGO. This set is based on Bluetooth communication and planned

mostly for educational purposes, however, there are also numerous research applications using NXT.

2. The conventional scatternet

As in our experiments we used NXT robots it is important to give a brief description about this robot builder system regarding their communication and programmable capabilities. The main part of the robot is the programmable brick, which is a microcontroller. This brick basically consists of: an Atmel® 32-bit ARM® processor AT91SAM7S256 as a main processor, and a CSR BlueCoreTM 4 v2.0 +EDR System for the Bluetooth wireless communication.

An NXT brick can be connected wirelessly to three other ones at the same time. The communication is set up as a "master-slave" communication channel. The master can communicate only with one of the slaves at a given moment. The slaves cannot communicate directly with each other.

The brick has three output ports and four input ports. We can connect servomotors and lamps to the output ports, and touch, light, sound and distance sensors to the input ports. Currently, several companies sell new sensors, such as for example: magnetic compass, colour or rotation sensors, etc.

Furthermore, several programming languages, like NQC, NXC, NBC, LeJOS are being developed as well, and in addition to this an icon-directed Mindstorms NXT programming language developed by LEGO, which made it more popular. Nowadays the MATLAB programming environment is the one mostly applied in the NXT programming.

To solve the problem of the limited roles within the group, instead of the piconet network we applied a "static Scatternet" network. In this new group a so called "super-master" robot worked as the only master. The super-master could only communicate directly with its "sub-master" robots. These sub-masters worked like bridges in the network (see Figure 1).

They played two different roles: the first is a slave, while communicating with the super-master and then, after the super-master's disconnection the second is a master role, while communicating with their slaves. The super-master could communicate with the slaves only trough its sub-masters. Still, the sub-master could play only one role at a time, either it was a slave for the super-master or it was a master itself for the slaves. When it was playing the role of a slave for the super-master, only the super-master had the right to connect or disconnect to it. In the other case, when it was playing the role of a master, only the sub-master had the right to connect or disconnect to the slaves. The super-master could not make connection with the sub-master while it was in connection with the slaves. For this reason, it was very important to reduce the sub-master's communication time as much as possible, to let them back to their "waiting for connection" positions.

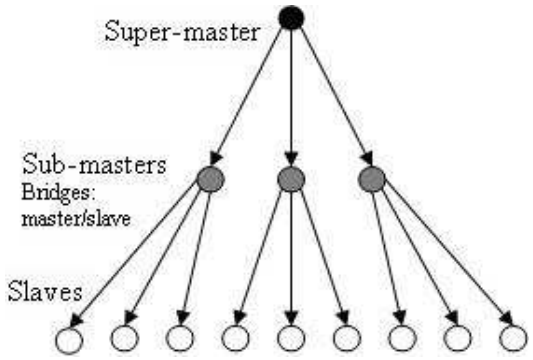

Fig. 1. The implemented Scatternet network of NXT robots

In order to implement the communication scheme above, a connector, a disconnector and a message-sender function were written in the NXC programming language. (The NXC language includes functions to control the Bluetooth system. These functions were used to write our protocols.

We also had to apply a static "rooting" hierarchy to compensate the unreliability of the Bluetooth technology used in NXT robots. In this way, the number of connections and disconnections was reduced. The super-master and the sub-masters both had a "routing table", containing the names of all the connectable slaves, their connection numbers and the fact, whether the connection to the connectable slaves is connected or disconnected. This "routing table" could not be extended, that is, each master-robot could be connected or disconnected with only the three slaves originally assigned to it. The super-master could be connected or disconnected with the sub-masters, the sub-masters could be connected or disconnected with only its slaves. The slaves in the bottom level of the hierarchy had no "routing table" at all.

To reduce the unreliability of the Bluetooth communication, the connecting, disconnecting and sending messages had to be repeated with inserted timeouts and retries amongst them.

The communication of this network was tested by simple message packets. As it was expected the communication was reliable but slow. It was obtained that to build up a connection securely requires 4 to 5 seconds in the NXT Bluetooth system, therefore a packet transfer takes at least this time for a bridge node. By knowing this it is easy to estimate that a total broadcast time in a network given in Figure 2 takes at least 6 times 4 seconds i.e. 24 seconds, if we start out from the situation when there is no a priori connection. In reality the total broadcast time in our experiments was 50 to 90 seconds,

since the packet transfers also took their times and due to the simultaneous connecting procedures the disturbing interferences were high.

3. The dual-radio scatternet

By the means of the previous section our first goal is to create a communication unit equipped by two independent Bluetooth radios. The NXT is not a skeleton system i.e. it is not possible to extend the original electronics of the central brick. That is why we invented an unusual solution, the basic idea of which is that two central bricks are connected to each other through their RS485 ports. These ports regularly serves as a receiver of measured data from various sensors of NXT standard, however, they can not only receive but also send data via the NXT sensor cable, although these sensors do not require data of any kind. Using this capability of the RS485 ports, a fast half-dulpex communication link can be established between the two bricks. Thus, the two bricks form a new autonomous unit that has two independent radios (each in its own host brick), as it is seen in Figure 2.

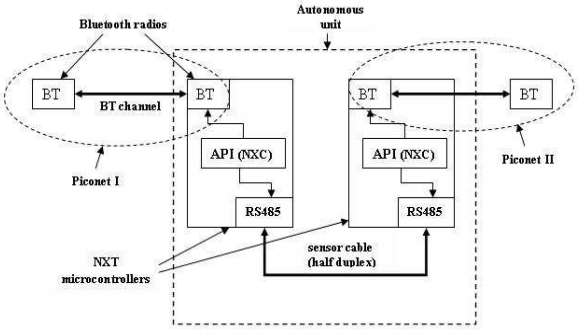

Fig. 2. The architecture of the autonomous communication unit consisting of two NXT microcontrollers

The point to point communication or on the Bluetoth either on the RS485 link must be controlled by program codes in the application layer. In the present project we also applied the NXC programming language of the NXT microcontroller, which contains API functions not only for the to treat the Bluetooth system but for the RS485 port too.

Each of the radios of the autonomous unit can be either master or slave in the piconet it belongs to. Every unit with the two radios is a connection point between the two piconets, so a large connected network can be formed by such units.

It is also possible to involve Bluetooth equipped cell phones into this network, however the cell phones must be end points (leafs) of the communication graph since they have only one Bluetooth radio. With the help of this multi-hop network the cell phones can communicate with each other so that in this scenario the cell phones are the clients and the mobile robots render service for them.

Various self-assembly algorithms to create such networks are detailed by Sohrabi et al. [7] for sensor nodes with fixed spatial positions. The situation is much more difficult when the nodes are mobile robots or cell phones carried by their owners, since the topology is continuously changing. Presently, our aim is to implement a real communication capability test for a simple topology consisting of several autonomous NXT robots assembled by the scheme above and two cell phones. This communication test is described in the next section.

There are two tests implemented and presented here. The first test is based upon variable number of robots and two cell phones arranged in a linear graph topology shown by Figure 3. The phones were Java MIDP 2.0 enabled ordinary devices equipped with Bluetooth. In order to get a picture about the communication speed and reliability a simple ping application was written for the cell phones using the Sun's Java Microedition tool, which is capable to control the Bluetooth radio by its JSR-82 packet. In this application the cell phones initiated a serial port connection to the a priori appointed neighbouring robot and the sender phone began to send small (several characters) ping packets into the chain, while the other phone replied automatically the ping packets.

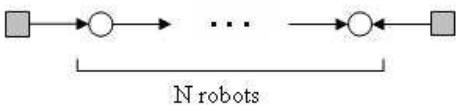

Fig. 3. The linear testing scenario. The autonomous robots and the cell phones are denoted by circles and rectangles, respectively. The arrows start from the maser and point to the slaves

A ping procedure sent ten packets in one series. The next packet was sent as soon as the acknowledgement arrived. The success rates and the average reply times were measured and recorded for various robot chain lengths of N = 1, 3 and 5. For each chain length five ping procedures were executed. The success rate was 100 per cent in any cases, and the average reply times are shown in Table 1.

Table 1. Communication test results.

Number of robots (N)	Average reply time (milliseconds)	Measuring error (millisecons)
1	664	16
3	2444	570
5	4198	431

It can be seen that each robot-robot link raises the hopping time by approximately 0.5 seconds. Based on these results it can be established that with the help of this latter scenario the communication works much faster. Besides, it should be noted that the program governing the packet hopping was written so that acknowledgements were applied at every hop in order to increase the reliability. By giving up some amount of reliability it is possible to optimize the program to get even a higher speed.

The other test is based on a ring topology of the autonomous robot units, where the robots are using a closed communication loop as it is shown in Figure 4.

In this scenario a ping packet was sent round the ring to measure the total travel time of the packet. The total rounding time was under 2 seconds (this time there were no accurate measurements), which means that a pure robot network can achieve a considerably faster communication that a hybrid robot-cell phone network.

It is also important that the experiments were executed in a closed room with solid walls the diameter of which was less than ten meters that is each Bluetooth radio was within the coverage of all of the others. In spite of this closeness the possible interference did not corrupt the packets.

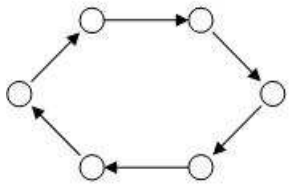

Fig. 4. The “ring” testing scenario of the autonomous mobile robots

3. Conclusions

Based on the experiments and reality tests above the next conclusions can be drawn:

- It is possible to realise a reliable and scalable Bluetooth communication network based on the NXT robot system either with the help of a conventional scatternet or a novel dual-radio based scatternet.
- The dual-radio based scatternet though more difficult to accomplish renders a much faster communication than the conventional one.
- It is possible to involve cell phones in the network of the mobile robots and the communication network is able to render a free messenger service for the cell phones.
- In the dual radio base scenario a simple ring topology can be used for broadcasting in the robot swarm.

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Physical Education and Sports Activities of University Students in the City of Slavonski Brod – Yesterday, Today and Tomorrow

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Abstract

The modern way of life entails many dangers, especially when young people (primarily students) are concerned. Therefore, Physical Education (PE) together with extracurricular activities can be just the right solution for all negative challenges of our time. It is worth mentioning that this year we celebrate the 30th anniversary of organised PE at the Mechanical Engineering Faculty of Slavonski Brod, J.J. University of Osijek. Furthermore, the Bologna process has raised many questions concerning standards of PE for approximately 2,000 students in the city of Slavonski Brod. There is also a need for building a sports hall, which could be used by all students of the M.E. Faculty and of the Polytechnic, because there are some indicators that these institutions might enrol even more students in the near future due to the fact that some new courses could be offered.

Keywords: kinesiology, students, Physical Education, sports activities, education

1. Introduction

The aim of this paper is to investigate the current position of Physical Education (PE) and sports activities of students in the city of Slavonski Brod. In order to do this, it is necessary to give the historic overview of the PE beginnings. Consequently, it is also necessary to give some guidelines for the possible growth and development of this extremely important segment of the educational system of the higher education institutions in the city of Slavonski Brod and Brod-Posavina County.

2. Physical Education – Historic Overview

The 30th anniversary of introducing Physical Education (PE) as a separate course at the M. E. Faculty of Slavonski Brod, the University of Osijek, is certainly a good reason for making this critical review of the last thirty years.

PE was introduced in the summer semester of the academic year 1979/80 for the students of the 1st and 2nd year. It was a legal obligation to introduce this course as obligatory, together with the extracurricular activities. This created a possibility for other students (from the 3rd and 4th year) to participate in kinesiologic activities. Based on their interests, the students could choose between numerous sports activities that were offered.

There were three institutions of higher education in the city of Slavonski Brod in the 1960's: Higher Commercial School, Pedagogical Academy and Mechanical Engineering Faculty. However, PE was not the obligatory part of the curriculum at that time, even though Pedagogical Academy educated PE teachers for primary schools.

During the sixties and seventies, there were numerous tests on the persons who could serve military (18-27 years), which showed the real motoric skills of the observed population. There was a need for neutralisation of these catastrophic results, due to the fact that these

young men were supposed to protect the country in the case of any danger.

Therefore, these tests were one of the main reasons for the introduction of PE at all levels of institutionalised education. Since PE was already part of the curriculum in the primary and secondary schools, the intention was to include PE in all institutions of higher education (polytechnics and faculties). Consequently, PE became obligatory at the University of Zagreb and at the University of Osijek in the 1970's. The fact that college sport was becoming more and more important also in other countries (especially in the USA, where college students often went to the Olympics) contributed greatly to the establishment of college sport and kinesiologic activities in our own country.

3. Physical Education Today

Good physical and mental health are the basic preconditions for all human activities. Hence, this area of education is vital in the education process for development of all anthropologic characteristics of the students. The main purpose of PE is to ensure development of the positive characteristics of each individual.

Nonetheless, we should keep in mind our present situation and the way we live. Our students are subjected to many harmful influences on a daily basis. All this is intensified by the dubious messages from different advertisements (TV, radio, newspapers), which do not always promote a healthy life style, e.g. beer and wine are represented as ingredients that have the nutritional value. The modern way of life and the adopted concept of consumer society offer young people (especially students) numerous ways of having good time. However, exercise is not the top priority for most of the young population, and it is often the case that some sort of unacceptable behaviour with extreme socio-pathological violence, which is accompanied by the use of narcotic substances and alcohol, may occur.

All this raises some very important questions from the kinesiologic point of view: What can be offered to the population of approximately 2,000 students in the city of Slavonski Brod? Which sports and extracurricular activities can satisfy the demands of these students, keeping in mind the fact that the necessary facilities (i.e. sports hall and equipment) do not exist at this moment?

Despite many difficulties, there are also some very good examples of how free time of the students can be creatively organised. STUDENT is the Sports Association which was founded on December 13, 1995 at the Mechanical Engineering Faculty of Slavonski Brod (J.J. Strossmayer University of Osijek). The aim of this Association is to promote college sports and to help improve the life quality of students. The members of this association can choose between various types of sports, e.g. soccer, basketball, athletics, rowing, hiking, chess, bowling and fitness. Significant results have been achieved during the last fourteen years: for example, the students won two times the indoor-soccer tournament at the University level (in 1996 and 1997), and currently there are two teams in the 2nd and 3rd League of the indoor-soccer (the city of Slavonski Brod). The rowing club participates at the regatta, which is organised each year for all the students of mechanical engineering in the Republic of Croatia. Furthermore, our volleyball team won the bronze medal at the Cup, which was organised by the newspaper *Glas Slavonije*.

College sport has a bright future, because there are more and more students in the city of Slavonski Brod each year. Beside the M. E. Faculty, there are two more institutions in our city: the Polytechnic of Slavonski Brod and the Teacher Training College. The representatives of all these institutions were part of the first sport competition of the academic community of the city of Slavonski Brod, which was organised in May (2009).

4. Conclusion – Suggestions for the Future

Although it is the 30th anniversary of PE at the M. E. Faculty of Slavonski Brod, the University of Osijek, there are still many problems in that area. These issues became even more apparent after the introduction of the Bologna process. This problem is worth dealing with, primarily because there are approximately 2,000 students in the city of Slavonski Brod.

The primary concern is the building of the new sports hall, which would be used for

PE and extracurricular activities of the students. This is indeed a necessity, since there are some indicators that the existing institutions of higher education will be organised as the University of Slavonski Brod, and that the new student campus will be built. We can only hope that this will happen in the near future, because that would be the perfect solution for the existing situation.

Nevertheless, this problem could be solved temporarily by allowing the students free access to one of the auxiliary sports halls in the new sports centre *Vijuš*.

In order to enrich extracurricular activities of the students, other sports associations (next to STUDENT) should be founded for each institution of higher education in the city of Slavonski Brod. The basic purpose of these associations would be promotion of sports and positive life values. After all, we all know a famous Latin quotation *mens sana in corpore sano* (a healthy mind in a healthy body).

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The model of the system for monitornig and team performance in a competive soccer game

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Abstract

The issues of monitoring and explicating the soccer-related phenomena make it necessary to create independent models that enable the objective scientific analysis of a soccer game. Therefore, it is necessary to construct such a model that will make it possible to objectively quantify the events, that is, the series of events in a soccer game.
The main aim of this paper is to establish the system for the objective scientific analysis of a soccer game. Furthermore, it was necessary to create a new assessment tool, which encompassed various procedures in which the list of variables was defined, as well as the evaluation criteria.
The play of a soccer team during attack is entirely described by a set of actions executed by the players on the field. Theoretically, the construction of such an assessment tool enables the monitoring and the analysis of the soccer game either on the basis of a set of discrete actions of players and the referee or on the basis of a set of events. Since a soccer game is designated as an actual space and time phenomenon of the set of actions, this phenomenon is theoretically open when the type of actions and their total number are in question. Each action may be described by a set of variables that portray all relevant play indicators.
The variables used to describe the events that occur during attack enable the selective application of parametric and non-parametric methods of data analysis. The non-parametric analyses will be used mostly for description and determination of relations between particular types of events based on the categories of games, team, type of player or field area. Based on the results in parametric variables, it is possible to carry out various multivariate correlation analyses in order to determine the latent components of the play, as well as the analysis of variance for determination of differences between the stratificationally defined groups.

Keywords: model, analysis, soccer, soccer team, players

INTRODUCTIONS

The probably exist no place on this planet where soccer is not played today. Competent sociological and kinesiological research studies will give their judgment on the phenomenon of soccer as sport No.1 in the world and of his popularity among huge numbers of people from all continents. However, what is in this moment definitely certain is the fact that soccer has a leading role in the sport community, and FIFA World Coup is the peak of interest of public throughout the world. The successes of the Croatian national soccer team have lately attracted the attention of the soccer public from all over the world, which is an illustrative proof that the small countries and small peoples may also largely contribute to the increase of the quality level of soccer play. Researches and numerous coaches who deal with kinesiology, that is, with soccer, have an outstanding role in this respect and they work dedicatedly on the improvement of the techniques and tactics of play and, consequently, on the improvement of the game itself.

The issues of monitoring and explicating the soccer-related phenomena make it necessary to create independent models that enable the objective scientific analysis of a soccer game. Such approach further makes it possible to systematically monitor and elucidate numerous occurrences in a soccer game that help to define this game both in kinesiological and in phenomenological sense as one of the most complex kinesiological activities that a contemporary man deals with. Particularly valuable for a research study are pieces of information that may be obtained from direct activity, especially during a soccer game. It, therefore, appears to be necessary to construct such a model that will make it possible to objectively quantify the events, that is, the series of events in a soccer game. This may be considered as an attempt to extract the maximal number of pieces of information, both as regard their quantity and as regards their quality, in the conditions

of a standardized video recording of a soccer game. Therefore, the intention of this paper was to offer a model that systematically, thoroughly and objectively enables the registration of the course of play. This will further make it possible for the experts, coaches and researcher to apply this assessment tool.

However, such identification of events is a source of many difficulties that are put before the researchers, because it is well known that a soccer game is held in the conditions that are characteristic for the functioning of a bipolar contact communications network (Gabrijelić, 1966; 1968; 1969). The aspiration to construct model that would be acceptable both to the researchers and to the experts who work on the field and yet that would be relatively simple to apply should not be neglected.

The play of a soccer team on attack is fully described by a set of actions of all players on the field. The set of actions is theoretically an open set as for the types of action and their total number since soccer game is categorized of an actual spatial and time phenomenon. In a theoretical approach the construction of an assessment tool enables the monitoring and the analysis of this actual phenomenon on the bases of a set of actions of players, and of the referee or on the basic of a set of events (Pavičić, 1991).

In the theoretical and in the scientific sense the contribution of this paper is reflected in the construction and validation of a new assessment tool or the analysis and evaluation of a soccer game, of players and of the whole team on attack. The practical significance of this paper is evident in the capacity of this assessment tool to accurately describe the play of a soccer team and of its players. Therefore, this paper is beneficial for practical work in top soccer, but not only in top soccer. The data presents in this paper may be applied in the following areas: planning and programming of the training process, selection in soccer, particularly in top soccer, analysis and development of game tactics, etc.

The attempts to identify the actual going-on in a soccer game, that is, in competitive conditions, area also present in other sports games. Naturally, we are taking about different aspects of monitoring and their interrelationships, but the data obtained on actual events on the field in such a way will undoubtedly help to elucidate numerous problems and to give answer to the questions characteristic for particular sport games. These research studies may be divided into those that are directed towards constructing the system for monitoring the game and into those that deal with the evaluation of the monitoring system itself, on the one hand, or on the other, with the analysis and evaluation of individual players and of the whole team.

In soccer the number of this type of research studies was particularly increased in the last decade. A soccer game and its analysis drew the attention of numerous authors who, often by means of video recording, identified and interpreted characteristics incidents in soccer. Throughout the world numerous research studies contributed to the comprehension and improvement of soccer. One of the events that are the meeting point of numerous scientists from all over the world is the *World Congress of Science and Soccer* that today has a ten-year-long tradition. One of the most important Conferences of this issue was held in Eindhoven in 1991.

At this conference Dufour (1991) presented an outstanding review in which he analyzed the physical activity of players, scrutinized the technical elements of play and carried out their quantitative analysis. He concluded that the phenomenological treatment is the only valuable approach to combine subjective interpretations and objective measurements.

One of the basis of a video recording of a game Gerish and Reichelt (1993) evaluated all situations in which player is in a duel with the opposing player. They determined the existence of the following categories: time, player, and zone of the field, winner in a duel (one-on-one play), fouls, and possession of the ball, intent-success and opponent. They emphasized the complexity of the collected material and necessity of freeing the coach from the burden of the multitude of data, thus giving him to prepare the diagrams that will point to important aspects.

Jinshan et al. (1991) analyzed in their paper the scoring of goals at the 14th FIFA Word Cup. For the purpose of the analysis of game development, the authors identified the sub-area of the field. Taking into account these sub-area and situation in the game they determined the development of the situation leading to scoring a goal with regard to the types of action and the sub-area of the field.

Bishovets et at. (1993) dealt with the computer analyzing of the effects of collective technical-tactical moves in the matches played at the Olympic Games and at the FIFA World Cup. The number of attacks, the zone of the field in which an attack occurred, the number of passes per game unit and the number of kicks directed towards the goal and towards their position were mentioned as the basic categories of the monitored variables. The authors concluded that the

data should be basis for programming the training process and thus also for the preparation of players.

In their paper Jerković and Bašić (1997) analyzed the influence of some situation-related parameters on successfulness in the final matches of the 1990 FIFA World Cup in Italy.

The purpose of Swalgin's research studies (1994, 1998) was to perfect the basketball evaluation system (BES), the computer model that evaluates the successfulness of a player in a match taking into account the playing position and the time spent in a game. The significance coefficient for the given set of criteria of efficiency was developed on the basis of a questionnaire circulated among the top coaches. The pondered factors were then incorporated in the original model in order to strengthen the validity of results obtained for the total efficacy.

In his book *Strukturalna analiza znanja u košarkaškoj igri [Structural analysis of knowledge in basketball]* Trnić (1996) focused on task set before the players in the game (79 task). These tasks were described by 15 basic and 8 specific attributes. The values according to individual attributes were obtained for the assessment of the knowledge acquisition level with ten qualified basketball experts. By means of factors analysis the author had identified four factors within the space of basic attributes that he called: inside players, the course of play, outside players and the court sub-area (C), whereas within the space of specific attributes he identified three factors that he named information-related components, energy-related component of intensity of play and socio-motor interaction. It was found that as entities, the task in the game provided both qualitatively and quantitatively exhaustive pieces of information about the total body of knowledge in basketball. The author concluded that the tactic of play is primarily reflected both by role and task assignment to individual players within the concept of play and by an arranged series of organized actions in all phases of the game. In their paper *Analiza stanja u košarkaškoj utakmici [The analysis of state in a basketball game]* Trninić et al. (1994) considered a basketball game to be a characteristic series of situations in the game. Parts of the game designated by common characteristics were labeled as the category *state of play* and the sequence of these states as the category *course of play.* A formal mathematical model for the description of the system "basketball game" was presented from the point of view of a kinematic description. In 1995 Trninić et al. carried out a research in which they isolated four relatively independent latent dimensions designed as: efficiency of the back-line players on defense and front-line players on offence, efficiency of front-line players on defend and the back-line players on offence, general efficiency on offence and efficiency of shooting at the basket from a distance. In their research on 70 basketball players Dizdar et al. (1997) obtained within the space of 13 standard indicators of situation-related efficiency four homogeneous groups defined as: group A – outside players, group B – players specialists, group C – polyvalent players and group D – inside players.

In his doctoral thesis *Kineziološka analiza tehničko-taktičkih sadržaja rukometne igre [Kinesiological analysis of technical-tactical contents in a handball game]* Vuleta (1997) constructed and validated the assessment tool for collecting the data on all technical- tactical elements of a handball game on the bases of a video recording. By analyzing the hierarchical clustering he determined the existence of the following four groups: (A) technical-tactical elements on attack without the ball, (B) technical-tactical elements on attack with the ball, (C) technical-tactical elements on defense and (D) technical-tactical elements of the goalkeeper. Additionally, the existence of hierarchical interrelationships between different technical-tactical elements as regards their contribution to success in the game was determined.

On the basic of monitoring and analyzing the efficiency of the opposing team Janković et al. (1991.) defined a model of play of the volleyball team "Phillips" for the final match of the European championship.

RESEARCH GOAL

The basic research goal was to devise a system for a subjective scientific analysis of team play on attack and to construct a new assessment tool. The construction of the assessment tool encompasses the procedures in which the list of variables comprising this tool is defined together with the definition of information bearers – entities, and with the description of the procedure or the protocol of measurement execution.

Each action be described by a set of variables that can be divided into groups: space – position in a sub-area of the court, time – absolute and relative time of play and phase of the game, tactics-execution of the set plan of play, biomechanics of movements within an action-description of the ways of action execution and

rules of the game-actions that are the consequence of the actions of a referee.

The basic hypothesis of the paper is that in soccer all important characteristics of play on attack, for example, tactics of play, phase of attack, team play efficiency, characteristics and capacities of a team as a whole, but also of each player individually, may, to a satisfactory set accuracy, be evaluated by means of the presented assessment tool.

The model must provide several basic hypotheses. Firstly, the distributions of each assessment tool variable may be approximated by one of the statistical distributions that enable a multivariate approach in data analysis. Secondly, the latent structure based on correlation between the variables will reflect the basic characteristics of play: continuous attack, counterattack and semi- counterattack. An assessment tool must be sensitive enough to differentiate between the teams in accord with the criterion of the sample selection in terms of the part of the whole which a group (team) is from and in congruence with the stratification criterion with regard types of players regarding the position in the game.

THE MODEL OF THE SYSTEM OF MONITORING THE GAME

The model is comprised of three units in which the following are determined: a) experimental procedure, b) entities on which the measurement were carried out and c) variables that describe the actions of entities.

Description of the experiment

Data collection implies the procedure in which an expert evaluates or measures each action of all players of each team, as well as the actions of the referee according to the video recording. Each action will be evaluated or measured by assigning the values to previously determined modalities of the variables on non-metric scales or as the measured result on real scales. The modalities of quantification of non-metric, nominal and ordinal scales were determined in advance by a detailed description. The procedure of data collection was planned in such a way as to enable the simplicity and objectivity of monitoring.

The events monitored are simple actions, and their registration does not, as arule, require a particularly high expert knowledge of a soccer game. This knowledge may be acquired by a short training. An event in a game is recorded in the specially constructed form (Figure 1) as a simple proof that a particular event had occurred. For the purpose of speed and accuracy all variables monitored are adapted, by means of the form and the way in which is used, to the aforementioned registration circumstances.

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Figure 1 about here

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Although the collection described in this paper is done on the basic of a video recording, the monitoring system was constructed in such a way as to maximally approach the conditions that make it possible to monitor the game at the moment at which it is held (live).

Entities

The set of entities, that is, of information bearers is comprised of actions executed during one attack. Each attack, as an entity, is determined by the sum total of all actions executed during one attack, that is, from the moment in which a team wins possession of the ball till the moment in which the team loses possession of the ball. The monitored entities comprise the statistical sample extracted from the set of attacks of all matches of the targeted population.

Variables

In data collection procedure in terms of attack in a soccer game each action will be described by a series of different characteristics, that is, modalities of these characteristics. Taking into account the type of characteristics the following groups may be listed: biomechanical characteristics, those characteristics that are the consequence of the application

of the rules of the game, spatial characteristics, types of player, course and tempo of play development, absolute and relative time of play, ball dribbling and ball passing, ball positions (across/on the surface, above the surface) and the outcome of an action. Each characteristic of play, as well as the corresponding modalities and potential values of characteristics or their quantification were accurately described. Quantification modalities in the variables designation particular characteristics are such that they may be reduced to either a nominal, an ordinal or proportional measurement scale. The variables describe all occurrences in a monitored game that

relate to the contact with the ball and are listed in a special way (Figure 1) in this order:

1. GAME denotes match identification according to the ordinal number of the game monitored [(1, 2, …, n), n = total number of games)].

2. ATTACK denotes the current monitoring of an attack performed by a team that has possession of the ball, that is, the ordinal number of an attack at a game [(1, 2, …, k), k = total number of attacks in a game.

The term ATTACK implies an action characterized by various characteristics that will be observed from the point of view of attack, which means that the course of the action till its completed will be recorded for the monitored team that has possession of the ball. If an action of a team that has possession of the ball is interrupted because of any reason, for example, because of losing the ball due to activities of the opposing players or due to action interruption by the referee, then the attack continues to be ˝ recorded ˝, however, this time it is the attack of the opposing team that is ˝ recorded ˝.

At least two contacts with the ball are required to commence the observation of the attack of a team. If only one contact with the ball is recorded, then such a situation is considered to be the one in which this action is interrupted by an opposing team. This action is not timed by using a stopwatch. In this way, for example, the monitored team A continues to keep possession of the ball, this team is still on attack, although the ball went out abounds due to the activity of opposing players. Such attack is, therefore, designed as medium-successful (M) and the attack executed by team A continues to be recorded. The relative time of attack is not interrupted.

3. ACTION NUMBER (ONACTION) denotes the total number of actions monitored previously.

4. ABSOLUTE TIME (ATIME) denotes the time when a team wins possession of the ball with regard to the beginning of the game.

5. RELATIVE TIME (RTIME) denotes only the time of the duration of the actual attack observed, that is, the duration of an attack from the moment of gaining possession of the ball till the moment of losing possession of the ball.

6. ACTIN denotes the basic unit of attack in the observed team. This term implies the activity of a play from the moment of receiving the ball, that is, of winning possession of the ball till the moment of passing the ball to a team-mate or shooting it at the goal, that is, till the interruption of this action either by a referee. All relevant characteristics of an action in a kinesiological activity such as soccer are regarded in this description, together with the assessment of its successfulness (16 variables that describe each action). In data collection about play on attack only those actions in which a player dribbles the ball will be observed. In other words, the main channel of interpersonal motor communication, that is, the direct moving of the player with the ball will be monitored. The description of activities comprising various actions on attack in soccer has the following modalities:

DS – passing the ball to a team- mate
OG – defense by a goalkeeper
PS – receiving the ball from a team-mate
GP – ball manipulation by a goalkeeper
PP – receiving and passing the ball
DP – winning possession of the ball by interception
VL – dribbling the ball
DO – winning possession of the ball by stealing it from the opponent
DR – maneuvering with the ball
PK – winning possession of the ball due to an incorrect pass by an opposing player receiving and passing the ball
UG – kick towards the goal
PKPP – winning possession of the ball due to an incorrect pass by an opposing player, receiving and passing the ball
VLDR – dribbling the ball, maneuvering with the ball
DPPP – winning possession of the ball by Interception, receiving and passing the ball

7. BODY

Regarding all characteristics of play, the biomechanical characteristics of activities of players in soccer are very complex and may be considered as a research object. Significant reduction of dada was made fore the purpose of collecting and quantifying play characteristics in this paper. This reduction was done primarily with reference to utilizing particular parts of the body for ball control, regardless of the

physical description of forces at work while performing particular movements. With regard to this approach at biomechanical characteristics are of the anatomical-topological character. BODY comprised the modalities that describe the following topological characteristics:

NH – leg, foot, middle of instep
NY – leg, foot, toes
NU – leg, foot, inside of the foot
NT – leg, lower leg (tibia)
NV – leg, foot, outside of the foot
NN – leg, upper leg (femur)
NP – leg, foot, heel
TR – trunk
NS – leg, foot, foot sole
GL – head

RU – hand (execution of a throw-in, goalkeeper

catching the ball, goalkeeper executing a goal

throw, goalkeeper handling the ball).

In order to record the more sophisticated differences between the players or between the teams the combinations of basic sings of manipulating the ball were also recorded. The combinations present in the game were, for example: leg, foot, outside of the foot – leg, foot, inside of the foot (NV – NU); leg, foot, middle of instep – leg, foot, outside of the foot (NH – NV); leg, foot, inside of the foot – leg, foot, sole of foot (NU – NS), that is, dribbling the ball with the outside and then with the inside of the foot, by the instep and then by outside of the foot, inside of the foot and then by the sole of the foot; leg, foot, outside of the foot – leg , foot, inside of the foot (NV – NU), leg, foot, middle of instep – leg, foot, inside of the foot (NH – NV), leg, foot, inside of the foot – leg, foot, sole of foot (NU – NS), leg, foot, outside of the foot – leg, foot, middle of instep (NV – NH), leg, foot, middle of instep - leg, foot, outside of the foot (NH – NV) and leg, foot, outside of the foot - leg, foot, sole of foot (NV – NS).

8. SPACE

A soccer field is divided with regard to the vertical axis (V) that passes through the centre of the both goals and with regard to the horizontal axis (H) that is parallel with the centre line (Figure 2)

Figure 2 about here

With reference to the vertical axis the soccer field is further divided in central area ranging between the lines that pass trough the vertical line of penalty area, and left and right sub – area of the filed that is on one side border by the middle (central) sub – area (midfield) and on the border of the sideline. With reference to the horizontal axis the field is divided in six parts. All lines are parallel with the axis that passes through the center line and are set with regard to visual clues on the field, the perimeters being the goal line and the 11m line (1), then the 11m and the 25m line (2), and the 25m line and the center line (3).

These sub – areas extended symmetrically on both sides of the field, that is, they extend across the front field and across the back field. The midfield (central) area implies that the opponent's half of the field that comprises the area is bordered by the centre line and the team's own goal line. Such division with regard to the vertical and with regard to the horizontal axis produced 18 sub – areas of the field that are significant as regards the functional sense of the development of play on attack.

For example, the sub – area PGL (front field – goal area – left) denotes that part of the field that is bordered by the left vertical axes and the side line and by the horizontal 11m line and the goal line (K) within the half of the field that belongs to the team that is defending itself, namely, the sub – area PGL denotes the front field. The sub – area ZCD (back field – centre – right) is border by the right vertical axis, and by the sideline on its right and by the horizontal axis that passes through the centre line and the 25m line within the half of the field that belong to the team that is on attack, that is, the sub – area ZCD denotes the back field. The sub – area PPD (front field – penalty kick line – right) is bordered by the right vertical axis of the penalty area and the right side line and by horizontal axes, one being the 11m line and the other the 25m line.

9. BALL (PBALL; VBALL; DBALL)

All movements of players for purpose of advancing (running with) the ball such as dribbling the ball and passing the ball are very different as regards the fact whether the ball is on the surface or above the surface. In order to register these characteristics the variable PBALL that denotes the position of the ball with regard to surface was defined. This variable comprised the following modalities:

P – across/on the surface
I – above the surface, as well as the combination
IP.

Dribbling the ball (VBALL) and pressing the ball (DBALL) were classified with regard to the length expressed in meters:

K – short, 5 – 6 meters
S – medium, up to 25 meters
D – long, more than 25 meters.

10. COURSE OF PLAY

Actions taken by referee are always present in game. He sanctions the actions by strictly abiding by the rules of the game. These characteristics as regards the development of play may be divided in those actions that occur during the 'normal' course of the play and in those that are the consequence of play interruption, that is, the interruption by the referee in congruence with soccer rules. Thus the characteristics of actions such as passes or kicks have following modulates:

NO – normal course of play, meaning that there are no play interruptions, that is, that play is continuous without any interruptions by the referee. The actions that are result of the referee's interruption due to any violations or due to officiating in the game in accord with the rules of the game have the following modalities:
PN – commencement of attack – denotes the situations when attack commences at the beginning of the game, at beginning of the second half, at the beginning of each extra time or after the referees throw.
FD – foul, direct kick
FI – foul, indirect kick or pass

FP – penalty kick

LA – the ball is out of bounds – throw – in

UH – direct kick after handling the ball bay an opposing player

LK – the ball is out of bounds – corner kick

OF – illegal position – offside position
GA – the ball is out of bounds – goal kick

PN – denotes those situations when the attack commences at the beginning of the game, at the beginning of the second half and at the beginning of an extra time, after goal scored and after the referee's throw.

11. PLAYER

A soccer team consists of 11 players on the field and each one of team can have his special role in play. For the purpose of data collection and quantification a team is divided into the following types of players:

GO – goalkeeper	VE – midfield player
OS – inside defender	NS – inside forward
Ob – outside defender	NB – outside forward

Such classification of players basically corresponds with a more rough division done by Barišić (1996). According to his division a team is comprised of 1) goalkeeper and 2) players on the field. However, in this paper a player is designated according to the current role he has in particular action carried out on the field and not according to his strategic role determined advance by the coach or by number worn on the jersey. A midfield player (VE) may thus find himself in the role of the outside forward (NB) or of the inside defender

(OS), depending on the given situation and current situation on the field. Likewise, the inside defender (OS) may find himself in role of the inside forward and score a goal.

12. PHASE OF ATTACK

One of the subjects of analysis in this paper is the phase of play on attack. With regard to the sub – area of the field and the types of actions, the attack of a team is basically comprised of three phases:

FO – the phase of attack commencement

FS – middle phase

FZ – final phase

It is also possible that one of the phases be omitted. This depends on type of attack.

13. TAYPE OF ATTACK

With regard to the tempo of attack development the following classification may be made:

TO – continuous attack

TK – counterattack

TP semi – counterattack

14. OUTCOME

This variable implies the successfulness of execution of each of the observed actions. Generally, the outcome of an action may be either successful. As for actions, three different types of outcome at the most may be recorded. These modalities of the outcome regardless of the action will be determined by the following symbols designating various outcomes:

U – successful

M – medium – successful

N – unsuccessful

The outcome evaluation may, therefore, have several modalities. In congruence with these modalities possible outcomes may be determined for various actions in the following way, for example, a kick towards the goal (UG) can be designated as:

U – a goal scored

M – the ball is kicked the goal and reaches the area immediately in front of the goal (goalposts pr the crossbar) and, for example, the goalkeeper defends the goal, or one of the players of the defending team strikes the ball away from the goal, etc.

N – the ball passes near goal and across the goal line into the out – of – bounds area.

To describe the passes to a team – mate (DS) the following outcomes are possible
:

U – successful, that is the ball passed to a team – mate

M – medium – successful (the ball is passed to a team – mate in such way that he must put in additional effort to keep possession of the ball, for example, when the opposing player briefly, by touching the ball once, interrupts the attack, that is, the attack is re – established)

N – unsuccessful (the ball is either directed across the boundaries of the field into the out – of – bounds area or it is passed to the opposing player).

When dribbling the ball (VL), the possible outcomes are:

U – successful dribbling

N – unsuccessful dribbling, a player controls the ball poorly until he finally loses possession of the ball

DISCUSSION

The only possible outcome when receiving the ball (PS) and when possession of the ball (DO, DP) is denoted as successful, since other outcomes in the aforementioned types of actions are excluded. For example, if a player receives a pass unsuccessfully it is considered as an unsuccessful pass and the end of attack executed by the monitored team.

If the game is observed from the aspect of an individual player the variable ACTION
(6) gives an accurate insight into the structure of basic elements of the soccer game. On the basis of these perceptions conclusions can be made that are important for structuring of the training process in terms of giving considerable importance to some elements in the structure of play, but also to creating

the tactics of play a team. The variable SPACE (8) is particularly important for analyzing a particular team, because it illustrates the good and the bad points of team, that is, the good and the bad points of an individual player, on basis of the frequency of contacts with the ball (actions) in certain subspaces. For example, a good forward on team may be spotted immediately due to the significantly increased frequency of actions in his responsibility zone. Besides, this variable provides the insight into the total distribution of contacts with the ball or actions on the field during the game.

Subsequently, this supplies the basics for planning and creating a team with regard to the technical – tactical capacities of players and their importance for resolving certain situations in the play. The variables DBALL and VBALL (9) are used in the model to record the types of communication between the players (DBALL), and the variable VBALL to denote the ways of occupying the space on the field and the dominance of some modalities (short pass, medium pass, long pass). Eventually, this is connected with the tactics – related concept of the play with regard to positioning of players on the field (e.g. 3 – 5 – 2, 4 – 4 – 2, etc.). The variable PLAYER (11) is included in the model in order to identify, that is, to analyze the positioning of players on a team as regards their primary role in the game.

It should be said that this relates to that portion of activity during the game that is manifested through the direct contact with the ball. In terms of successfulness, the outcome of an action was designated in such a way as to cover all types of actions. Thus the successfulness level of passing the ball and dribbling the ball that make up the communication between the payers, on the one hand, and the successfulness of realization of kicks directed towards the goal on the other are recorded. This also relates to all other actions. This variable, connected with other variables that are being monitored and recorded gives an accurate insight into the successfulness of players and the successfulness of teams. The presence of this variable in the model significantly contributes to the sophistication – level pf play analysis.

The variables describing the events occurring on attack enable a selective application of parametric and non – parametric methods of data analysis. In further research the non – parametric analyses will mostly be used to describe and to determine the interrelationship between different types of events on the field with regard to the game categories, with regard to team, to the type of players or to the area of the field.

On the basis of results in parametric variables various types of multivariate correlation analyses may be employed to identify the latent components of play. Likewise, the analysis of variance may be employed to determine the differences between the stratification-ally defined

groups from different parts of the world. In this sense, standard algorithms and multivariate data analysis methods such as factor analysis under the component model, multiple regression analyses, canonical discriminated analyses and the multivariate analyses of variance may also be employed.

CONCLUSION

In this paper a model for the systematic and consistent monitoring of events in a soccer game was presented by describing the experimental procedure, by determining the categories of entities and by determining the list of variables.

The entity is the phase of play on attack. The results in the variables were expressed on normal, ordinal and proportional measurement scales. Modalities of possible results were accurately determined for all variables of the nominal and of the ordinal type. Appropriate transformations of original variables (nominal and ordinal) made it possible to apply standard multivariate statistical algorithms.

The assessment tool described in this model represents a complete system for monitoring, that is, for registration of the soccer game. Due to its relative simplicity this assessment tool may be used by various experts – coaches and researches. This is the reason why it may be assumed that this model will, provided it is more widely used; significantly contribute to the development of soccer both in the process of programming and planning the training process and improving the tactics of the game.

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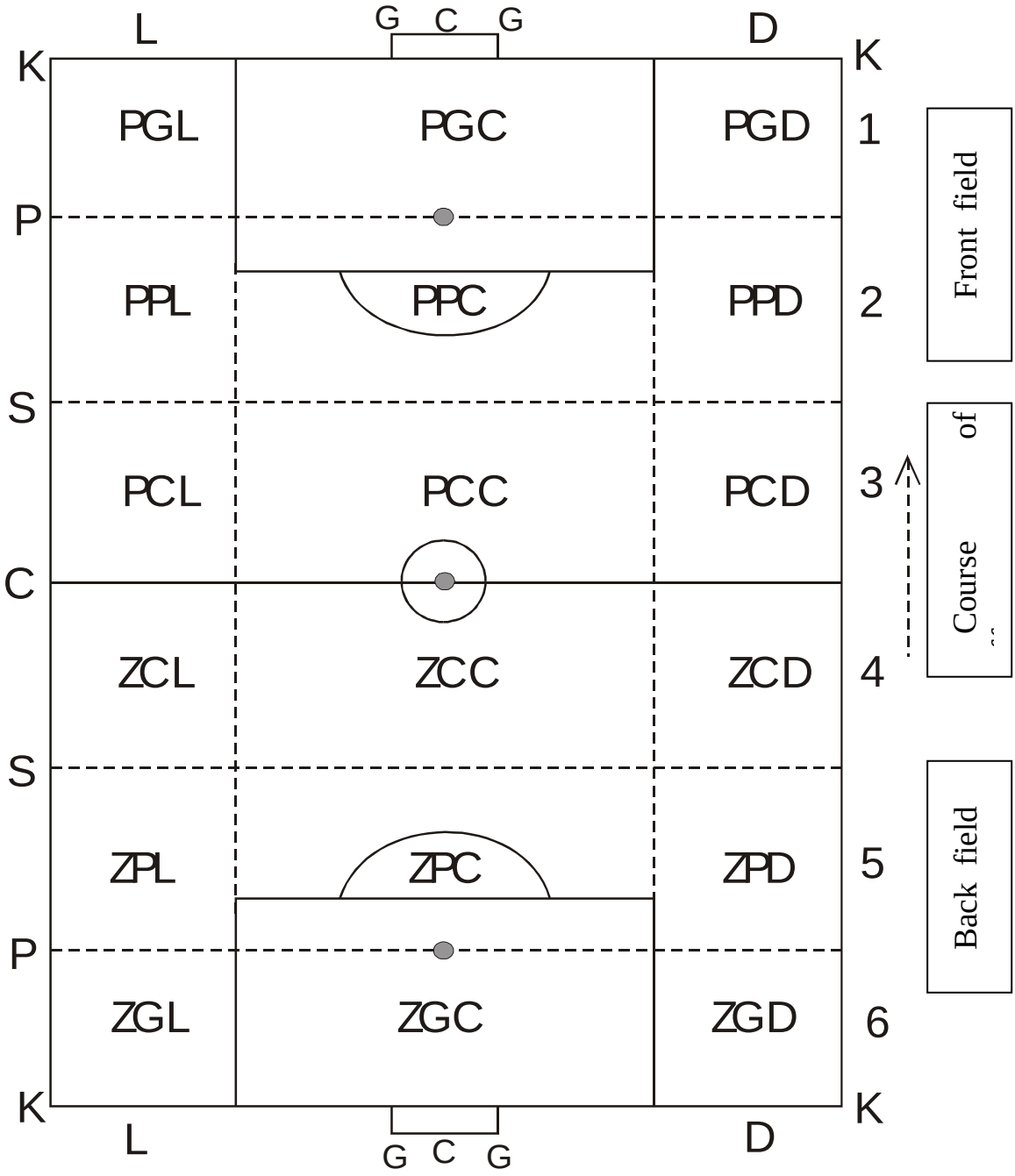
Pic. 2 – Marks of subspace



Legend:

L – left
D – right
K – goal line
P – penalty kick line
S – middle
C – central position
GCG – goal-centre-goal
PGL – front field-goal area-left
PGC – front field-goal area-centre
PGD – front field-goal area-right
PPL – front field-penalty kick line-left
PPC – front field-penalty kick line-centre
PPD – front field-penalty kick line-right
PCL – front field-centre left
PCC – front field-centre-centre
PCD – front field-centre-right
ZCL – back field-centre-left
ZCC – back field-centre-centre
ZCD – back field-centre-right
ZPL – back field-penalty kick line-left
ZPC – back field-penalty kick line-centre
ZPD – back field-penalty kick line-right
ZGL – back field-goal area-left
ZGC – back field-goal area-centre
ZGD – back field-goal area-right

Form for collecting and input of data

GAME	ATTACK	F.NUM.OF ACTION	ATIME	RTIME	ACTION	BODY	SPACE	PBALL	DBALL	VBALL	COURSE	PLAYER	PHASE	TYPE	OUTCOME

Pic. 1 – Demonstration of a form for data input

Visualization of Solved Problem at the Kinematic Analysis of Mechanism

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Abstract

The article deals with the visualization of solved problem at the teaching of the subject Technical mechanics - strictly speaking at kinematic analysis of individual mechanism components. Visualization by means of virtual 3D models and assemblies serves as support equipment for education. The contribution shows on possibility of CAD/CAM system utilization within subjects, which unrelated with modelling at the first side. Virtual presentation can be part of electronic scripts in PDF format, what enables to students not only the better visualisation of the created part in the choosing CAD system, but the possibility to obtain the geometrical data of the object without their description in the scripts.

Keywords: Visualization; 3D model; Mechanism; Education; CAD/CAM system

1. Introduction

The quality of academic study in complex form is based on the knowledge of high and grammar-school leavers, which usually aren´t on the same level.

Most of the leavers come at the technical universities without the idea about terms connected with the application of mechanics in practice. Students are already forced to work with these terms and theories in 1st year of academic study.

In despite of that working out and understanding of theoretical basis of mechanics laws is essential assumptions of education in today conditions, on the other hand the demonstration of practical application of obtained theoretical knowledge is missing. There are not used available instruments and computer aid in education process in the regard to the visualisation of problems and achieved results of research. Some types of problem solving (for example graphical solution) are inaccurate and non-aktual in today digital age. Therefore it is necessary the classical, well-tested approaches to supplement update and adapt to modern trends and possibilities. One of the tools that enables to students the accessing and visualisation of problems is CAD/CAM system Pro/Engineer.

At the problem solution in the scope of education process it is very important for student to understand the goal of task to which the student has to arrive. Kinematics analysis of mechanical assemblies is one of the difficulties which students meet during their studies of Mechanical Engineering, concrete Technical Mechanics. On the basis of kinematics scheme students has to determinate what type of the motion execute individual components (points), whether it is translate, rotate or general motion.

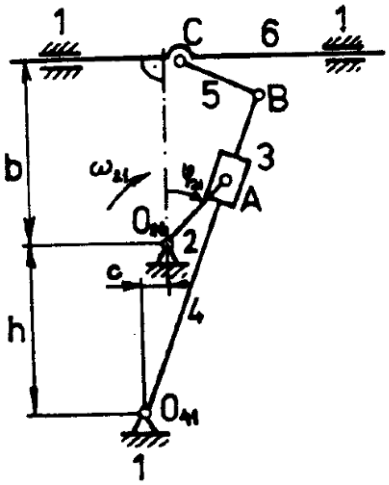
2. Mechanism in education - problem definition

In the past various dummy models were used for the verification of suggested design, dimensions and part activities. Models were labour and long time built in scale. These dummies were static, they express only the shape and model properties in specific time without reference to outer environment influence and so they seldom adequately reflect the real situation. The evolution in the computer field becomes milestone for the work enhancement of designers and technologists. Computer design is very substantial and effective tool today that enables not only model creation in virtual 3-dimensional space, but allows the

visualisation of its operating during time interval with possibility to simulate various outdoor influences. [3]

3D models are used in all industry sectors at the simulation of real situation and in education, too, so they can aid the subjects, which don´t relate with 3D modelling at the first sight. One of these subjects on FMT TU Košice with a seat in Prešov is Technical mechanics. The students meet with kinematic analysis of mechanical systems components; they solve the tasks by graphical and analytical manner within lesson of Technical Mechanics. Their task is to execute the kinematics analysis and on the basis of input data to determine the velocity or acceleration of output component. The process of solution can be for students difficult and often impossible, if they don´t understand what they do and how mechanism is running.

On Fig. 1 is shown the example of the kinematics scheme that students see at the table or in their exercise-book. It is a skeleton of real existing shanking machine.



Obr.1. Kinematic scheme of mechanism

The kinematics scheme as a form, in which mechanism is sketched, is for most of students by unknown field. They don´t know to define the type of motion of individual mechanism members connected each other by so called “kinematics join”.

These lines, triangles and other schemas on the Figure above are for students only primitive pictures, but they don´t know to imagine the real mechanism and the motion of its individual components, too. So it is important for the teacher to bring near situation to students. Significant tools for explaining of mechanism motion in the education process today are visualisation and simulation.

The principles of simulation are supported by various software products, which can be on different stages according to the level of software processing. The degree of approximation to the real situation is higher at the difficulty systems as at the simple software, what increases the demands for hardware. Therefore it is important to correctly choose the simulation tool so as it doesn’t over-price the manufacturing, but so as the achieved results accordingly correspond to the specified conditions on the other hand.

2. Mechanism in education - problem solution

The environment of CAD/CAM systems allows the creating of static and kinematic joints between individual components with the next possibility to execute the kinematic and dynamic analysis. In such prepared mechanism it is possible to simulate the assembly motion as a whole and so to put near to students the most real image not only of mechanism, but the complete action, too.

Kinematic scheme of mechanism showed on the Fig.1 serves as the basis for preparation of 3D model of mechanism in CAD/CAM system Pro/Engineer, showed on the Fig.2.

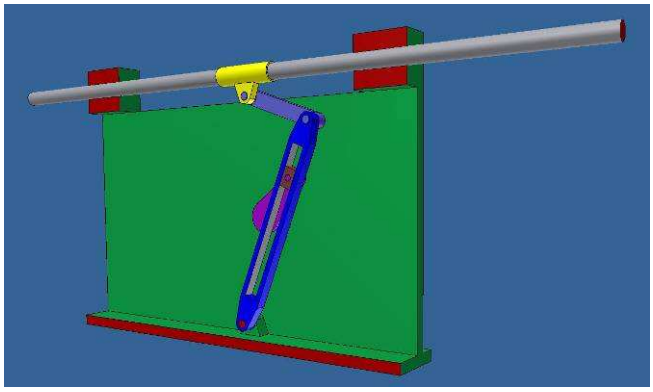


Fig.2. Mechanism modelled in CAD/CAM system Pro/Enginneer

The simulation tools of Pro/Engineer system belong in the software, which are suitable for the analysis and the control rationalization of complicated processes. Its module Mechanism Design Extension (MDX) provides engineers within the product development process to perform the kinematic motion simulation and behavioural insight into the assembly through the easy definition and animation of connections with Pro/ENGINEER, such as pin joints,

ball joints, sliders and other. These connections, and resulting assembly constraints, facilitate the easy assembly of closed loop systems. They can be used compatibly and in combination with packaging and traditional Pro/Engineer constraints like mate, align insert, offset and so on. [1]

Once assembled, engineers can observe how their mechanism designs will behave geometrically through interactive part dragging and user-defined motion simulations. Any point on a mechanism assembly can be dragged interactively by the user to animate the mechanism. Predefined motion simulations, using drivers to simulate motors or actuators, also provide animation. Mechanism Design is a powerful design tool enabling engineers to create industry-best mechanism designs by clearly building and communicating "design intent" into mechanism assemblies and subassemblies.

If students understand motion principles and learn the basic techniques of solution, they can simply and relative quickly to solve the problem and give the answer about speed or acceleration of output unit. At the graphical solution is used scale for individual kinematics parameters and by means of vectors can be result achieved. The graphical method of the mechanism solution showed on the Fig.1 and Fig.2 is designed on the Fig.3.

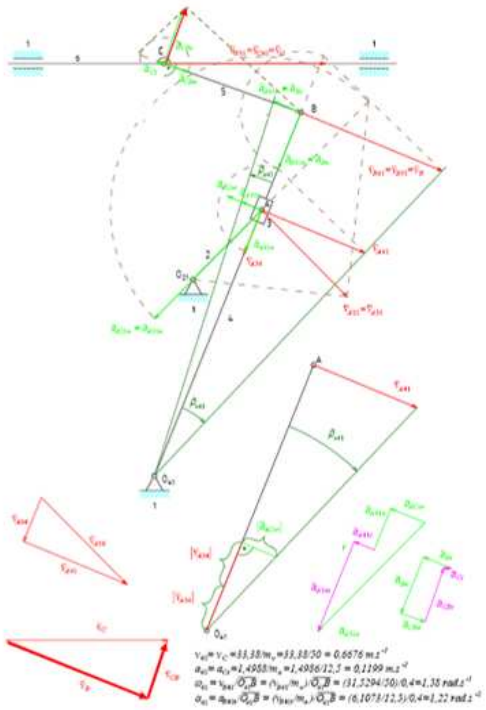


Fig. 2. Graphical solution of mechanism

If the students could use the CAD/CAM system, they could solve following types of tasks within the virtual modelling:

- Static tasks: serves for approximate dimensioning of drive and mechanical robot parts; mathematically there are solved the algebraic equations.
- Kinematic task: direct or inverse kinematic task, trajectory generating – solution of algebraic nonlinear equations, eventually transcendent equations,
- Dynamic tasks: there are solved the inertial effect of mechanical parts by means of system of nonlinear differential equations; at inverse task by means of nonlinear algebraic equations,
- At the defining of material characteristics it is possible very simple (on one click) to detect the geometric and integral characteristics of individual mechanism components (weight, moments of inertia, deviation moments, centre of gravity position,...), the calculation of which would be in many cases very difficult
- The suggestion of drivers on the basis of knowledge about needed force and velocity, respectively on the basis of knowledge about moment and angular velocity, it is possible to select or construct suitable driver (engine or gear box)
- Strength analysis: serves for the dimensioning of individual parts of construction for example by means of FEM method. The part is object that stands alone in this method; the mechanical properties are monitored and evaluated in specific time. On the other hand the MMS method considers the component as a part of system and during the analysis the forces are monitored, which act on every parts of assembly, in the joints and in connections.

Other advantages of virtual presentation are:

- Simple editing and very quickly actualization of concrete mechanisms
- Construction mistakes elimination
- The utilisation of the object in the assembly allows detecting the conflicts with other

components not only in static, but in kinematics state, too, so in marginal constrains of the motion.

- Reutilization of existing solution
- Models in virtual form are 3-dimensional what enables to obtain more complexly image about real object (the possibility to show mechanism detail)
- The possibility to define extreme position of individual mechanism components not to come to collisions.

One of the next advantages of 3D models presentation is possibility to prepare electronic schoolbooks and scripts with interactive 3D models. Today forms of electronic documentation enable to put in electronic scripts 3D models instead of classic pictures. It raises effectivity of education with the possibility to roll up the object to various views without the necessity to buy of expensive CAD software. One of such formats is PDF format that provides the wide scale of set up possibilities for result document properties and so the transferred document always very exactly adapts to the using purpose.

Software Acrobat 3D in version 8 provides the possibility of 3D sight, without the difference of CAD application in which software was created. Through the software Adobe Reader students and other users can rotate 3D objects to reach sufficient overview about model. They can check the model display, detect model dimensions, they can make cross section and execute other activities connected with 3D model.

Acrobat 3D supports conversion to 3D PDF from over 40 formats, including those for Autodesk Inventor, Dassault Systemes CATIA, PTC Pro/ENGINEER, SolidWorks, and UGS NX and I-deas. [4]

4. Conclusions

The term "virtual representation" becomes part of life of scientific workers, engineers and common users. The word "virtual" means something fictive, for example modelled by computers. [2]

The industry development is stimulated today by competitive fight and by the increasing of technical level of new suggested design, therefore the utilization of computers becomes necessity. There is tendency to reduce the advance working time (within design, technological and project manufacturing preparation) and flexible producer reaction on varied market requirements results from it. The using of computer equipment has direct influence on the time for product location to market and for the product price, too, which depends on the whole charges. Exigencies on exactness, mainly on the information completeness about part, increase substantially. It would be operated safely and failure free.

By means of virtual model it is possible to reduce this time considerably. The simulation model allows to realize the complicated processes through the use of computer in a while, which take weeks, months, or years in real time, and it represents the ideal tool for the aid and the deciding on the various levels of the manufacturing. This model allows identifying of the problematical points of the project, to determine the main risks of work, etc., too. [5]

3D models as simulation equipments present complete series of impulses for theoretic study and consequently they are instruments for the problems solution in many branches of science and practice. The geometry created in 3D CAD system can be used not only for simulation, but for the various types of analysis, for technological accounts and for NC program creation, too, such that the production become more effective from the view of time and economy.

On the other hand simulation is not "panacea" for all problems. There are problems, when it is better to apply other, cheaper tool of problem solution, when the simulation appears as few effective. Even though the additions of 3D models using within the simulation several times exceeds the costs for simulation project. That is why the simulation can be considered one of most effective tool for decision and solution testing.

Even though the virtual simulation of mechanism has fixed place in engineering practice, it seldom satisfy to real conditions due to outside and inside influences, which can be predicted and defined very difficult. Therefore it is necessary to deliberate influences and results multiply by surety factor. In various phases of real prototype suggestion are used 3D models created on different stages of precision and approximation so to be whole process effective.

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Outputs of International Project on Inter-Countries Research for Manufacturing Advancement

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Abstract

The international project Inter-countries Research for Manufacturing Advancement - IRMA is focused on the realization of a research and comparative analysis in the 27 European Union's states, aimed at promotion of excellence and efficiency of the instruction in higher education institutions. Realization of the IRMA project is oriented on the manufacturing engineering field, taken into consideration its high level of innovation and fast changes in requirements that students must possess, in order to be adapt and competitive on the labour market. The objectives of the IRMA project is to innovate and to improve educational systems of technical universities at European level, in order to offer to students a competitive environment based on innovative teaching methods, instruments and contents.

Keywords: manufacturing advancement, lifelong learning program, international project

1. Introduction

Manufacturing engineering is a relatively new term applied to some aspects of planning and control of manufacturing; it is a service function to the production department. Manufacturing engineering as a planning activity takes place between product design and the planning of the overall manufacturing process. Manufacturing, in its broadest sense, is the process of converting raw materials into products. It encompasses: the design of the product, the selection of raw materials, and the sequence of processes through which the product will be manufactured. Manufacturing engineering includes product design and manufacturing system design as well as operation of the factory. More specifically, manufacturing engineering involves the analysis and modification of product designs so as to assure manufacturability, the design, selection, specification, and optimization of the required equipment, tooling, processes and operations: and the determination of other technical matters required to make a given product according to the desired volume, timetable, cost, quality level and other specifications [1].

Research analysis in the IRMA project was realized in time of second phase of project realization from July 2008 to February 2009. The main tasks of this phase were preparation of document "IRMA Research Analysis Format" by every IRMA project partner and IRMA subcontractor. Research analysis was realized in the all 27 European Union's member states. Research analysis format was oriented to problems of general analysis of the manufacturing engineering sector in every country of European Union, preparation of design the IRMA model by realization of SWOT (Strengths - Weaknesses - Opportunities - Threats) analysis of manufacturing engineering area in every country of European Union, description of trends and main indicators in the manufacturing engineering in states of European Union, analysis of situation in area of manufacturing engineering specialists preparation by higher education institutions in states of European Union and presentation of the best practices from manufacturing engineering area in every country of European Union. These documents with IRMA Research Analysis Format from all countries of European Union are available for all person interested on the Lifelong Learning Manufacturing Portal - LLMP (www.irmaproject.eu).

2. Manufacturing engineering area

Manufacturing engineering involves the analysis and modification of product designs so as to assure manufacturability, the design, selection, specification, and optimization of the required equipment, tooling, processes and operations: and the determination of other technical matters required to make a given product according to the desired volume, timetable, cost, quality level and other specifications. Manufacturing engineering is a relatively new term applied to some aspects of planning and control of manufacturing; it is a service function to the production department. Manufacturing engineering as a planning activity takes place between product design and the planning of the overall manufacturing process. Overall manufacturing planning is usually considered within the profession of industrial engineering. But in attitudes of greater specialization, manufacturing engineering may be considered a separate profession closely allied to industrial engineering [5].

Manufacturing, in its broadest sense, is the process of converting raw materials into products. It encompasses (l) the design of the product, (2) the selection of raw materials, and (3) the sequence of processes through which the product will be manufactured.

Manufacturing activities must be responsive to several demands and trends [6]:

1. A product must fully meet design requirements and product specifications and standards.
2. A product must be manufactured by the most environmentally friendly and economical methods.
3. Quality must be built into the product at each stage, from design to assembly, rather than tested in after the product is made. Furthermore, the level of quality should be appropriate to the product's use.
4. In a highly competitive environment, production methods must be flexible enough to respond to changes in market demands, types of products, production rates, production quantities, and on-time delivery requirements.
5. New developments in materials, production methods, and computer integration of both technological and managerial activities in a manufacturing organization must constantly be evaluated with a view to their appropriate, timely, and economical implementation.
6. Manufacturing activities must be viewed as a large system, the parts of which are interrelated. Such systems can now be modeled, in order to study the effect of factors such as changes in market demands, product design, and materials. Various other factors and production methods affect product quality and cost.
7. A manufacturing organization must constantly strive for higher levels of quality and productivity (defined as the optimum use of all its resources: materials, machines, energy, capital, labor, and technology). Output per employee per hour in all phases must be maximized. Zero-based part rejection (and consequent reduction of waste) are also an integral aspect of productivity.

3. Analysis of the Current Situation in Manufacturing Engineering Area

Manufacturing engineering is a relatively new term applied to some aspects of planning and control of manufacturing; it is a service function to the production department. Manufacturing engineering as a planning activity takes place between product design and the planning of the overall manufacturing process. Manufacturing, in its broadest sense, is the process of converting raw materials into products. It encompasses: the design of the product, the selection of raw materials, and the sequence of processes through which the product will be manufactured. Manufacturing engineering includes product design and manufacturing system design as well as operation of the factory. More specifically, manufacturing engineering involves the analysis and modification of product designs so as to assure manufacturability, the design, selection, specification, and optimization of the required equipment, tooling, processes and operations: and the determination of other technical matters required to make a given product according to the desired volume, timetable, cost, quality level and other specifications.

On the base of realized research in project IRMA in the area of manufacturing engineering it is possible to collect recent outputs and analyses of the current situation in three main areas of IRMA project interest: universities, enterprises and intermediaries.

Following section consist of some basic views into areas that are specified via project indicators. Some graphs are directly rewriting database outputs, some were created as junction of results taken from more output values. For more detail or some specific results, the particular section of database needs to be accessed. User of the database has an option to access the results after selecting of desired criteria in complex form. Views can be made with filtering per countries, genders, levels of study, etc. Output values are readable in exact amounts of respondents or in their percentage rate. Among the project indicators, following were selected as the ones that can be generalized without loss of expression value [3]:

1. *Qualitative level of teaching in higher education institutions.* As the quality of teaching is intimately related to readiness of graduates to become a functional and reliable part of real praxis, research in this area provides the answer to the question about possibility of improving the quality of teaching in higher educational institution in the frame of relationship consisting out of three parties – universities, enterprises and intermediaries. It indicates the cooperation between them on particular levels expressed through the numbers of respondents.

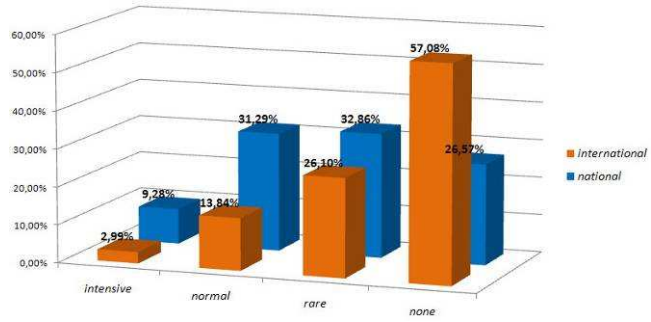

Fig. 1 Cooperation between Universities and Enterprises

Research proves that very low percent of enterprises has serious cooperation with university. More companies should be involved in such cooperation, what would increase the quality of teaching by bringing it closer to praxis.

Another figure shows that only three percent of respondents think that current university structure is suitable. 70% of respondents would like current university structures to be changed in order to be better designed for technology transfer.

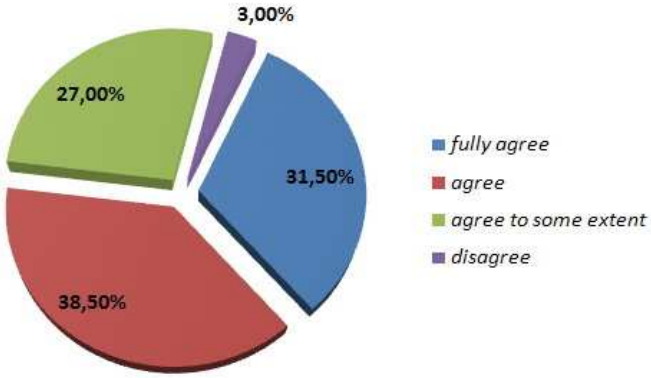

Fig. 2 Organization of cooperation between Universities and Enterprises

2. *Innovation level of teaching in higher education.* Level of innovation is important from the view of increasing the quality of education with respect to the knowledge oriented for use in future. As shown in Fig. 3, over 80% of universities use modern SW technologies on sufficient level. At the same time Fig. 4 shows, that over 70% of companies agree with necessity for involving the universities also into programs for supporting the start-up business or for enhancement of the one that is already running.

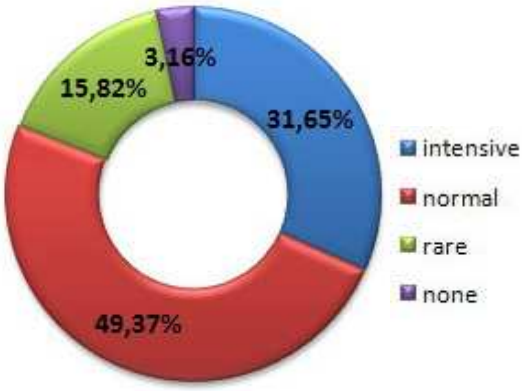

Fig. 3 Use of modern SW technologies

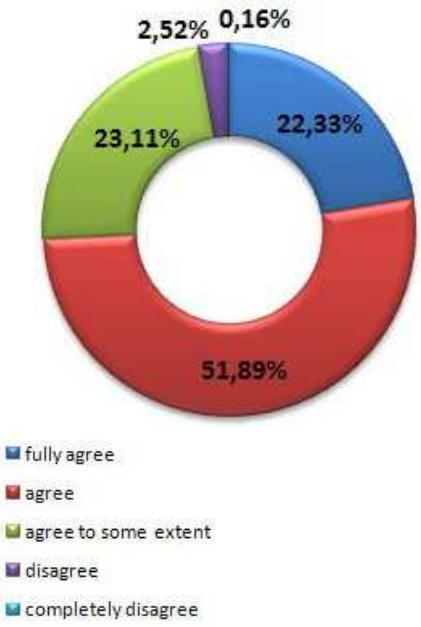

Fig. 4 Need for higher involvement of universities

Universities themselves are obviously working right, but they need to become more involved into life of enterprises in order to provide students with more innovative system of educational process.

3. *Quantitative level of students in manufacturing engineering area.* This indicator is readable from following graph, that shows that only 16% of responding universities have more than 30% of their students oriented to sector of Manufacturing Engineering.

Changing of these proportions is independently relevant in each country, detail opinions can be made after closer access to database results

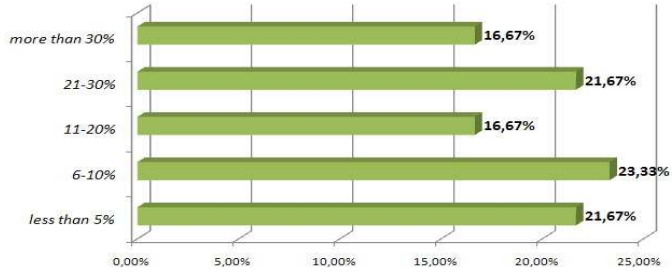

Fig. 5 Percentage of students doing their studies in Manufacturing Engineering sector

4. *Rate of scholastic defection, preventive actions of scholastic defection.* Fig. 6 shows the rate of scholastic defection for both bachelor and engineer studies. It is obvious and understandable that higher general defection can be recognized in bachelor level of study, where still over 20% of responding universities have 50% of their students not completing their studies. On the other hand only up to 30% of students on engineering level do not complete the study according to 90% of respondents.

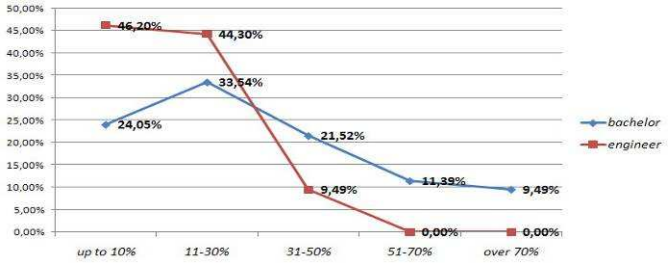

Fig. 6 Rate of scholastic defection

Reasons for scholastic defection can be various, Fig. 7 shows their percentage allocation. The lowest amount of respondents selected as defection reason the subject of study itself.

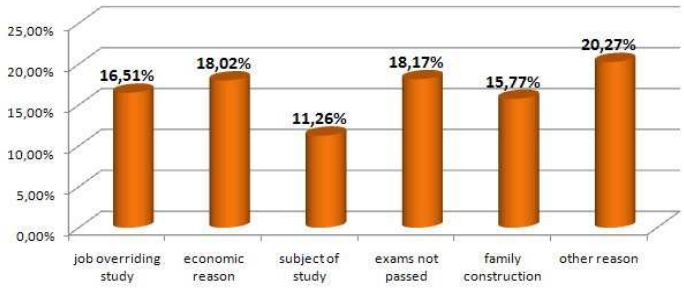

Fig. 7 Reasons of scholastic defection

Trying to decrease the importance of each of these reasons is a serious task for universities. They have to find the ways how to integrate individual groups of students affected by particular reason in order to provide them with conditions, that would make their study possible despite their specific situation. More details from this area can be also find after closer look at database results. Relevant answers are connected to sequence of questions about integration actions for weak ranges.

One way of preserving the defection rate from increasing is to remove the obstacles to change to another faculty or course of study. Another steps are providing e-learning services and programmes of life-long learning possibilities.

5. *occupational way out on 3°, 5°, PhD level of study.* For demonstration of results concerning this indicator, Fig. 8 shows the opinion obtained from

enterprises and intermediary organisations on readiness of student for full adaptation and flexible working in real praxis environment. Question calling the results for this graph was based on the statement, that university graduates are well prepared from theoretical point of view, but they miss practical skills.

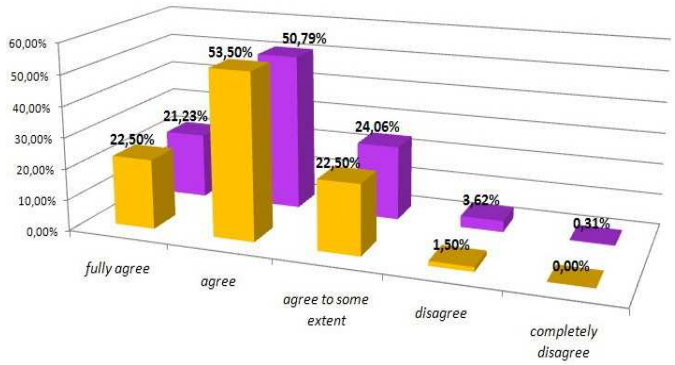

Fig. 8 University graduates miss practical skills

Universities thus need to improve their cooperation with enterprises. Companies on the other hand first need them to provide innovative approaches and study programmes and to flexible react to market needs. This relationship opens the space for intermediary organizations that need to become stronger part of mutual communication – not with purpose of self surviving, but real and positive help.

4. Best Conjunction between Universities, Enterprises and Intermediaries

The discipline of Manufacturing Engineering is evolving rapidly to meet the needs of manufacturing industries. It is important for the development of the discipline to define a common basis for communication and to strengthen networks among educators. This is the only way we can fully realize the benefits of the diversity in the discipline that exist nationally and internationally. The IRMA Project is an opportunity for manufacturing educators to address issues related to global shifts in manufacturing, shifts in jobs, pollution, international trade, and international manufacturing.

Important areas in manufacturing engineering higher education:

- integrating product design into manufacturing engineering curricula,
- education on design and manufacture of sustainable products,
- innovations in manufacturing engineering education (multimedia/posters),
- new educational methods for manufacturing engineering education,
- globalization issues in manufacturing education,
- new technologies for manufacturing engineers (virtual reality, rapid prototyping)
- building connections for manufacturing engineering education,
- professional teaching teams in manufacturing engineering education.

It is widely thought that a higher manufacturing engineering degree is now the norm if people want to work in any of the various roles offered by manufacturing engineering. Manufacturing engineers can play a part in every aspect of the manufacturing process including developing products, running operations, designing manufacturing systems, and advising and supporting customers. As for graduates of a manufacturing engineering degree program, work duties would be probably centred on the manufacturing process, either in its totality or with focus on a particular area. Engineers might design or develop new products, using your skills to produce designs that were effective and could be manufactured economically. They might take responsibility for supervising a production line from raw materials to finished product. Some people with manufacturing engineering degrees work as sales engineers, helping to sell products where technical expertise is required to present the product to the customer.

For achieving success in manufacturing engineering, quality education is the matter of highest priority and absolute must. Engineers draw heavily on mathematical and scientific knowledge, and these skills are best developed in a manufacturing engineering degree program. An excellent manufacturing engineering degree program also provides students with an opportunity to fuse math and science with top-notch communications skills. But, how can a potential student decide if manufacturing engineering is the right field to pursue? Several things need to be considered.

At one hand, a potential student should investigate the scope of his engineering interests. Manufacturing engineering is just one facet of the engineering industry. A manufacturing engineer enjoys improving the production process from start to the end. He or she has the ability to keep the whole production process in mind as he or she closer focuses on a particular portion of the process. For example, successful students in manufacturing engineering degree

programs are inspired by the notion of starting with a natural resource, such as a block of wood, and ending with a usable, valuable product, such as a desk.

On the other hand, earning a college degree in manufacturing engineering involves intense and thorough study of advanced mathematics and science, including calculus, computer science, physics, and other upper level courses. Potential students should thrive in such courses. Proper preparation for earning an engineering education includes high school courses in math, science, computers, and computer assisted drafting.

Many choices exist even within this highly specialized field of engineering. Whether a student is interested in developing an initial set of engineering skills before pursuing a more intense degree program, or whether a professional engineer is hoping to expand a general knowledge of manufacturing engineering with an advanced degree, distance learning provides a plethora of appealing opportunities.

Cooperation between universities and enterprises involves two communities with marked differences in culture, values and missions. Examples of successful cooperation between the two sides exist throughout Europe and EU programmes that have sought to build partnerships between the two domains, normally focusing on partnerships in specific areas such as research or student mobility. But the level of cooperation remains very unequal across countries, universities and academic disciplines. Furthermore, the extent to which such cooperation has influenced governance or organisational cultures in the two sectors concerned is limited. Few universities have an institution-wide strategy for cooperation with enterprise; those that do are concentrated in a small number of Member States of EU. In many countries the legal and financial framework still fails to reward or may even inhibit the efforts of universities to cooperate with enterprises.

Curricular change of the magnitude and at the pace sought is only possible if the internal structure of universities provide an enabling and rewarding framework. Internal quality assurance (QA) and external accreditation systems should pay more attention to the social and economic relevance of learning programmes. Accreditation agencies should include representatives from learners as well as of business and society at large.

The comparatively low levels of entrepreneurship in the EU call into question Europe's ability to foster growth and jobs. The challenge for higher education is to provide learning environments that stimulate independence, creativity and an entrepreneurial approach to harnessing knowledge. A regular flow of students and faculty members from university to enterprises and a constant presence of enterprises people on campus would help create the required change in culture. A good example in this respect can be found in the postgraduate training programmes funded by relevant funds focus on entrepreneurial skills.

Expansion of existing forms of cooperation with enterprises should be achieved, such as conferences, internships and project work (individual or in multidisciplinary groups). Extra-curricular opportunities were seen as valuable, e.g. junior consultancy companies or incubators providing customized support to university students and staff who articulate concrete ideas for new business ventures (start-up, spin-off companies). All these activities should reach students from an early stage in their studies and should be more strongly integrated into curricula.

Europe is productive when it comes to the generation of knowledge. The challenge is, however to improve the use and exploitation of publicly funded R&D. Although there is a number of programmes strengthening pathways by which the knowledge generation capacities of public higher education and research can work together with enterprises to bring innovations to market, the level of lasting strategic cooperation between the two sectors remains too low.

Now is the right time for a strong new push for university-business cooperation. In times of economic downturn, when graduates face greater difficulty to find jobs and enterprises are subjected to higher competitive pressure, the economic and social value-added of university-business collaboration should make it even stronger priority.

5. Conclusions

As mentioned in the Introduction part, the research analysis - involving three interfaces – has been focused on understanding of competences and knowledge demanded by enterprises, supplied by universities, and spread by intermediaries. The results of the research give a response to the questions that could be outlined in the following conclusion: The discipline of Manufacturing Engineering is evolving rapidly to meet the needs of manufacturing industries. It is important for the development of the discipline to define a common basis for communication and to strengthen networks among educators. This the only

way we can fully realize the benefits of the diversity in the discipline that exist nationally and internationally. The IRMA Project is an opportunity for manufacturing educators to address issues related to global shifts in manufacturing, shifts in jobs, pollution, international trade, and international manufacturing.

Acknowledgements

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Influence of globalization on education

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Abstract

With development of market operations and inclusion of the Republic of Croatia into contemporary tendencies that globalization carries with itself there comes to the need for new competences in the labor market and thus a change in the way of education of future workforce. The modern approach to education demands new teaching methods that will provide students the synergy of knowledge and skills, so that they could not only recognize the opportunity in the market, but develop their ideas into entrepreneurial ventures. The success of individuals in competitive conditions depends on a variety of criteria, but mostly on their ability to cope with the challenges of the market. The best example of adaptation to such conditions is working in practice firms that simulate real business and give students the opportunity to convert theoretical knowledge into practical skills, whereas their synergy stimulates and develops students' ability to teamwork, to learn from each other and respect other people's work, tactics of negotiation and discussion are improved – in a word desirable traits for taking part in the global competition are created.

Keywords: education, globalization, practice firm, knowledge, skills

1. Introduction

Since ancient times people tend to abolish restrictions and move limits of possibilities. There is a special need to abolish restrictions regarding the flow of information, goods, people and ideas on the global level. Already in the 19th century there came to the establishment of globalization through free trade of the British Empire, whose development languished with the post-war protectionism after the World War I. After the World War II, the Cold War restrained globalization which brougt the time of the United States domination. The establishment of economic liberalism promoted globalization as a solution to most problems in the contemporary world. Antiglobalists want to stop the tendency of major powers to maintain inequality in the world and balance that will not seek a general concern for the welfare of mankind. The Republic of Croatia must, in such a situation, by joining the EU, become part of the world market, with high standards, with the desired economic development. In doing so, it must rely on the flexibility of small businesses. Small businesses need knowledge that will enable successful competition and opportunities to adapt to changes. On the way of development it should work with schools as sources of human resources qualified for the competition, constant change and endless possibilities of information exchange. Vocational schools have to redesign their programs, but primarily to change methods of teaching in order to provide the labor market with human resources ready to accept new rules and challenges imposed by the market. The aim of this paper is to analyze the current situation and possibilities of vocational education, and to present the possibilities of implementation of practical training as integral system of skills and knowledge acquisition, which are necessary to perform their future occupations. Current situation was analyzed using the historical method, and the method of comparison helped to determine which activities are desirable in order to improve the education system. The comparison and classification methods were applied in order to compare different methods and forms of work, whereas the method of analysis was used to analyze the curriculum. Finally, the analysis of facts brougt to the conclusion about the possibilities of improving education through practice firms. Deductive method was used to analyze the achievements of M. A. Reljković Secondary School and brings the conclusion about the school's work.

2. Influence of globalization on entrepreneurial education

Globalization in education is becoming a new trend. The United States of America began to lose their dominant position. China is going through the biggest changes in higher education. The number of students who wish to continue their education after high school is constantly growing. Even if only a small number of these students continued their studies abroad, they would overwhelm universities around the world. China invests and builds top class universities like the ones in which the Nobel Prize scientists set out their career. Structure of change and contribution of individual regions in the sciences are changing, so that American scientists are no longer in the center of the world. Their primacy has not been taken away, but the influence of globalization can be felt in a way that other nations in Europe, Canada and elsewhere, support their scientists by enabling them to work in conditions once reserved only for American scientists. In order to ensure the conditions for development of science, for those who want to do scientific work in Europe, there is a supporting network that will enable that: Researchers' Mobility Portals and European Mobility Centers, to support the development of science. EU expansion gives the opportunity for creating career and mobility of scientists. The European Credit System for Vocational Education and Training is introduced in order to make transfer, accumulation, evaluation and recognition of results achieved through the process of learning in formal or informal setting easier, particularly in order to standardize the achievements of individuals who have acquired their competences in various countries. [3] Educational systems in the region are facing new challenges, particularly in the field of vocational education. Instead of theoretical knowledge it is necessary to transfer and acquire key qualifications required for the labor market, for which practice firms are an ideal instrument.

3. Education in global conditions

In conditions of globalization education becomes an increasingly important component of life. In order to be more competitive, the process of learning continues throughout people's lives. Back in 1976 the UNESCO defined the concept of adult education in a way that adults are included in organized educational processes, fields, levels and methods, regardless of whether they continue their education or re-educate themselves, and regardless of whether they develop their attitudes or behavior in the perspective of personal development, participation in balanced and independent social, economic and cultural development. Article 26 of the Universal Declaration of Human Rights defines education as one of the general, indivisible and inalienable human rights, but also as an important instrument of enjoying all other rights and freedoms. It must promote understanding, tolerance and friendship among all nations and racial or religious groups and support the efforts of the United Nations for the maintenance of peace. Croatian Government adopted the Strategy for Development of Vocational Education. The strategy demands available, flexible and passable education system for vocational education and training which will contribute to general development and greater economic competitiveness, increase employment and meet the needs of the individual and society. The new economy demands changes in education. As a result of globalization, there are virtual universities today. Educational institutions must abandon their old teaching methods and become publishers, television networks, digital libraries and museums. However, while respecting the global standards they must not abandon the traditional form of correspondence. Basic drivers of growth in the new economy are knowledge, ideas and new technological infrastructure. Production inputs, such as innovation and knowledge are setting an example and represent a competitive advantage in the global market.

4. Entrepreneurship and entrepreneurial education

Back in 1880 Blaz Lorkovic defined entrepreneurs: ''He, who united productive forces, managed them, and took jeopardy (risico) that production brings along, is called the entrepreneur, and that his job is called the company.'' una Modern economies of the world, both rich and economically developed countries and transitional and developing countries, rely largely on entrepreneurship. According to many scientists and theorists, entrepreneurship is the main lever of the world economy and the holder of general social development. Most will agree that the spirit of entrepreneurship is the driving force of economic growth. Entrepreneurship takes on new forms today. Entrepreneurship, networking, virtualization of business and intellectual capital belong to contemporary aspects of globalization. In the new economy entrepreneurship grows into the economy of

knowledge. As a result of such changes there comes to a capital intensive manufacturing that eliminates workers from the manufacturing process. Entrepreneurial education is becoming a priority for all levels of education. In vocational schools, enterpreneurial competences are introduced in order for it to outgrow the former notion of starting one's own business. Schools must take over their new task to prepare students for starting their own business and give the student competencies that will ensure successful management of their own lives. Entrepreneurial education is becoming a priority for all levels of education. Teachers in universities and polytechnics perceive it as a source of research and the opportunity for students to be trained for future successful careers. Community colleges, as institutions for adult education, use various entrepreneurial aspects of education to develop interest in the future business career of their students. Entrepreneurship is taught in summer camps in order for young people to upgrade their skills as employees and potential entrepreneurs. Primary and secondary schools encourage awareness of entrepreneurship development through general education and social subjects. Experience is transferred to young people so that they could see new opportunities in their own lives. Their mind-set is changing in a way that they are encouraged to work independently and be self-employed. Through this framework of enterpreneurship knowledge transfer the concept of lifelong learning in five stages is developed.

5. Practice firm

Practice firms are introduced int vocational schools in order to apply knowledge in the economy, increase competitiveness and create conditions for business in the single European market. Practice firm is an innovative teaching method focused on practice, a model enterprise in which the flow of real business enterprise becomes transparent for the educational process. In a simulated business world with real partners in the country and abroad the development of key skills such as ability to work in a team, willingness to work, flexibility and endurance, willingness to decision-making, competence in conflict resolution and especially intercultural sensitivity are promoted. The model of practice firms can be introduced to different types of vocational schools, depending on educational needs. The concept of practice firms proved itself in projects in Bulgaria, Romania, Albania and other countries in transition as a successful starting point for adjustment of economic education to needs of the developing market with the capabilities of simulation of real flow of business enterprise in schools. Different target groups appear as social partners in the work of practice firms, such as representatives of ministries of education of the participating countries, persons engaged in professional training of teachers in partner countries, the heads of central practice firms in partner countries, the principals, teachers and students in the pilot schools. Every practice firm has modules that can be flexibly combined depending on the needs of the environment in which certain practice firm operates. Flexibility allows adjustment of the implementation process of practice firms. Quality standards are established by providing key contents of each module in order for practice firms to be comparable. There are three fundamental objectives of practice firms, the acquisition of content and methodological skills of teachers, ensuring the creation of national and regional schools networks, and formation of competences for competitiveness in the labor market.

6. Example from practice: Matija Antun Reljković Vocational School Slavonski Brod

Activities during practical training are not enough for the declared educational principles to be successfully implemented and adopted by the enrolled students and trainees. Practice firms, in a decentralized system, are the right place for implementation of skills and knowledge for which practical training in schools does not provide. Faithful simulation of actual economic situation and performance of business transactions between practice firms prepares the students for development of an idea into an entrepreneurial venture, and for creation of marketing strategies required for placement of finished products or services. Work in practice firms encourages values such as quality work, modern way of thinking, decision making ability, communication skills and good performance. Applying theoretical knowledge in practice strengthens the ability of team work, learning from each other, develops respect for another's work, improves negotiation and discussion tactics, encourages the creation of core values for success, such as innovation, image, talent, knowledge, research and development, entrepreneurial spirit, customer satisfaction, staff satisfaction... In order to successfuly organize all activities necessary for success of practice firms the school is constantly

encouraged to create prerequisites for the start of practice firms, as well as to establish cooperation with other schools in the region. Practice firms have won their special place in the organization of the school.

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Fig. 1. Position of the practice firm in school

Each year a curriculum is made for the purposes of practice companies on the basis of material-technical, personnel, spacial and financial possibilities. Goals of education, previous knowledge of students, establishment of a practice firm, corelation with other subjects are all determined by the curriculum in order to ensure logical spiral arrangement of the teaching contents. Furthermore, it is decided which contents can be realized in the school and which will be implemented outside the school, and etc. Based on the curriculum a schedule of activities is made for each month, which should include presentation and application of interested students, organization of student teams and collection of business ideas, establishing of practice firms, testing ideas, market research, developing and completing a business plan, its approval and fund raising necessary for practice firm's work, manufacturing, marketing and sales, participation at the fair, monitoring of results and drafting the annual report as well as a review of the learning effects and providing information to new students.

6.1. An example of the practice firm for growing blackberries

At the beginning of the school year, second grade students of the three-year program and third grade students of the four-year program are informed of the possibility of organizing into practice firms. On that occasion the school capital available for the work of practice firms is also presented. Interested students are required to develop a program with which their firm will manage its available assets. The best designed programs will receive part of the school property to use in order to realize their business plan. A group of students presents its plan to organize production of blackberry wine. The next step is the establishment of the practice firm. A certain number of students gathers around the idea, mostly intuitively, or with the suggestion of the manager that newcomers should be involved in the work of certain teams. Students distribute tasks among themselves and determine the responsible person who will contact all members of the firm and enable communication with the environment. Then, students determine the name and company logo, research the market to profile a potential customer, to determine the characteristics of the supply market and profiles of the competition. Based on such research they create their own marketing program that describes the product, price, distribution and promotion. After that they start preparing their business plan. Their business plan provides good and bad sides of their business ideas. Their business plan consists of the name of the firm, members, production technology, product with unit price, description of the production process, plan development, market and investment required. They also state the firm's business revenues, expenditures and planned profit. Members of the firm have various forms used in order to make creation of their business plan easier. It has the minimum of required elements that the business plan should have: summary, description of business ideas, market information market, information on competition, marketing plan, organization of practice firm's work, financial business plan, ecology and enclosures. The next phase is the creation of their own products, which is represented at the school fair. The firm represents its business plan, its work and product. The fair is an opportunity for the practice firm to be better acquainted with other exhibitors. Is also an opportunity to publicly present the work of the project and thus interest the new generations that will get the chance to establish their own practice firms in the following years. After completion of one cycle and fulfiling of all the activities provided by the business plan of the practice firm, the responsible person of the firm prepares a report to show the effects of their work during one cycle, management of assets and to make a decision on termination of work. After checking that all the commitments were fulfiled and after the established condition of assets used business of the practice firm is closed.

Conclusion

Practise firms are the right opportunity for young people to acquire basic knowledge and develop skills necessary for the development of entrepreneurial initiatives before finishing their formal education. Working in practice firms and simulation of the real economic situation foster values such as modern way of thinking, decision making ability, communication skills and good performance. Applying theoretical knowledge in practice improves the students' ability of teamwork, their ability to learn from each other and

to develop respect for another's work, improve tactics of negotiation and discussion – in a word – desirable traits for inclusion in the global competition. Educational system allows the positioning of young people as social partners in achieving the country's strategic objectives, active approach to life and work after finishing high school, and the possibility of entering into life in which they will have to deal with many temptations and problems.

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ICT Management: Online course *Change Managemen*

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Abstract

The basic objective of this study was to determine usefulness of Moodle LMS in management of educational process and its organization in the classroom. The basic method applied in this study was an experimental method. As a result it has been proved that network cooperation of students, assistants and lecturers through CARNet's LMS Moodle online course Change Management brings many benefits, when used as in educational process, such as better organization of lectures, knowledge tests and their evaluation. Communication between all participants in the course is more efficient and lectures are more interesting when compared to classical lectures. Time saving is also one of the important advantages of this way of organizing a course; it is possible to get relevant statistics about the activities of course participants in short period of time and save those data easily and quickly. Availability and visibility, paper saving and toner saving are also important advantages of this online course. The course includes following options: activities (forum, questions, resources, tests and assignments); administration (assessment, registration, profile, backup, restore); and participants.

Author's one-year experience in the Moodle virtual practice has confirmed the aforementioned advantages. Results have shown multiple benefits in management of educational process: time management (scheduling of activities, and access to the course at any time), content management (presentations, documents, images, sounds, etc.), and management of space (distance learning - the ability of access from anywhere in the world "), successful management of communication (e-mail, chat and forum) and permission management (lecturer, assistant and student).

Keywords: Network cooperation; Online course; Moodle; ICT management; LMS;

1. Introduction

Change Management - CARNet Moodle LMS course was created as a result of the previous one-year experience of working on virtual server Apache 2.0, Moodle installation and MySQL database installation in the IT classroom in Županja Grammar School at the beginning of the school year 2008/09. These experiences are also based on creation, implementation and performance of online course *Informatics for General and Mathematical High School* for the school subject Computer science for nine classes which comprise in total over 300 students.

The course has been performed while teaching informatics in the classroom, as a complement to regular classes, through 32 thin clients which were connected to fast Internet connection. As a major drawback to this concept it was shown that it was necessary to adopt more specific IT knowledge to set the IT platform (software) in order to use Moodle. It required quite some time for research and experimentation. Next disadvantage of this concept was that it did not allow submission of students' tasks and seminar papers directly from their homes, as well as their immediate correction and evaluation by teachers. Network cooperation of teachers and students was possible only when the school computer was turned on.

At the beginning of this calendar year, the author found out about the existence of CARNet's LMS system Moodle

(on CARNet's server) and started creating school subject for the next high school year and also the online course at the University of applied Sciences in Slavonski Brod called *Change Management*. In that way the author, with CARNet's LMS Moodle implemented in that new courses, decided to retain all the benefits from already realized course model and

eliminated those basic flaws (restrictions) of the old model in practice. (Virtual Server Apache 2.0) In this paper we do not analyze methodical-didactic aspects of the course and its curriculum but the control aspect of the course. We also carry out a brief analysis of what the successful management of the course gives to the participants in online communication and their process of teaching/learning (lecturers, assistants and students). A ten minute online presentation of the course called *Change Management* made in Adobe Captivate 2 (Flash Player 7 is necessary for performance) can be found on web page http://www.vusb-moodle.pondi.hr and serves as an instruction

for use for the course participants. In order for students to successfully participate in an online course they should have an electronic identity AAI@ EduHr created by CARNet. The high education institution they enrolled at is obliged to organize that. Students should have access to online course with Internet connection and only then online testing could be performed. To submit access papers and seminar papers, students need to have at least periodical access to the Internet from home or institution where studying.

Experience has shown that good cooperation between lecturers, assistants, IT experts and institution's schedule makers result in realization of all conditions (organizational, IT and other) needed for participants of the course (lecturer / assistant / student) to successfully virtually communicate within this online course.

2. Virtual learning environment: CARNet LMS Course *Change Management*

Virtual learning environment is an electronic system which provides online interactions of different kinds (displaying the content, communication and cooperation) and thus mediates between students and teachers (JISCO, 2003 and Becta, 2005).

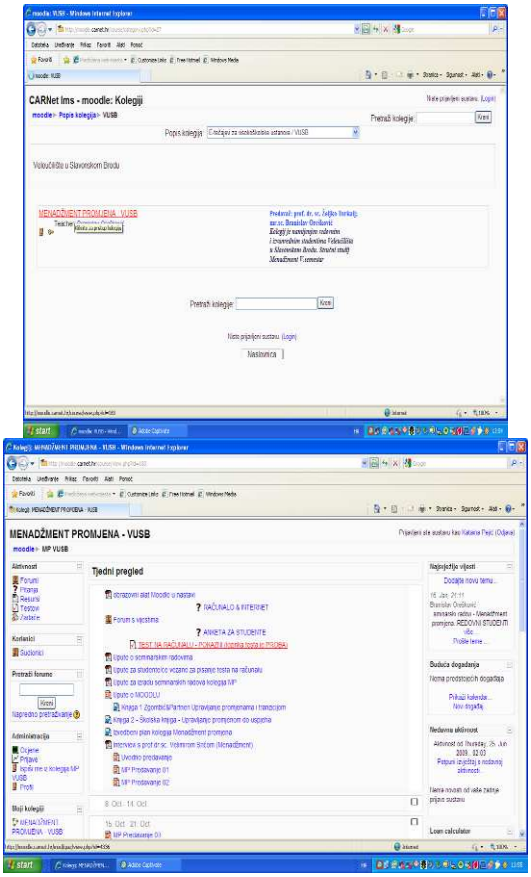

Figure 1 Course Layout on screen

Students log into the course through the electronic identity AAI@EduHr. They should also know the password which is usually given by the lecturer. Moodle makes it possible to limit the time period during which students can register at the course. The lecturer has the authority of the administrator and he or she can administer the course, while the assistants get the status and they can overview everything within the course and evaluate access work and seminar papers. Student's profile provides an overview of all of student's own tests, tasks, review of course participants, use of forums, e-mail etc. Each individual profile can be changed only by its owner by using the option "*change your personal data*". Students, assistants and professors are required to add their photo to profile settings. Students, teaching assistants and professors are for 24 hours virtually connected. The lectures within this course are structured weekly, and their content can be downloaded at every moment. There are also online exercises for preliminary exams available to students. Students write their tests in the IT classroom at the University of Applied Sciences, and they immediately

after the completion of the test get to know their test results. Students can also upload their access works and seminar papers, within the time limit predicted by the lecturer. Seminar papers and access works can be assessed by the lecturer immediately after submission, and students can directly see their grades. The course also provides a variety of surveys for students. Lecturers can also have a direct insight into the activities of students within the course. Activity report can be obtained in form of tables and charts.

3. LMS course offers many advantages

The authors of this scientific work are attempting to emphasize a managerial (control) aspect of the LMS and the advantages of its use based on results of application of the online course in practice. This work presents somewhat different approach than the most previously published works in this field. Significant is the fact that this work could open up some discussion. One year experience of work with Moodle as a supplement to lectures has resulted with significant advantages in management of this course for all participants in the course:

- Time management (scheduling activities, and access to the course at any time)
- Content management (presentations, documents, images, sounds, etc.)
- Management of space (distance learning - access from anywhere in the world ")
- Management of communication (e-mail, chat and forum), and
- Management of permissions (lecturer, assistant and student).

The course allows evaluation of test results immediately after the online test is being written. Score points are visible to participants in the course (the participant is a person who has been enrolled in the course). In this way the oral examination of students can be organized immediately after the online test (written exam). The students can come to know the final assessment of the exam, and do not have to wait for the results of written exams, so they can use their time to prepare themselves for another course. LMS course also allows the lecturer insight into all activities of students, and he or she can easily and quickly get accurate statistics. It provides excellent control of the course.

Figure 2 Insight into activities of students within the online course

Students do not have to print and give their access and seminar work to the lecturer or send them via e-mail. It is enough to make an upload within the course and join the account to display the work. It becomes visible and available also to the student, assistants and lecturer. When a lecturer enters a grade into the right column, it is immediately visible to the student. In this way communication between teachers, assistants and students is simplified and quick. There is no need to send test results via e-mail. The course also allows lecturer to set

deadlines for the submission of seminar papers.

The lecturer has the possibility to monitor activities of all students during the semester; he or she can read available statistics concerning students' ratings, and logs. Lecturer, assistant and students can participate in the

debate on forum according to default themes, as well as start new discussions. If a lecturer has the information to be shared with all students he or she can publish it within the course or send it via e-mail with the option "to all students". If a lecturer is interested in students' opinion, he or she can create a questionnaire within the course in a way to choose the option "questions" and create questions; he or she can also offer multiple answers and thereby create online survey. After students answer the questions, the lecturer has an immediate review of the survey through its statistics (tables and charts).

All lectures and instructions are published within

the course and students can download them to their own computers. There are many other activities and resources within the course that can enrich the online course and raise its quality, and it is desirable to include them in the course and upgrade them during the usage. In every case online course has been an important resource of great help to the lecturer, assistants and students and has improved teaching process significantly.

Figure 3 Profile of the online course participant

4. Conclusion

One year of research of the application of LMS Moodle system as teaching supplement has resulted with facts which confirm its advantages. After the course has been organized, it has been proved that efforts spent on learning about Moodle and time and efforts invested in design and creation of online courses resulted with numerous benefits for lecturer, assistant and students. Teaching process has been enriched with new teaching methods, contents, and organizational solutions. In order to convincingly describe how helpful for the teaching process online course is, we will try to illustrate it with following situation.

If we should go back to the classical form of lectures after this one year of experience of using Moodle, we would feel like people who traveled to work by car for 15 minutes every day, and now should walk the same distance every day. The end of the school year brings the greatest satisfaction, when instead of looking for something on shelves full of tests, assignments and papers, and instead of searching for folders and files on your computer, you can easily make a successful backup of the entire course and save it on a CD (with all contents and data), and entire work lasts for around ten minutes if you use the backup command within the course.

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Efficiency of Carbon Toner Removal by Double Stage Flotation

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Abstract

In order to investigate the efficiency of black toner removal by double stage flotation, recycling was performed on Navigator office paper printed by two different colour laser printers XEROX PHASER 7700 and LEXMARK C920. In chemical deinking by flotation the sodium laurylethersulphate as the nonionic surfactant was used. Froths collected by flotation were re-floated in purpose to increase the usage of fibers. For an efficiency evaluation of above-mentioned method, an image analysis of all formed handsheets was done. During the first flotation the removal of particles bigger than 0.07 mm^2 is very well achieved, whereat some better efficiency for Lexmark toner removal was obtained. By second flotation extra removal of particles bigger than 0.04 mm^2 was accomplished. Image analysis results gained on froth handsheets point out the good efficiency of carbon toner removal from Lexmark and Xerox froth suspension. These results indicate the need for froth flotation in purpose to achieve enhanced usage of fibres which were in previously done flotations removed from suspension together with impurities.

Keywords: Office paper, Recycling, Chemical deinking, Double stage flotation

1. Introduction

Office papers are widely used every day, not just in photocopying purposes, but also for handwriting and printing documents used for archiving. This type of paper, like any other, is the product made from vegetable origin fibers, mostly of wood. In order to decrease the cutting of trees, which are used as the raw materials for paper production, the recycling of papers is necessary. The production of a good quality paper requires an adequate modification of the secondary fiber properties and the removal of a large amount of contaminants, namely stickies, sizing and coating agents, mineral fillers and inks.

Recycling of the used papers is a complicated technological process composed of four basic process units: a) disintegration or defibering – which comprises the preparation of used paper suspension, b) removal of impurities from the suspension, mostly by washing or flotation, c) whitening of fibers and d) treatment of the process water [1].

It is difficult to define the recycling rules, which would be equally valid for all papers on global landfills. Chemical composition of paper, printing ink and printing technique have an important influence on the recycling efficiency. Also many printer producers are available on market: Xerox, Canon, HP, Lexmark, Epson and others. Nonimpact printed white office papers that include xerographic and laser printed papers are difficult to deink with conventional deinking methods [2]. Because offices use more laser printers and copy machines every year, the amount of nonimpact printed papers entering the recycled paper stream is increasing. Ink removal from these papers remains still a major challenge. Conventional chemical deinking is not an effective mean for deinking nonimpact printed papers. The efficiency

is due primarily to the strong adherence of the toner particles to the paper surfaces [3], [4].

Enzymatic deinking methods represent a new approach to convert these recycled papers into quality products [5], [6].

Nowadays the requirement for paper manufacturing from recycled fibres is increasing. Chemical deinking flotation for impurities removal is a usual method for paper recycling used in paper mills all over the world. However, during flotation process the lost of fibres is unavoidable. Fibres are important raw material for recovered paper production. So in this work the maximal usage of fibres after flotation was tried to achieve. That is why the double stage flotation as well as the froth flotation collected during flotation was performed.

2. Methods and materials used for research

For the deinking flotation investigation the Navigator paper (grammage of 80 gm^{-2}) printed only with black toner by laser colour printer XEROX PHASER 7700 and LEXMARK C920 has been used. Each printed output contained 848 words arranged in 56 lines. Navigator paper was chosen for printing as one of the most used office paper on Croatian market.

Chemical deinking by flotation was done using Enrico Toniolo disintegrator (V = 2.0 L), laboratory flotation cell (V = 12 L) and handsheet former for handsheet dimensions 340 mm x 250 mm (Figure 1). The apparatus consists of two parts separated by screen. In upper part suspension and water are repelled, while the bottom part is filled with water.

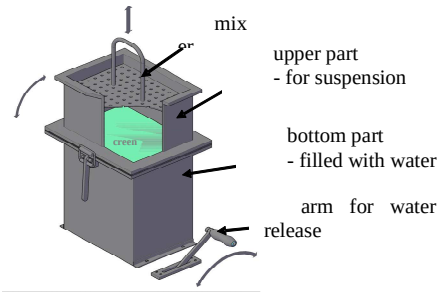

Fig. 1. Laboratory handsheet former.

The schematic presentation of deinking flotation process flow is presented in Figure 2. At the same experimental conditions, but separately, paper samples printed by different printed was recycled. Disintegration of 100 g printed paper sample during 10 minutes in 2 litre tap water at the temperature of 50°C, pH value of 11 (adjusted with soda alkali) and the consistency of the suspension of 5% was performed. The sodium laurylethersulphate as the nonionic surfactant was used. The suspension obtained by the disintegration was homogenized with 10 litre of cold tap water, and the temperature was decreased at 30°C, with the pH value of 7.5 and the consistency of 0.83%. This homogenized suspension was divided into two parts A and B, of equal volume, which were separately floated during the time of 8 minutes after the addition of 6 litre of tap water (the first flotation). Need for suspension partition was occurred as a result of too big suspension volume for flotation cell. Namely, suspension was agitated before division but some differences in solution composition after division was expected because of precipitation of some components. During the first flotation the froth was manually collected.

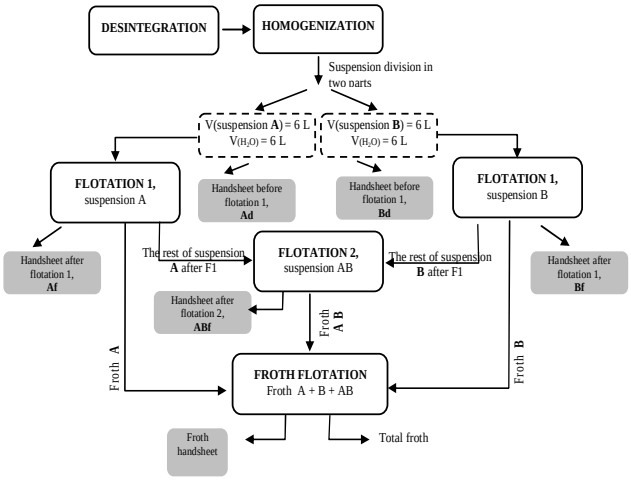

Fig. 2. Process flow of chemical deinking by flotation

Laboratory handsheet before flotation (Ad, Bd) and after flotation (Af and Bf) was made from each suspension. After the laboratory handsheets were made

after the first flotation the rests of the suspensions A and B were mixed into the suspension AB that was floated (the second flotation) under the same conditions as A and B suspension during the first flotation. After the second flotation the laboratory handsheet ABf was made. The froth AB collected in the second flotation was mixed with the froths A and B collected in the first flotation. The collected froth was homogenized with the addition of 10 litre of tap water and after that floated for 8 minutes. By froth flotation the impurities were manually collected on the suspension surface. After the flotation time the whole suspension from the flotation chamber was used for making the laboratory handsheet from froth.

On all laboratory handsheets formed after the recycling the image analysis were made.

3. Results and achievements

The total number and the total particle surface on all handsheets made during the chemical deinking by flotation are presented in Figure 3. These results are obtained by image analysis method on all handsheets made from Navigator Lexmark and Xerox printout.

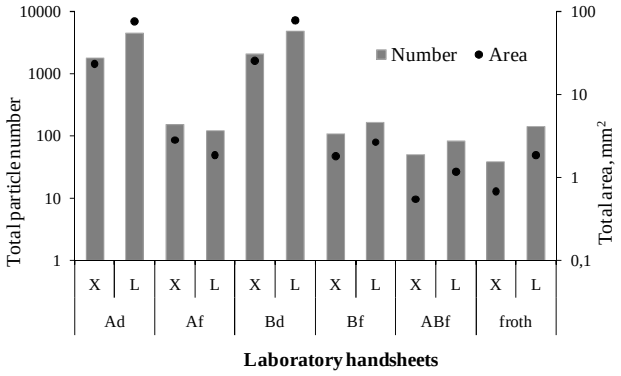

Fig. 3. Image analysis results of the handsheets made during chemical deinking by flotation

It is interesting that although each printed output contained equal number of words arranged in same number of lines, does not contain the same total particle number of black toner in handsheets made at same stage of recycling process for Lexmarx and Xerox printer. For all stages of recycling process handsheets from Lexmark printout contain higher amount of black toner particle. After homogenisation suspension was divided into two equal volume parts (A and B), so before the first flotation laboratory handsheets for both suspensions were formed (Ad, Bd). As it was expected Bd handsheets contains greater number of toner particles for both printers because of precipitation of some components. The laboratory handsheets of each suspension after the first flotation (Af, Bf) consist significantly less number of toner particles.

The flotation efficiency was investigated by detection of toner particles number in handsheets formed before (Ad and Bd) and after flotation (Af, Bf and ABf). The efficiency of the each colour toner particle removal (E_f) is calculated according to Equation 1:

$$E_f = \frac{\text{particle number}_{\text{before flotation}} - \text{particle number}_{\text{after flotation}}}{\text{particle number}_{\text{before flotation}}} \times 100\% \qquad (1)$$

The removal efficiency of black Xerox toner for suspension A is 91.5%, while for black Lexmark toner removal efficiency is 97.3%. The removal efficiency of black Xerox toner for suspension B is 94.8% and 96.6% for black Lexmark toner. During the second flotation (ABf) the part of the both printer toner particles, which was left after the first flotation, was removed. The efficiency of black Xerox toner removal by second flotation is 61.4% and 42.6% for Lexmark toner. The results obtained by froth handsheets image analysing are notable for increasing the usage of fibers. Namely, total particle number in those handsheets is significantly lower for Xerox black toner in comparison with handsheets formed after first and second flotation for same printer printout on Navigator paper. While Lexmark toner removal from froth is not so efficient as for Xerox black toner but is still noteworthy.

By image analysis, the particle with the size ranges from 0.001 mm^2 up to greater than 5 mm^2 divided into 25 size classes are identified. The particle size classes identified on handsheets formed before the first flotation of suspension A (Ad) are presented in Figure 4. Lexmark and Xerox black toner particles are fragmented by disintegration into the size range from 0.001 mm^2 to 0.25 mm^2. The identification of the particles smaller than 0.001 mm^2 was not possible by this method. Although the black Navigator printouts were printed with same number of signs, number and size of black Xerox and Lexmark toner particles in handsheets before the first flotation (Ad, Bd) were not identified. This difference in toner particle size used by

different printer machines greatly influence on flotation efficiency, what can be seen on Figures 5, 7, 8 and 9.

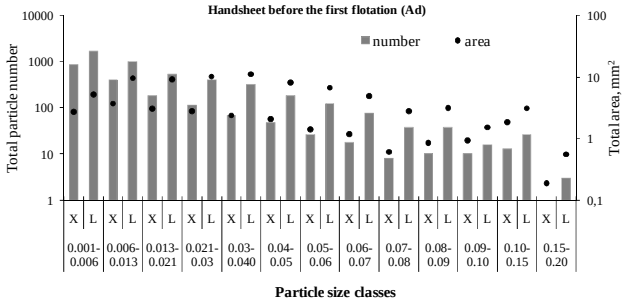

Fig. 4. The image analysis results of handsheets before the first flotation of suspension A (Ad);
L-Lexmark, X-Xerox

The particle size classes identified on handsheets after the first flotation (Af) are presented at Figure 5.

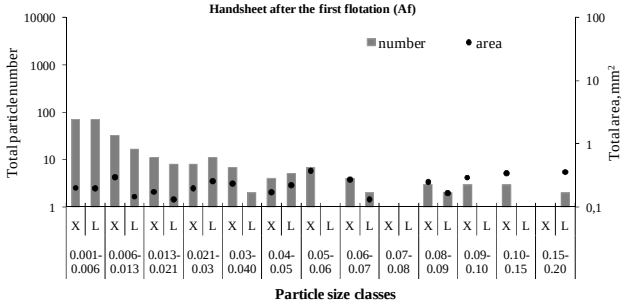

Fig. 5. The image analysis results of handsheets after the first flotation of suspension A (Af);
L-Lexmark, X-Xerox

From these results it is clearly to see that larger particles are easier to remove by flotation. Although handsheets made after Lexmark printouts disintegration made contain higher total particle number than Xerox handsheets (Figure 3), the higher number of black Lexmark toner particles was removed by flotation in comparison with Xerox particles at same experimental conditions.

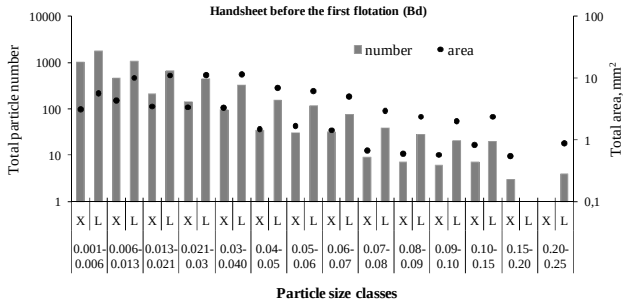

Fig. 6. The image analysis results of handsheets before the first flotation of suspension B (Bd); L-Lexmark, X-Xerox

At Figure 6 classes of the particle sizes identified on handsheets made before the first flotation of B suspension (Bd) are presented. As it was expected Bd handsheets contains greater total number of toner particles for both printers in comparison with Ad handsheets because of precipitation, which is unavoidable consequence of suspension division. From obtained results it could be conclude that size of toner particle effect on precipitation. Higher number of larger particles in Bd handsheets is consequence of precipitation.

The particle size classes identified on handsheets formed after the first flotation of B suspension (Bf) are presented at Figure 7. Just like for suspension A, flotation efficiency for suspension B is better for larger toner particles.

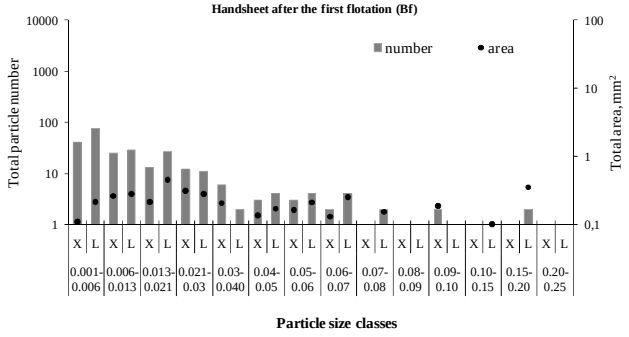

Fig. 7. The image analysis results of handsheets after the first flotation of suspension B (Bf);
L-Lexmark, X-Xerox

After Af and Bf handsheets were made, the rests of the suspensions A and B were mixed into the suspension AB that was floated (the second flotation) under the same conditions as A and B suspension during the first flotation. After the second flotation the laboratory handsheet ABf was made and the particle size classes identified on that handsheet is shown at Figure 8.

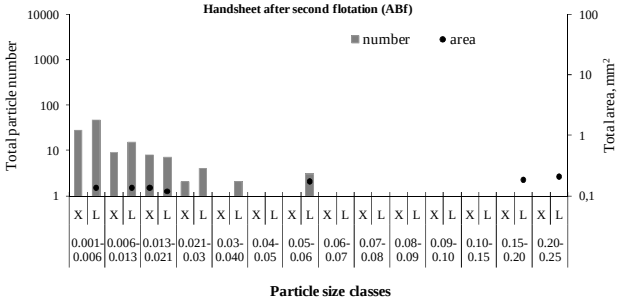

Fig. 8. The image analysis results of handsheets after second flotation (ABf); L-Lexmark, X-Xerox

During the second flotation the part of the particles (especially lager ones), which was left after the first flotation, was removed. It is interesting that the second flotation is more efficiently for black Xerox particles that were heavier to remove by first flotation in comparison with black Lexmark particles.

Based on image analysis results flotation efficiency was calculated according to Equation (1). By the first flotation of suspensions A and B and second flotation of AB suspension 95% of black Xerox toner and 98% of black Lexmark toner were removed.

Image analysis results of froth flotation collected during the first (Af, Bf) and second (ABf) flotation are presented at Figure 9. The suspension for froth flotation (A+B+AB) was made from impurities collected with froth. After flotation of froth suspension froth handsheet was formed. When we compare the total number of particles in froth handsheets indentified by image analysis method with total number of particles in handsheets after second flotation, for both printers, we can conclude that there are no big differences in these numbers. These results pointed out the efficiency of froth suspension flotation, i.e. it is possible to reuse fibres which are usually thrown away with froth.

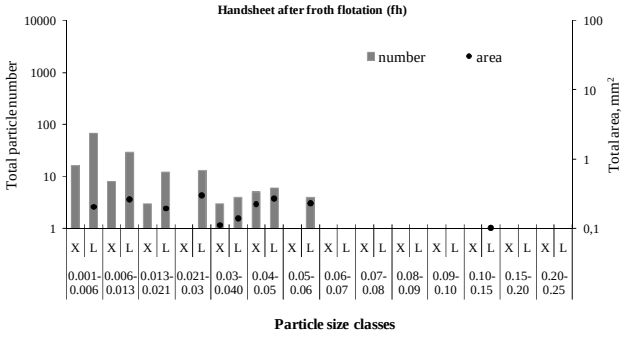

Fig. 9. The image analysis results of handsheets after froth flotation (fh); L-Lexmark, X-Xerox

4. Conclusions

In this work the removal efficiency of black Lexmark and Xerox toner on Navigator paper by chemical deinking flotation is confirmed. Black Lexmark and Xerox toner particles from disintegrated Navigator printouts suspension are all in size classes from 0.001 to 0.20 mm^2. During the first flotation the removal of particles bigger than 0.07 mm^2 is very well achieved, whereat some better efficiency for Lexmark toner removal was obtained. By second flotation extra removal of particles bigger than 0.04 mm^2 was accomplished.

Image analysis results gained on froth handsheets point out the good efficiency of carbon toner removal from Lexmark and Xerox froth suspension. Froth handsheets image analysis results indicate the similar distribution of particles size and number as in handsheets formed after second flotation.

These results indicate the need for froth flotation in purpose to achieve enhanced usage of fibres which were in previously done flotations removed from suspension together with impurities. In all formed handsheets after flotation (Af, Bf, ABf, fh) by image analysis method particles smaller than 0.04 mm^2 were identified. From these results it could be conclude how those small particles are merged in fibres lumen and in that way their removal by flotation is impossible.

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Importance of Human Resource Management at the Macro Level – Impact Analysis of Various segments of Human Capital on Economic Development of Countries of the World

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Abstract

The goal of each national economy and economic policy of countries of the world is to provide greater and faster rates of development of human capital of its inhabitants, and with optimal investment in people, raising their moral, intellectual and social capital, achieve the higher economic growth rates, high level of economic development and living standard of all its inhabitants. To achieve the goal, is required a systematic approach to the managing of human resources in the implementation of economic policy and to create such a system of moral values, legal and legislative system that will encourage and reward honest behavior, such an education system that will achieve optimal raising of knowledge, skills and abilities of educated personnel and such a network of the state, local and civic organizations that will encourage social connection and cooperation of all its citizens.

The research, which deals with the importance of human resource management at the macro level, and impact analysis of various segments of human capital on the level of development of countries of the world, is divided into three parts. The first part gives a brief overview of the theoretical importance of different segments of human capital (the moral, intellectual and social capital) on the personality and success of individuals, the result of business enterprises, and economic growth of countries, with special analysis and emphasis on ranking of influence, or weight factor of each observed segment of human capital. In the second part of the paper is shown the methodology of work and explained data which are used for research and analysis by countries of the world. This is about sample of 52 countries of the world and their statistical data on segments of human capital, for the observed year 2008. The moral capital as part of human capital for research in this paper represents a variable the index of corruption, the intellectual capital as part of the human capital represents a variable the Prosperity Index Education, the social capital as part of the human capital represents a variable the Prosperity Social Capital Index, while the economic development of countries of the world represents a variable the gross domestic product per capita. This is the official statistical data for 52 countries of the world by the organization in London the Legatum Institute, publicly published in year 2009. In the third part of the paper is provided the analysis and interpretation of results of the conducted studies which show the influence of different segments of the human capital on economic development of countries.

The study was aimed to test the hypothesis that human capital has a positive and significant impact at the macro level and that countries with more developed human capital, on average are significantly more developed economically and have a faster and higher rates of economic growth. The research further tested the hypothesis that segments of human capital, the moral, intellectual and social capital, have also the positive and significant impact on the economic development of countries of the world, with the fact that the greatest impact on the economic development of the individual country by average have the moral capital, then intellectual, and finally the social capital.

Keywords: human capital, moral capital, intellectual capital, social capital, GNP

1. Introduction

The research, which deals with the importance of human resource management at the macro level, and impact analysis of various segments of human capital on the level of development of countries of the world is divided into three parts. The first part gives a brief overview of the theoretical importance of the different

segments of human capital (the moral, intellectual and social capital) on the personality and success of individuals, the result of business enterprises, and economic growth of countries of the world, with special analysis and emphasis on the ranking of influence, or weight factor of each observed segment of human capital. In the second part of the paper is shown the methodology of work and explained the data which are used for research and analysis by the countries of the world. This is a sample of 52 countries and their statistical data on segments of human capital, for the observed, year 2008. The moral capital as part of human capital for research in this paper represents a variable the index of corruption (CPI), the intellectual capital as part of the human capital represents a variable the Prosperity Index Education, the social capital as part of the human capital represents a variable the Prosperity Social Capital Index, while the economic development of countries of the world represents the variable gross domestic product per capita (GNP p.c., PPP, USD). This is the official statistical data for 52 countries of the world by the organization in London the Legatum Institute, publicly published in year 2009. In the third part of the paper is provided the analysis and interpretation of the results of the conducted studies which show the influence of different segments of human capital on economic development of countries of the world.

2. Theoretical overview of the importance of different segments of the human capital

The goal of each national economy and economic policy of countries of the world is to provide greater and faster rates of development of human capital of its inhabitants, and optimal investment in people, with raising their moral, intellectual and social capital, to achieve the higher economic growth rates, high level of economic development and living standards of all its inhabitants. To achieve the goal, is required a systematic approach to a managing of human resources in the implementation of economic policy and to create such a system of moral values, legal and legislative system that will encourage and reward honest behavior, such an education system that will achieve optimal raising of the knowledge, skills and abilities of educated personnel and such a network of the state, local and civic organizations which will encourage social connections and cooperation of all its citizens.

According to equation of development (Lauc): $Y = ax1 + bx2 + cx3 + dx4 + ex5 + fx6$, where is: Y - an expression of full development, a–f weight factors by the independent variables, x1 - the motivation of employees, x2 - the knowledge and skills of employees, x3 - mutual relations, x4 - technical equipment of work, x5 - money, and x6 - environment of the observed system, the odds ratio (weight factors) is as follows: a> b> c> d> e> f, from which it follows that of the segments of the human capital, the most important and in the largest correlation with the economic development is exactly the moral capital, then the intellectual capital and, finally, the social capital.

According to one survey (Delleck, Von den Bosch, De Lathouwer), no amount of the intellectual and social capital cannot compensate the lack of moral capital. Only individuals with high moral capital can properly use the intellectual, social, physical and financial capital, and hence increase the value of the company. Although the moral capital can not be measured exactly, only it can increase the value of other, more easily measurable types of capital.

Business ethics has emerged from consideration of the relationship between economics and morality, consideration of the moral status of the economic procedures, practices and moral characteristics of the market relations. Business ethics (Collins, Devanna) has two perspectives: ethical and business (economic). Business perspective is based by the economic values: benefit, profit, cost, price, efficiency and competition. Ethical perspective is based by the moral values: honesty, justice, confidence, trust, rights and duties, and all that can be described as "good" or "right" in a moral sense.

Intellectual capital actually aims to clarify the differences between the book value and market value of company (Armstrong), where market value is the total value of all shares of the company, while book values is the present value of the physical and financial asset. The value of intellectual capital is equal to the future conversion of intangible asset in the financial profit of the company. With this, we display value of the business entity more extensive and more accurate, which can be of great importance for potential investors. Only if we know of which consist the core values of our company and what kind of intellectual capital we are at disposition, we will know to manage in the way to maximize the growth of precisely these values.

It is important to mention that managing of the intellectual capital includes not only managing of the knowledge of employees, but also the process of creating knowledge and values within the company, and also the process of acquiring knowledge outside of the organization (Marusic). We must not forget that the intellectual capital of the company is all employees, their organization and the art of creating values which evaluate the market, where the investment in employees is not observed as an expense in the business, but as an investment. This is the difference between the accounting of human resources, where employees are treated as company assets, and standard accounting approach, that observe employees as an expense. Employees invest knowledge and skills, resulting in created added value confirmed on the market. Classic indicators of business success, such as total income, profit or cash flows, less and less are reflecting the actual business ability of firms, because they do not speak whether companies are creating a value or not.

Successful management of the intellectual capital in enterprises can be divided into six stages (Frank, Bernanke). The first step is to determine where the necessary knowledge is, then how to get it, how to enable employees to find the knowledge, in the next step to define the possibilities of using the knowledge, then ensure that the system works and keep it up to date. So, first it is necessary to develop the awareness of importance of resource across the organization and to visualize and categorize the intellectual capital of the company.

Social capital comes into play when with other people we come into relations, so, when it comes to the establishment of interactions and networks which in some society we realize based on common values (Baker). It represents and social trust also, or a link with witch we contribute to coordinated and cooperative work with others for mutual benefit. In short, the social capital is important to us because it affects on the intensive involvement of employees in the company's activities and work performance, warns us on the fulfillment of obligations, on the affiliation and loyalty to the economic entity in which we work.

From the standpoint of the company, social capital becomes interesting only if it can be directly recast in the economic capital. For example, if we have a pronounced social capital and expand our circle of people, thus we reduce our dependence of a single source and arrive at new sources, new people, who offer us useful tips and information (Simmons). With our social capital, we establish and expand confidence that represents the foundation for progress of our company and economic development generally. In companies where between the employees is high level of social capital, there is enhanced the quality and quantity of spreading information, transparency is greater, also the credibility and accountability of employees and their activities, and we are facilitated by provisioning of external resources and public services.

3. Data collection and research methodology

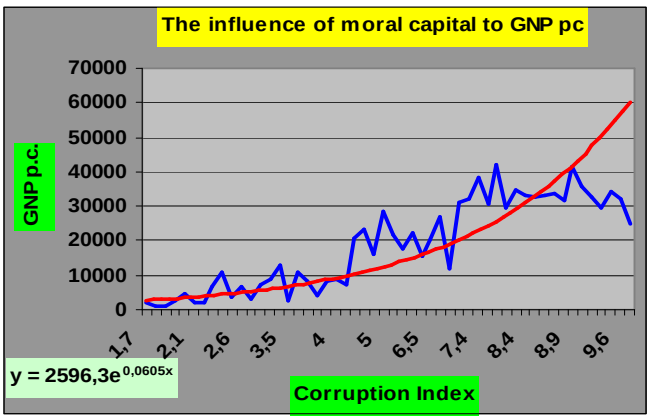
The collected data refer to a sample of 52 countries and their statistical data on segments of human capital (the moral, intellectual and social capital), for the observed, year 2008.[1] The moral capital as part of the human capital for research in this paper represents a variable index of corruption, the intellectual capital as part of the human capital represents a variable the Prosperity Index Education, the social capital as part of the human capital represents a variable the Prosperity Social Capital Index, while the economic development of countries of the world represents the variable GNP p.c. This is the official statistical data for 52 countries of the world by the organization in London the Legatum Institute, publicly published in year 2009.

3.1. Analysis of survey results

The collected data were processed and analyzed using the statistical package of program SPSS, with the application of exponential functions and analysis of linear correlation matrix and multiple linear correlation matrix, and obtained research results are presented and interpreted by creating graphs and tables.

3.2. The influence of moral capital to GNP p.c.

The survey observed the impact of moral capital, which is represented by a variable the index of corruption, on the economic development of countries of the world, which is represented by the variable GNP p.c.



Graph 1. The influence of moral capital to GNP p.c.

As shown on Graph 1, it can be seen (blue curve) that with increase of the index of corruption is growing the GNP p.c. also, with specific, less significant and mostly irregular deviations. Also from the same graph can be concluded (red curve), and it is about the exponential function y=2596,3e0,0605x, that there is regularity of the impact of variable index of corruption on the GNP p.c., and that with the growth of index of corruption (methodology of corruption index calculation said, the higher is the index of corruption in a particular country of the world, actually the corruption is less) also grows and GNP p.c. of world countries, besides that the graph shows that the growth rate of GNP p.c. is larger and faster as the index of corruption grows. From this we can conclude that, at high underdeveloped countries that have low moral capital, or high corruption in society, every combating of corruption, brings less positive effects, while, as the level of development of countries of the world grows, every decrease in corruption in the society brings increasing positive effects on economic growth and development.

3.3. Influence of different segments of human capital on economic development of countries of the world

The survey observed the influence of different segments of human capital on economic development of countries of the world, or the influence of moral capital, which represents a variable the index of corruption, then the intellectual capital, which represents the variable Prosperity Education Index, and social capital, which represents the variable Prosperity Social Capital Index, on the economic development of countries which represents the variable GNP pc.

Table 1. Linear correlation matrix of variables: the index of corruption, the Education Index Prosperity, the Prosperity Social Capital Index and the GNP p.c.

Linear correlation matrix				
	Corruption Index	Prosperity Education Index	Prosperity Social Capital Index	GNP p.c.
Corruption Index	1,00	0, 8	0,53	0,91
Prosperity Education Index	0,8	1,00	0,27	0,88
Prosperity Social Capital Index	0,53	0,27	1,00	0,55
GNP p.c.	0,91	0,88	0,55	1,00

As shown on Table 1, or analysis of linear correlation matrix, it can be seen that all observed segments of human capital (the moral, intellectual and social capital) have a positive impact on the GNP p.c. Variables the corruption index (0.91) and the Education and Prosperity Index (0.88) have a very significant positive impact on the GNP p.c., while the variable Prosperity Social Capital Index (0.55) have positive, but have no significant impact.

Multiple linear correlation matrix	
constant	20.949,9
square coefficient	0.92
standard error of regression	3.896,9
number of observations	52
degrees of freedom	48
dependent variable	GDP pc
variable	coefficient
Corruption Index	189.5
Prosperity Education Index	21.9
Prosperity Social Capital Index	8.9

Table 2. Multiple linear correlation matrix of variables:

the index of corruption, the Education Index Prosperity, the Prosperity Social Capital Index and the GNP p.c.

As shown on Table 2, or analysis of multiple linear correlation matrix, it can be seen that by the square coefficient of 0.92, in interaction of the observed three variables and dependent variable the GNP p.c. all variables of the human capital (the moral, intellectual and social capital) have a positive and significant impact on the dependent variable, besides variable the index of corruption has the greatest positive impact, then the variable Prosperity Education Index, and finally, the variable Prosperity Social Capital Index.

4. Synthesis of research results

The study was aimed to test the hypothesis that human capital has a positive and significant impact at the macro level and that countries of the world with more developed human capital, by average, are significantly more developed economically and have a faster and higher rates of economic growth. The research further tested the hypothesis that segments of the human capital, moral, intellectual and social capital, are also positive and also have the significant impact on the economic development of countries of the world, with the greatest impact on the economic development of individual countries, by average, has the moral capital, then the intellectual and finally the social capital.

As can be seen from the analysis of research results, the hypothesis that human capital has a positive and significant impact at the macro level and that the countries with more developed human capital, by average are significantly more developed economically and have a faster and higher rates of economic growth proved to be positive. Research has also shown a positive hypothesis that segments of the human capital, moral, intellectual and social capital, have also the positive and significant impact on the economic development of countries of the world, with the greatest impact on the economic development of individual countries, by average, has the moral capital, then the intellectual, and finally the social capital.

Furthermore, analysis of survey results showed that with the growth of the index of corruption is growing the GNP p.c. also, and the GNP p.c. growth rate is greater and faster as the index of corruption grows, or as the corruption in the society of certain country is reducing. Also the results of research showed that the variables of moral and intellectual capital have a significant positive impact on GNP p.c., while the variable of social capital has a positive, but have no significant impact on GNP p.c.

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Appendix

Australia	Kenya
Austria	Macedonia
Bangladesh	Mexico
Belgium	Netherlands
Brazil	New Zealand
Bulgaria	Nigeria
Cameroon	Norway
Canada	Pakistan
Colombia	Paraguay
Czech Republic	Portugal
Chile	Romania
Croatia	Russia
Denmark	Singapore
Estonia	Slovakia
Finland	Slovenia
France	South Korea
Germany	Spain
Ghana	Sudan
Greece	Sweden
Honduras	Switzerland
Hong Kong	Turkey
Hungary	Ukraine
Ireland	United Kingdom
Italy	USA
Jamaica	Venezuela
Japan	Vietnam

Table 3. List of countries involved in the research.

Prevention and rehabilitation of ACL injury to the athlete's knee

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Abstract

One of the worst injuries that can happen to an athlete is anterior cruciate ligament (ACL) damage or rupture. The objective of this work is to highlight the significance of preventative conditioning training in preventing the number and severity of injuries of an athlete on an example of anterior cruciate ligament injury to the footballer's knee. Moreover, in the interest of this work is to outline the program of rehabilitation of anterior cruciate ligament injury to the footballer's knee through individual stages from the moment of injury to returning to sports activities with the emphasis on functional rehabilitation of postoperative rehabilitation. Special attention should be paid on the gradualness of usage of individual operators with reference to structural condition of the knee joint. The footballer should integrally accomplish the individual stage aims of rehabilitation to achieve the knee stability and to completely return to the sports activities as fast as possible.

Keywords: prevention, rehabilitation, anterior cruciate ligament, football

1. Introduction

Sport as a peculiar phenomenon of the modern world doesn't implicit only the values which are reflected in health and physical development, but the emphasis is much wider because it covers socio-cultural human nature, which is another reason it is an important factor in creating one's personality. Sport is undoubtedly one of the commonest socio-cultural phenomenons that has found its place at all levels.

Nowadays football is one of the most popular games in most countries of the world. With the development of football, different game systems, as well as their role that has changed through time, have progressed. This alone has led to extra requirements that have been put before the footballers. A complex of anthropological characteristics and specific abilities of a player to control the system and the game concept, game tempo and rhythm, as well as one's own bioenergetics capacity and functional state during the game is responsible for success in football [1].

Conditioning preparation contributes to injury prevention through its own multilateral-basic and specific-situational type of training. In the framework of multilateral-basic conditioning preparation, the prerequisites for specific and situational preparation are created. The greater the level of fundamental development of conditioning characteristics is, the lesser is the possibility of injuring within the situational type of training, which actually brings along the greatest danger of injuring [2].

Anterior cruciate ligament injury (damage or rupture), one of the major parts of the connective tissue that stabilizes the knee joint and connects femur (femoral bone) with tibia (shin-bone), is extremely painful and demands a lot of time for recovery, as well as a rather sophisticated rehabilitation technique in order to restore normal knee functions.

After the surgery, rehabilitation process contributes to quicker and proper healing, implanted transplant protection, recovery time reduction, and what is important to a footballer, quicker return to sports activities. Besides, properly conducted rehabilitation considerably decreases the risk of reinjuring which is significant in preventing chronic knee joint instability.

Every athlete, as well as a footballer, should practice preventative conditioning training. Preventative conditioning training is based on promoting of all

segments of the locomotor system with the purpose of avoiding athlete injuring, and alleviating of the sports injury consequences which is especially important with severe injuries like anterior cruciate ligament rupture.

2. ACL injury in football

2.1 Functional anatomy of the knee joint

Before describing anterior cruciate ligament injury, a brief insight into the knee joint anatomy is required. Knee stability is provided by the stabilizers which are divided into active (muscular-tissue system) and passive (ligaments, menisci, bone structure). Upper leg muscles (front, medial and rear group) are the most important for the knee joint stability, as well as for the football demands. That is way it is very important to pay great attention to strengthening upper leg muscles in prevention, as well as in ACL rehabilitation.

The subject of this work is cruciform ligaments, *lig. cruciatum anterius et posterius*. These are two short and very firm ligaments located in the joint interior. They are stretched between intercondylar notch of femoral and shin-bone and intersected, with each one of them being helical around its axis. The cruciform ligaments enable permanent contact of intra-articular bodies in any articular position because a part of the ligaments is always strained [3].

2.2 Injury mechanisms of anterior cruciate ligament of the knee

There are numerous variations of ACL injury scenarios, e.g. at the moment of running, when the leg is firmly on the ground, a collision with another person can occur which can lead to the leg being hit near the knee. ACL damaging can happen surprisingly fast in the case of a sudden tibia turning. This kind of injury and the tearing of ACL out of its bearing can occur when somebody's foot is stepped on during running or at landing, which leads the knee into the state of hyperextension. An excessive flexion and deterioration as a result can easily lead to ACL injury. Indicated appended tables show the most common mechanisms of the footballers injuring considering their positions during the game (Table 1.), and the major causes of ACL injuring in football (Table 2.) [1, 4].

Table 1. ACL injury occurrence mechanism

Position during game	Duels	Running	Fall	Kick	Rest
Goalkeeper	9 (50%)	1 (5,6%)	-	1 (5,6%)	7 (39%)
Defender	28 (42%)	16 (24%)	15 (22%)	5 (7,5%)	3 (4,5%)
Midfielder	25 (35%)	21 (29%)	10 (14%)	8 (11%)	8 (11%)
Striker	17 (34%)	18 (36%)	7 (14%)	7 (14%)	1 (2%)

Table 2. Main causes of ACL injuring in football

Main causes of injuring	
Acute	**Chronic**
Kicks	Overtraining
Falls	Microtraumas
Distortions	Imbalance
Control loss during performance	Control decrease during performance

3. ACL injury prevention in football

Based on the insight of the football demands, notions on the most common footballer injuries, as well as the anterior cruciate ligaments injury mechanisms and its diagnostics, it is possible to approach the planning and programming of preventative conditioning training for the footballer's ACL injury.

The main parts of the preventative conditioning training are: muscular and connective tissue improvement, flexibility development and proprioceptive training (Figure 1.). Preventative conditioning training is based on the advancement of all the segments of the locomotor apparatus with the purpose of avoiding the footballer injuring and alleviating football injuries. Injury prevention is possible in several segments: training, competition, weakened sensomotor system links after the injury and completed rehabilitation, and weakened sensomotor system links which could yield under maximum pressure. After defining the risk factor, the next step of injury prevention is an optimum training planning and programming [2].

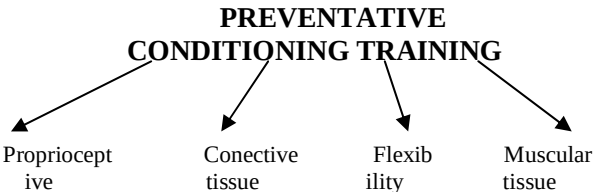

Figure 1. Integral parts of preventative conditioning training

3.1 Muscular tissue improvement

Although the muscular tissue improvement on structural and functional level is a constituent part of basic conditioning training, it can nonetheless be observed through a preventative context. Structural positive muscular tissue changing is directed at the optimalization of the pure muscle mass and subcutaneous adipose tissue, as well as at the optimalization of the total quantity of muscle mass in relation to football demands. Namely, one of the functions of the quality muscle mass is prevention of articular system from risk movements and incidental injuries. The functional aspect of an athlete's muscles improvement is reflected in the level of intra- and intermuscular coordination. Intramuscular coordination is described by the mechanisms of activating control and synchronization of different number and types of muscular tissues inside one muscle. Intermuscular coordination implies synchronization between more muscular groups during the performance of specific motion or series of motion in integrated or multiplanar surroundings. Considering coordination aspects of muscular development, the muscle injury possibility will be reduced and motor abilities of an athlete improved. Also, it is quite possible that, by accomplishing mentioned tasks, the number and severity of the footballer injuries will decrease [2, 5].

3.2 Connective tissue improvement

Connective tissue improvement is a particularly important segment in the preventative training of a footballer. Ligaments, tendons, cartilages and muscle fascia are critical points of the locomotor apparatus that are located between the muscles and bones. Joint stability, flexibility, and protection greatly depend on quality of connective tissue. Majority of scientific research and empirical notions have recognized that training can improve their quantity and quality. Main points where the quality of soft tissues can be improved are: tendon (ligament) and bone attachment; intra-tendon and ligament; in the fascia network inside of the muscles. Connective tissue development occurs somewhat slower than with muscles, but accounts for sufficient contribution of all the locomotor apparatus' segments, which is a basic prerequisite for the sports injury prevention [2, 5].

3.3 Flexibility development

Since the competition and training performance in football depends on the range of motions, the meaning of flexibility improvement becomes increasingly emphasized. According to Jukić and associates, 2003 benefits from the flexibility improvement, besides range of motions expansion (Taylor and associates, 1990), are reflected in muscular fatigue prevention (De Vries and Adams, 1972), prevention of the muscular abscess after training (De Vries, 1961). Moreover, flexibility improvement as a consequence has reduction of the number and severity of injuries of a footballer (Surfan and associates, 1988, Frontera, 1999, Jukić and associates, 2003). The safety aspect of the flexibility improvement is reflected in the framework of direct preparation for training and competition exertions, as well as in procedures in the framework of relaxation and muscular system recovery immediately after the training and competition. Modern tendencies in this segment of the football preparation are markedly directed towards the development of the dynamic flexibility [2, 5].

3.4 Proprioception

Proprioception is the locomotor system ability for adequate responses to specific, and often to unusual static and dynamic stimuli (Potach and Borden, 2000, according to Jukić and associates, 2003). Broad spectrum of training contents, that have become a part of proprioceptive training, are based on that. (Hanney, 2000, according to Jukić and associates, 2003). Placing of a footballer's body into a great number of training situations that will provoke the proprioceptor activation, conditions will be created that the footballer will react optimally in urgent situations, which might cause injuring. Proprioceptors are special sensory structures placed in joints, muscles and tendons (Harris

and Dudley, 2000, Lephart and Fu, 2000, according to Jukić and associates, 2003). That is at the same time basic meaning of the proprioceptive training [2, 5].

4. ACL injury rehabilitation

Rehabilitation (lat. RE – again; HABILITARE – to make fit) is a complex process of making competent for everyday and professional life, as well as for emotional and social stability of a footballer who has that kind of ability completely or partially lost because of the illness or injury. This actually means the return of the footballer into psycho-physical state that is identical to the state before the injury. The process of rehabilitation begins directly after the injuring and lasts as long as it is demanded by disrupted abilities, whereas it is individually adjusted to every footballer [1, 2, 5].

4.1 Preoperative rehabilitation

The aims of preoperative rehabilitation are: to closely determine the preoperative status, to determine the patient's objectives, to strengthen the muscular system of the shin-bone, to provide the patient with educational material (literature), and to teach him the preoperative and postoperative methods.

4.2 Postoperative rehabilitation

The aims of postoperative rehabilitation are: to protect the ligaments after the surgery in order to enable maximal, long-term stability; to restore the knee mobility without pain in order to enable the activity progress during rehabilitation; to develop muscular stamina and functional abilities in order to enable gradual activity reversion; to develop coordination, including contraction, balance, biofeedback in order to prevent reinjuring; to conduct functional testing, to explain to the patient the aims of rehabilitation; and to take orthosis into consideration during and after rehabilitation.

There are different methods of physical medicine and rehabilitation, kinesiotherapy and isokinetics in postoperative, as well as in preoperative, rehabilitation.

5. Practical example of acl injury rehabilitation after surgery

This practical example of ACL injury postoperative rehabilitation outlines individual stages which a footballer passes through before returning to complete competitive activity. Neither the stages nor the total duration of rehabilitation are terminable because they differ in age, individual abilities and characteristics of footballers, as well as in aims in sports career. Transition from one stage to another is defined by goal achievement of antecedent stage. Progressive level enhancement of training intensity and exertion is based on a footballer's pain tolerance, swollen joint condition, and articular range of motions [2, 4, 5, 6, 7].

5.1 Acute phase

The aim of the first phase of rehabilitation will be decreasing the swelling and increasing range of motions. That's why the RICE (Rest, Ice, Compression, and Elevation) method is used immediately after surgery. Furthermore, we use physical therapy, exercises of passive stretching to pain tolerance limit with the help of a kinesiotherapist, stretching 3 times a day for a period of 15-20 minutes, isometric contractions and walking on crutches with a light support on the leg to pain tolerance limit.

5.2 Post-acute phase

The aim of the second phase is to increase flexion, walking and returning to everyday activities. To proceed with kriotherapy. To proceed with physical therapy. Exercising: to proceed with passive stretching to pain tolerance limit with the help of a kinesiotherapist, and if possible, to begin active stretching and PNF exercises.

As soon as the footballer is ready, it is necessary to start with functional rehabilitation which will last as long as the footballer stops feeling pain during the activities. Four main aims of functional rehabilitation are: the return of complete and painless motion, the progressive strengthening of upper leg muscles, the restoring of neural-muscular coordination by proprioceptive training, and gradual integration of the footballer in the system of competition by conducting the exercises specific for his sport.

The consequences of inadequate ACL injury rehabilitation are: range of motions reduction, permanent pain, permanent swelling, and chronic knee instability. The objective of functional-rehabilitation

exercising is to restore locomotor system functions of the footballer to their optimal level, and in that way act preventive on chronic knee instability occurrence, and to accelerate the return of the footballer to training and competition.

5.3 Just before activity phase

The aim: strength and balance improvement. Exercising: ice, to proceed with kriotherapy, hydrotherapy, to proceed with passive and active joint stretching, isometric contractions with exertion, to apply the PNF exercises. To start the proprioceptive exercises, walking, support, to use bandages and orthopedic supports which limit the knee joint motion.

5.4 Activity phase

The aim: the return of the footballer to sports activities. Kriotherapy after exercising. To proceed with isometric exercises, progressiveness, PNF, proprioceptive exercises, eccentric contractions. To start the program of running. The beginning of plyometric exercising.

5.5 The phase of returning to competition

If necessary, proceed with kriotherapy after exercising. Exercising: sustainable training, everyday stretching, isometric program, plyometrics, specific exercises (the footballer should painlessly perform all the specific motions of his sport), muscular strengthening, proprioceptive training, walking, running, functional bandaging. The emphasis is on the proper performing of motions. Extremity function enhancement and returning of the footballer to the sports activities have to be gradual so that he will be provided with a safe return and minimal risk from reinjuring.

5.6 Knee joint stability phase maintenance

Active stretching exercises, isometric exercises conducting, PNF, running on uneven surfaces, isokinetic apparatus exercising, muscular strengthening exercises. Proprioceptive training is conducted with full support on the injured leg. Plyometrics – begin with two-foot and one-foot jumps, progressiveness. Prevention.

Conclusion

A footballer should, during his entire sports career, pay great attention to preventative conditioning training because it is based on all the locomotor apparatus segments with the purpose of avoiding injuring and sports injuries mitigation. In the framework of expertly organized team work, together with training specialists, sports physicians and physiotherapists, nutritionists and psychologists, conditioning trainers should take a great deal of time and responsibility together with footballers to prevent football injuries, in this case an ACL injury.

Process of ACL injury rehabilitation begins directly after the injuring and lasts as long as it is demanded by disrupted abilities, and is individually differed from footballer to footballer. The program of rehabilitation itself is divided into more stages. The aims and tasks of each phase is described which the footballers need to satisfy in order to accomplish the main objective, which is the knee stability and the return to sports activities, namely competition.

It must always be borne in mind that anterior cruciate ligament injury shouldn't be "the beginning of the end" for the injured knee.

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Proper exercise performance in a fitness center for students

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Abstract

University of Applied sciences of Slavonski Brod, it is organized and enabled additional educational sports program for students in a fitness center. The program is optional and consists of theoretical explaining of exercise performing and their impact, demonstrating the proper exercise performing, and training types and forms which can be practiced and organized in a fitness center. The reason of writing this paper is poorly or almost none previous knowledge of the students beginners in the program and wrongly obtained knowledge of the students non-beginners of proper exercise performance. The precise objective of this work is to explain the elements and methods, and to emphasize the importance of proper exercise performance to students. Only proper performance of exercises, that the students will learn, is the only proper workout which gives results. The results of this kind of work out will be manifested through context of desired and proper impact realization of the exercise itself, health prevention and improvement, motivation and work ability increment, and planned and programmed goal achievement. At the beginning of educational sports program there was an initial testing of foreknowledge and knowledge of the students of proper exercise performance in a fitness center. The purpose of testing was to obtain homogenized groups on the basis of attained results, so that each training and the entire program would be more fit to every student. Aims and tasks of these additional programs are of invaluable relevance for proper exercise performance education and achieved results and at the same time, there is the habit acquiring for self-initiated whole-life regular physical exercising and prerequisite for preserving and improving of health. Their will and interest in participating in this kind of programs is the most important task that should be continually conducted and provided, and realized objectives and results the most valuable prize.

Keywords: proper, training, fitness, importance, health

1. Introduction

Based on the combined interests and volition of the undergraduates alone at the University of Applied sciences of Slavonski Brod, the students are provided with optional participating and using of additional educational sports program in a fitness center. This aspect of class is really interesting to students because only a few high schools are equipped with such apparatus and they have rarely had the opportunity to obtain basic information of methods and possibilities in working with weights and straining. The training alone and workout in a fitness center are a big question mark for most students.

Students of diverse profiles, foreknowledge, habits, gender and physical constitution participate in the educational sports program. Teaching training methods is a group of learning and exercising procedures directed at improving abilities, knowledge, and qualities of students, and which determines contents, physical exertion, methods, localities, and training equipment [1]. These methods both affect and direct students to the value and importance of workout in the context of boosting the quality of healthy lifestyle, namely habit acquiring and creating for self-initiated whole-life regular physical exercising, which is a prerequisite for preserving and improving of health. A habit leads to the need for moving and, if it remains during life, it will have an optimal effect [2].

At the beginning of educational sports program there was an initial testing of foreknowledge and knowledge of the students of proper exercise performance in a fitness center. Students were tested in a way that they had to demonstrate and explain their foreknowledge and knowledge of the following elements: 1. warming up, 2. method of performing the exercises, 3. proper breathing technique, and 4. physical exertion. Understanding and realization of these elements from the aspect of proper exercise performing is a prerequisite for a proper exercise and workout effect, as well as targeted results of the plan and program of the entire training agenda. On the

other hand, ignorance of these elements, i.e. irregular performance and disregarding, doesn't bring proper and aimed exercise and workout effect, training motives fade, and the most importantly, leads students into a suitable situation for injuring. From the initial testing made at the beginning of the program, 44 students declared as not having any foreknowledge either of possibilities and methods of exercising in a fitness center nor of proper exercise performing. Remaining 34 students non-beginners declared as having some foreknowledge of a fitness center workout, but during demonstration of exercises it was noted that they do not know the tested elements enough, i.e. they have acquired a poor and irregular technique of exercise performing which should be corrected. Besides the mentioned elements that were used for testing, the students should be referred to the other elementary ideas, actions and elements that should be noted and are essential for proper exercise performing and training in a fitness center in general. Selection and method of performing individual exercises should necessarily be adequate to the level of acquired exercise structure and the level of student's preparedness and objectives.

2. Exercising in a fitness center

Since there were no considerable deviations in irregularities of exercise performing and in using aerobic stimulators (bicycles and steppers) at the aerobic type of training, namely exercises, the emphasis of this work is on anomalies in elements of proper exercise performing with weights (single-handed, two-handed, and weights within the simulator). Utilization of bars, dumb-bells, single-handed weights, two-handed weights, simulators and the range of similar apparatus with the purpose of creating external resistance on skeletal muscles is called weight training. The least weight training element is one session [3]. One repetition can be defined as a complete exercise motion that we perform. The emphasis on proper performing and one session is a mere basis for the realization of transformational process, health prevention and preservation as well as setting the workout objectives. Weight training leads to numerous adaptational changes in human organic system, from nervous to hormonal (endocrine) system, through cardiovascular and respiratory system to skeletal system [4].

Since the reason for writing of this paper is the students' (beginners and non-beginners) poor knowledge and foreknowledge of proper exercise performing in a fitness center, basic notions of the proper exercise performing in a fitness center will be explained. First of all, students should determine the health status and condition status. The next step is planning and programming. In planning and programming we start from the results of diagnoses (initial state), set objectives, tasks, control measure instruments and standards, work means and methods, kineziologic operators, and the physical exertion intensity for aim and task accomplishment [5].

In order to prepare themselves and their bodies for the workout, as well as for that workout to give results, students should be instructed to following things. Being in a situation when the students are, from the foreknowledge aspect, beginners and non-beginners with the wrongly obtained knowledge of exercising in a fitness center, they are bound to use services of a qualified expert specialized in weight training. Moreover, attention should be paid on the hygiene of the area for workout, as well as on adequate workout clothing, namely clothes that enable unobstructed performance of all motions and that are not provocative. It is also important for the students, especially at the beginning of the program, not to set themselves too high demands and aims, i.e. not to overdo or compare themselves to others. Exercising on a full stomach, as well as on an empty one, is prohibited; this also goes for liquid input before training. There should be ensured an easy access to liquids during the training. The way in which a trainee approaches the weights with his upper extremities is called a grip. There are different grip forms (palmar position in relation to the apparatus, opened, closed) and widths, depending on the effect of the exercise and the aim of the training. The range of a motion itself is defined by the construction of weights and simulators, flexibility of the trainee and the exercise training orientation [6]. A student should be warned that, in case of an inappropriate lifting, one doesn't save the weight because that is when the injuries happen most frequently. A required reference is not to avoid stretching, because muscle stretching accelerates recovery, increases joint mobility and muscle elasticity, decreases muscle tension, increases muscular and intramuscular coordination. Weight training has interval training characteristics, namely the intervals of work and rest alternate, which is why the rest is a constituent part of the training. There are different kinds of equipment in a fitness center. Regardless of the type of practical training or competitive equipment [7], it should above all fulfill elementary safety rules [1,6,7,8].

3. Examinee sample

There were 78 regular students from the 1st and 2nd year of the University of Applied Sciences of Slavonski Brod that participated at the beginning of educational sports program. Students that entered the sample were the ones that wanted to participate in the program optionally. 44 of them are beginners, i.e. not having participated in any sports program, and 34 non-beginners having participated.

The information that 44 students beginners don't have any kind of foreknowledge of proper exercise performance, nor have they ever been involved in any sports program, and therefore not analyzed in testing, is very disturbing. Given the fact that they are future college graduates and prospect exponents and society promoters, the information alone is warning.

4. The sample and the interpretation of the importance of elements in testing

Sample of elements which were used in testing consisted of four knowledge tests and proper demonstration 34 students non-beginners participated.

4.1 Warming up

The form and method of warming up were a student's choice. It was tested to what extent and if they even used warming up as a preparation of the body for physical activities.

Proper warming up increases the "temperature" of individual body regions or the whole body, pulse rate rises, circulation improves, which enables a supply of higher quantity of nutrients and oxygen to muscle cells, and waste removal. In addition, proper warming up enables more complete trained muscles contraction, improves coordination, flexibility, power, strength, stamina, and muscle and connective tissue resistance to injury. It altogether promotes safety and effectiveness of training process. [6, 7]

4.2 Exercise performing method

Students performed an exercise by choice in the fitness center, namely the exercise for which they could, in their opinion, best demonstrate performing technique. The only condition in choosing the exercise was to demonstrate an exercise with weight. Assuming safe starting position and continued, namely safe and controlled performance were tested.

Every exercise and training operator are chosen and/or created on basis of individual characteristics of the trainee and desired exercising effects [6]. This implies that different systems of exercises with weights will be applied to trainee of different age, gender, health status, and level of training [6]. There are distinct variants of exercise performing and, regardless of objectives (tempo of performing, range of motions) and individual characteristics (age, gender, flexibility, anthropological characteristics), way of performing the exercise should always be proper. Working out in a fitness center brings students into different positions of standing, sitting, kneeling, squatting, and lying. Regardless of the diversity of positions, exercising with weights demands extremely stable basic posture. This kind of position ensures mobility of extremities and bio-mechanical optimal course of body parts and weights, but also prevents injuries. At the beginning of performance of any kind of exercise with weights, a student has to find a position which provides him with a safe access to a weight in an optimal way and an ideal position to begin performance. There are two phases within the performance of one cycle: concentric phase (overpowering phase) and eccentric phase (easing phase). Considering the training objectives, the tempo of performing of both phases can last differently. It is important for the students of poor knowledge and foreknowledge to learn assuming safe starting position and controlled and safe motion.

4.3 Breathing

Inhaling and exhaling technique was tested during the exercise.

Proper breathing during the exercise enables oxygen supply to the lungs, heart and brain. Adequate technique and rhythm of breathing enables undisturbed repetition of exercises. A proper breathing technique will prevent dizziness, disorientation, temporary blacking out, and sudden high blood pressure. Breathing implies inhaling in eccentric, easing phase and exhaling in concentric, overpowering phase in performing of individual repetition [6].

4.4 Physical exertion

Physical exertion wasn't assigned in any way. It was tested how training exertion affects proper motion performing.

Training exertion [8] is structured by two components: exertion intensity, i.e. stimulus magnitude, and exertion volume, i.e. stimulus duration. Intensity is in proportion of training with exertion and defined by size of force surmounted (e.g. intensity of the used weight). Exertion volume in training with resistance is defined by the number of repetition during suppressing of some force (e.g. number of repetition, i.e. number of weight lifting). Exertion in exercise performing needs to be adjusted to individual characteristics of the trainee, respectively so the exertion doesn't disrupt proper motion structure. Inadequate exertion can lead to unwanted consequences, such as: pulling tendons and distortion of particular body parts. Therefore, rather small weight should be used with learning new motion structures so that proper exercise performing can be learned first (automatism of movement), and then gradually increase the weight, considering the objectives of exercising. [8]

5. Obtained results and a discussion

It can be concluded, based on the obtained results, that most students non-beginners don't have adequate foreknowledge of proper exercise performing, namely it can be asserted they have been wrongly educated and informed. The objective of the testing was to get homogenized groups of students, i.e. to learn their level of training, and to what degree they know and understand proper methods and technique of exercise performing. Out of 34, 12 students (35, 29%) didn't even warm up but immediately approached to performing the exercises, while 22 students (64, 7%) used warming up as a preparation of the body for the demonstration of the exercises. During the way of exercise performing, students' safe starting position, which they assumed at the beginning of exercise performing, and the continuity of movements evident in safe and controlled method of exercise performing, were tested.

Table 1. Movement performing method, the results of the students non-beginners in testing.

Movement performing method	Number of students	% of students in testing / in program
Performing position		
- safe	14	41,17 / 17,94
- unsafe	20	58,82 / 25,31
Movement continuity (overpowering and easing phase)		
- continued	9	26,47 / 11,53
- discontinued	25	73,52 / 32,05

According to the data in Table 1. it can be observed that most students don't have either the safe position of performing an exercise, nor movement continuity. During the demonstration of the exercises by the students, there were noticed uncontrolled weights accelerations, improper and unsafe posture which disrupts the balance and prevents proper movement amplitudes. The reason for not assuming the proper position and for movement discontinuity lies within the ignorance of proper ways of doing exercises, namely of the structure of the demonstrated exercise itself and its impact on the musculoskeletal (locomotor) system. This is not the way to achieve desired effects of exercising and it also increases the possibility of injuring. During the exercise demonstration, 7 students (20,5%) had the knowledge of proper breathing technique and they demonstrated it during workout. The observed mistakes were in irregular breathing and in not breathing at all during the exercise performing. The analysis also established that the students the demonstration itself perform with an excessive exertion (training exertion) which directly disrupts proper movement structure. The important remark is that the students do not understand the purpose of training exertion and the impact of too much exertion on proper movement structure and safe performing. The purpose of the training exertion needs to be in the function of progress. When the trainee is capable to correctly perform an exercise under various exertions (from minimal to maximal), then it is possible to say that the exercise has been completely acquired [6]. The reason for too high training exertion is setting oneself too high demands and aims, and comparing oneself to other individuals. Table 2. shows results in relation to proper and improper way of exercising.

Table 2. The results of proper and improper exercising.

Proper exercise performing	Improper exercise performing

Health status improvement	Health status disruptment
Achieving set goals	Failing set goals
Proper exercise impact	Improper exercise impact
Positive transformational effect	Negative transformational effect
Injury prevention	Injury possibility
Motivation	Lack of motivation

6. Conclusion

Nowadays everyday life of students is characterized by less moving and the minimum of leisure activities that are poorly or not at all connected to physical exercising or sorts in general. The scientific insight convincingly shows that nowadays the physical inactivity is one of the strongest factors of health disrupting [9]. It is indicative for the population of Croatia that motor abilities gradually decline with the young with maturity (functional abilities in particular) which is the cause of many health disturbances [10]. The important message and meaning of sport and sports training is health promoting, and the lifestyle which influences the health prevention and improvement, motivation and work abilities boost, and the creating of habit of regular physical exercising. Engaging in and sports activities practicing should be of prominent general social interest because of the negative impact of non-motion on the human organism, that the young are more and more exposed to because of technological development in modern world. In order to properly use sports programs in a fitness center or other sports programs, students need to be provided with acquiring of basic theoretic and practical knowledge which will enable them to program and perform the training process independently. Only the adequately formed training operator has a realistic transformational power in relation to targeted characteristics of a trainee/athlete [6]. Their foreknowledge and knowledge of basic training elements and proper exercise performing is unsatisfactory. What is satisfactory is their will and interest in providing them with a participation in quality and professional sports programs. The exercising itself will otherwise lead them into discomfort, failing to achieve goals, injury possibility and giving up on any kind of aspect of physical exercising. Everybody can work out in a fitness center, regardless of physical condition, age or gender, and diversity of objectives and motives of exercising. Students should be prevented from going into life with a lack of understanding of importance and habits of regular exercising.

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Utilization of computer simulation for teaching of technical subjects

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Abstract

The article deals with computer simulations using in teaching, which is becoming a modern trend of making technical subjects more efficient in teaching. It explains the principle of computer simulations, their distribution and characteristics of the modeling system and model. A special chapter is devoted to practical experience of using simulation software and access to its implementation into teaching.

Keywords: Computer Technologies and Applications, Computer Simulation, Pedagogical Process, Manufacturing Systems

1. Introduction

The process of model creation and execution of real experiments with this model for better understanding of the behavior of the system studied can be conveniently used in education, specifically for teaching courses in Manufacturing Systems, Logistics and so on. From past experiences it can be concluded that the simulation teaching models markedly support the teaching of subjects Manufacturing Systems, they built on good knowledge base of Manufacturing technology course, while allowing their practical application.

Simulation models are very flexible and can be used to solve a wide range of technical and managerial problems. They allow f. e. very well to quantify the consequences of capacity changes in various equipments. Some limiting of simulation models use lies in the ability of users to compile simulation models to show realistic situations studied. Current commercially available program funds provide a relatively high user comfort that the user does not excessive professional demands. Practically, this means that the simulation models allow us to pursue "fictitious experiments" and monitor their effects, without the user has to implement them in practice.

2. Principle of computer simulation

Simulation can be defined as an imitation of the real things, conditions, relationships or processes. Simulation is a numerical method of complex dynamical systems which use experiments with computer models.

Computer simulations can be characterized as a way of viewing behavior of real object on the computer. Generally, the term means the process of creating a simulation model of the real system and conduct experiments with this model for better understanding of the behavior of the study system in order to assess whether the different variants of system operation (Fig. 1) [2]

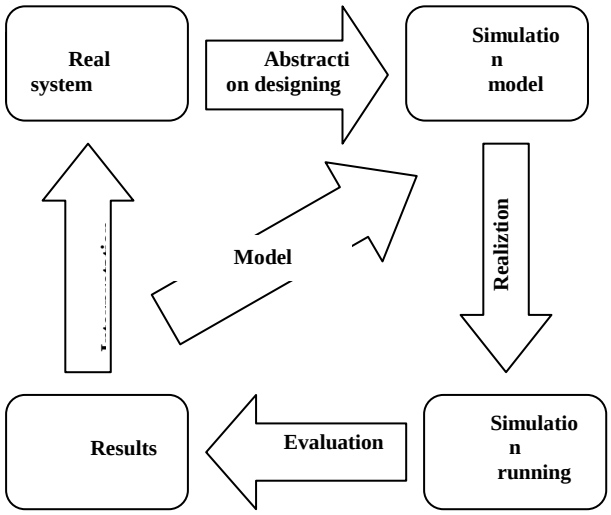


Fig. 1. The principle of simulation [2]

Simulation is the process of logical-mathematical model creation of a real object system as defined there in, or decision-making and

implementation of a large number of experiments with it, to:

- a description of system,
- the knowledge of its function,
- an estimate of its future behavior,
- finding solutions to the problem which is often transformed to:
- design and verification features of the new system structure.

The most expanded simulations are simulations on computer simulation models. For their design and realization can be used spreadsheets, but mostly specialized software products, which many are in the market. Their using remove one of the major obstacles to widespread use of simulation in practice - the compilation of simulation models in an environment of conventional programming methods were very difficult and it requires specialists work. Recent versions of these products also offer optimization features that are able to verify and select the best variant of the problem.

Nevertheless, it should be noted that the application of simulations is also associated with problems and their success depends on respecting the principles:

- Establishment of the model requires a mastery of the model object or process. Thereat, the cooperation of a wide range of experts is needed. It is not possible that the formulation of the model worked as a specialist focus on modeling.
- The simulation models more valid than the classical model of their design approaches finality. Interpret the results obtained are only for the purposes for which the model is formulated.
- Considerable effort also requires the collection of information. Without them it is not possible to test the accuracy of the model established by the office.
- For selection of model variables and the relationship between them the principle to identify those that are important to the proper function of the model. It makes no sense to try to move into the model elements and links which don't have to principally influence for the proper function of the model.
- If the simulation model is used repeatedly, f. e. for operational planning, it is necessary to ensure its continuous updating of the changes occurring in the real system. [1]

2.1 Dividing of computer simulations

Computer simulation can be divided into two groups according to the nature of the variables in the modeling of processes:

- discrete simulation process where the model variables can only take predetermined values,
- simulation of continuous processes with continuous-time variables.

From the term aspect we divide the simulation:

- static simulation, which generates a system status at any given time,
- dynamic simulation in which we are trying to capture the evolution of the system over time.

In relation to the random variables we talk about:

- deterministic simulations, without considering of the random variables,
- stochastic simulations with random variables. This group of simulations is known as Monte Carlo simulation.

The most advanced models are simulations of discrete, stochastic and dynamic because an continuous variables can be substituted by mostly sufficiently dense network of discrete values.

3 Utilization of the computer simulation in education

The using of computer simulations in teaching of the technical and economic subjects is becoming a modern trend, while an essential tool towards enhancing the efficiency and attractiveness of the teaching process. In the traditional method of learning and knowledge validation process is process of individual projects creation and their evaluation very laborious and time consuming. In recent years it is expanding the use of educational systems, electronic books and virtual laboratories and the growing importance of e-Learning as a modern way of teaching supported by computer technology.

Slovak Technical Universities are improving of teaching in that area and they are doing the preparatory works related to the processing of study materials, tests and making the award, as well as design their own proposal for the creation of educational software systems. In the pedagogy practice are used the following kinds of learning [3]:

A. Study of finished models. Demo-models are good material for initial acquaintance with the possibilities and principles of design and using of simulation models. The models of more complicated real systems present a detailed display options modeling reality and they are an important motivational factor for the study of Witness – the most used tool for simulation teaching.

B. Self-study, self-test, testing and evaluation of theoretical knowledge. Simulation and modeling in Witness also has some elements of the knowledge of which for students are appropriate and necessary to verify (model elements, features, rules, functions, variables in reports, special tasks, probability distribution,...).

C. Verification of practical skills in creating of models and analysis of manufacturing, service and other systems. Students solve the concrete assignments for which they are construing as described model to analyze, to propose improvements to optimize the system.

D. Simulation games. For students they are attractive by competitive forms of learning. An example might be a test, which was on the website Lanner Group, Inc. In which the visitor could verify his analytical skills in setting the parameters of presented system and try to reach a record in competition from other visitors.

E. A comprehensive system for teaching of production managing and modeling of manufacturing systems would be presented by simulation game in which the students get to know of run the entire company of the adoption contract and phased to the production and optimization, f. e. ways of planning and production management, capacity planning and term of production,

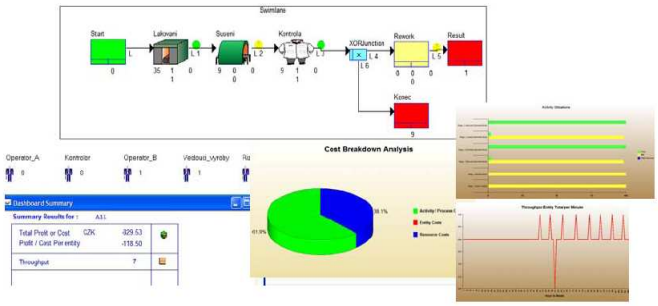


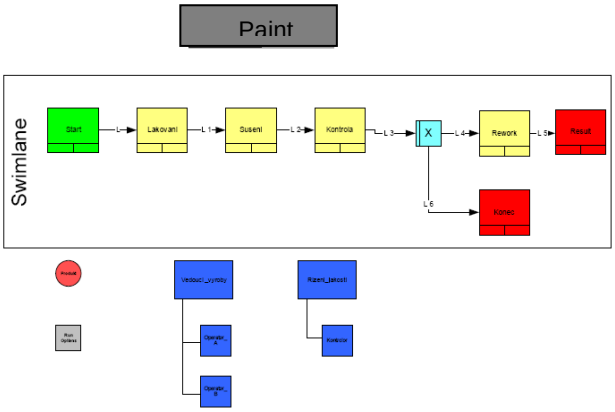
Fig. 2. Model of the paint shop [4]

F. determination of batches (different ways), the determination of transport benefits calculations bottlenecks, balancing production lines, or compare the analytical and simulation approach, and so on.

The main aim of the project of software integration into teaching is to design and process documentation for using of software for analysis and simulation. Self - solution was divided into several stages:

1. Proposal for software inclusion for analyzing, documenting and simulation of business processes into teaching.
2. Treatment of users manuals, which serve as an instrument in teaching and also for individual work of students and graduates.
3. Creation of case studies.

A good example of a case study application for students is a case study of the Paint shop [4]. The entered statements were: gloss oven capacity, technological process of painting expressed by the preparation and production times for 1 piece, the actual painting time, real time of visual control, % returning parts for repair and efficient working time. The task was to describe the process of using notation IDEF3 and then simulated for the time of one week. Graphical output of a simple model of the painting line is shown in fig. 2 and the generated result of simulation model, including an example of reports is shown in fig. 3.



Current requirements for upgrading of technical and economic subjects teaching, the premise of the needed individualization and increasing the attractiveness and accessibility of information objects leads to pursuit of a wider use of IT capabilities and the Internet in teaching and student self-learning. Quality teaching tools are particularly necessary for the individual studies the issue for the student projects and final thesis. Compared with the past is a vital need to increase the attractiveness of teaching process, students will be actively engage in problem solving, it develop their creativity and logical thinking, giving him a feeling of certainty that they will be able to solve complex problems and practice.

Using of computer simulations is an appropriate didactic method for attractive and innovation of the learning process. Students are able to create stimulating interactive simulation models by using the knowledge gained from previous courses and professional practice to apply the acquired knowledge through very interesting and attractive form.

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QUALITY VALUATION OF TEACHING SUBJECTS BY THE QUESTIONNAIRES

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Abstract

The quality of teaching and educational process at all, depends on various factors. In this process are the main stakeholders, students and educators. Educators convey their expertise to students and students participating in teaching in order to obtain such knowledge. To what extent are teachers satisfied with the level of duties and a management download matter is reflected in the evaluation or testing in the credits. How satisfied are, however, students can clearly show in their survey ranks eg. through questionnaires. The processing of questionnaires, using appropriate methods can be developed a clear picture of customer satisfaction, needs and ideas of those surveyed students. Expressing his opinion reveals the weaknesses and provide opportunities for improvement in different directions depending on the question in the questionnaire.

Keywords: Pedagogy and Didactics, Teaching quality, Manufacturing technology, the Questionnaire, Students.

1. Introduction

In the last time the evaluation of education has become an important area of pedagogical research. It has progressed from the description of phenomena to developing of the theory of the evaluation of the education and the training. The effectiveness of teaching has been changing in response to educational objectives and the creation of measurement and evaluation tools for objective investigation of the educative results.

Indisputable and undisputed, the underlying purpose has been the creation of evaluation - to assess the quality, that depends on the efficiency, providing an assistance, which is contretate on educational issues, track not only control the content, but also allow to monitore of the conditions of teaching and learning, promote capture the positive and negative changes in personality development of students. The findings and conclusions arising therefrom shall be used for planning and managing education policy in the broadest sense.

Two main factors affect The teaching process on the faculty is affected by assumptions and knowledge level of students in technology, that it depends on completion of courses in the secondary education and the availability of other, form a sufficient quantity and quality of teaching and study of literature in this study training for college faculty, respectively university.

First you must realize that this is about providing services. The educational institution provides services to students, i.e. learning objects, through their teachers. Students participate in classes to obtain expertise. To what extent are teachers satisfied with the level of the obligations of the feasance and management of subject matter is reflected in the evaluation of the test or examination credit. How are satisfied students' with quality of providing services provided, can clearly show the survey among the students the semester, by using - using questionnaires. By their expressing opinion, they reveal weaknesses and provide opportunities for improvement in different directions, which depend on the question in the questionnaire.

Appropriate methods are used in the processing of questionnaires can be made clear picture of their satisfaction, needs and ideas of respondents.

The students have the right, but they not always use it, how the teaching-educational and pedagogical skills of teachers. According to the Law on Higher Education is also a law student by an anonymous questionnaire to comment on the quality of teaching at his high school, respectively university. Legal anchoring this option supports its relevance and importance in improving the organization, management, course and level of education [3] [2].

2. Survey of student satisfaction by the questionnaires

Each organization should have a measurement of its performance about the customer monitor information how they are satisfied with results. They should identify methods of acquiring and using these issues. The University is not a manufacturing company. It's an institution that actually provides services. It efforts should be to realize its evaluation satisfactions and achievements. Whenever it should be conceived and carried out in different directions. Towards customers - students, public, or towards it is employees. It should be a process of analyzing organization and the initiation process of continual improvement.

There are many methods and tools have been applied in practice for assessing the quality of product or service. If someone has the opportunity to use many techniques, there is always a problem how to choose the correct tool for the treatment of the problem [1].

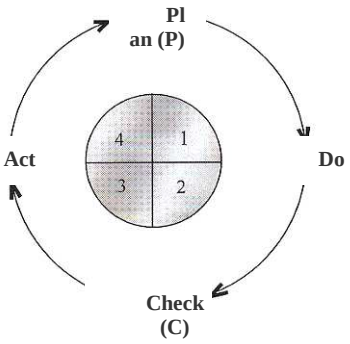

Fig. 1 PDCA cycle, Deming circle

For each process it can be applied Deming PDCA cycle - Plan - Do - Check - Act (Fig .1). It is also usable for the process of teaching. The last two phases C - Check and A - Act are the basis for assessing student satisfaction.

The survey student satisfaction with the quality of teaching - lectures and exercises, quality and accessibility study of literature as an appropriate tool to choose a questionnaire. Questions in the questionnaire should be formulated so as to have many answers to them should the "greatest benefit".

Students have to fill out questionnaires from various courses of the two degrees (bachelor degree and engineering degree), full-time university study at the Faculty of Environmental and Manufacturing Technology (FEVT), Technical University in Zvolen. The questionnaire was anonymous, run down to the "barrier of fear". Students are able to express their views honestly, without undue fear that their views will be some way by the teacher in the future affected.

2. 1. Make a questionnaire survey - first step

First a questionnaire survey was conducted in academic year 2007/2008, winter and summer semesters. A total 13 subjects were evaluated.

In the winter semester was assessed in the questionnaire 6 items:

- The first stage of university studies:
  Quality management
- survey involving 24 students,
  Manufacturing Technology I.
- survey involving 24 students,
  Production technology
- survey involving 31 students.
- In the second stage of university studies:
  Construction materials
- survey involving 17 students,
  Logistics
- survey involving 22 students,
  Production systems
- survey involving 13 students.

The questionnaires from the winter term of the academic year 2007/2008 contain the following questions:

Questions for the evaluation sessions:

1. Which secondary school have you completed?

a/ high school, b/ secondary school, c/ secondary vocational school.

When your answer is b/, c/ specify the school.

2. Lecturing and understanding the issues:

a/ full, b / part, c / not understand.

3. To understand the contents I used knowledge acquired:

a /during secondary school, b/ in the subject "Technical Materials", c / during vocational training,

d/ during operational exercises, d/in another subject (what).

4. Methods used during seminars:

a/ meets, b/ meets part, c/ fail

When your answer is b/, c/ specify the shortcomings.

5. What are your abilities for obtaining literatures?

6. Did you use website to obtain literature for studying? If yes, does it enough information? What would you suggest for improving?

Questions for evaluation exercises:

1. Indicate what method do you prefer for accessing treatment:

a/ self-study, b/ consultation with a teacher, c/ consultation with others (classmates, practitioners, etc. ...), please specify.

2. Ways how to manage exercises for me:

a/ meets, b/ meets part, c/ fail

When your answer is b/, c/ specify the shortcomings.

3. What literature did you use when preparing for your seminars and assignment processing?

4. Write, what you see negatives during seminars and exercises in vocational, educational and organizational parts.

In the summer semester were evaluated 6 items in the questionnaire:

- The first stage of university studies:
  Technical materials
  - survey involving 29 students,
  Fundamentals of management
  - survey involving 38 students,
  Production technology II.
  - survey 52 students participated.
- In the second stage of university studies:
  Innovative processes and creativity
  - survey involving 7 students,
  Industrial Safety II.
  - survey 8 students participated,
  Technical preparation of production
  - survey involving 8 students.

Questionnaires that were used for assessment of courses in summer semester of the academic year 2007/2008 were simpler as last one, they contained fewer questions, with no choice answers.

In the questionnaire the following questions:

1. How do you find the object in context with other objects of your study program?
2. How do you level lectures - give the pros and weaknesses.
3. How do you level exercises - give the pros and weaknesses.
4. Send your recommendations to improve the level of teaching the subject [4].

As we can see from above, the questionnaires are used in survey of satisfaction with teaching have the same form. Asked questions were the same for winter and summer term.

2. 2. Making a questionnaire survey - second step

The second survey was made in academic year 2008/2009during both terms, but were not evaluated the same subjects. The survey items were included in the first stage of university studies at the faculty in the term. Questionnaires had the same form as in the summer term during the academic year 2007/2008, students were asked the same questions.

Questionnaires were used for evaluation of courses in the winter and summer semesters of the academic year 2008/2009 were the same as in the summer term of the academic year 2007/2008.

Six subjects were evaluated.

In the winter semester was evaluated 3 items:

- The first stage of university study:
  Quality management
  - a survey involving 22 students,
  Manufacturing Technology I.
  - a survey involving 23 students,
  Production technology
  - a survey involving 22 students.
- In the second stage of university study:
  Production Systems
  - a survey involving 8 students,
  Simulation and optimization of processing and systems
  - a survey involving 8 students.

In the summer term the questionnaire was evaluated one object:

- The second stage of university study:
  Industrial Safety II.
  - a survey involving 8 students [4].

Although in this case, the assessment of student satisfaction with teaching used in both terms the same questionnaires, objective comparison was not feasible.

3. Results

The evaluated subjects are shown in the Table 1 during both academic years. It is only separating according terms. Another separating for example according the university degree is not shown.

Table 1 *Rated items in the questionnaire*

	RATED OBJECTS	ACADEMIC YEAR 2007/2008		ACADEMIC YEAR 2008/2009	
		WINTER TERM	SUMMER TERM	WINTER TERM	SUMMER TERM
1.	QUALITY MANAGEMENT	■		■	
2.	MANUFACTURING TECHNOLOGY I	■		■	
3.	PRODUCTION TECHNOLOGY	■		■	
4.	CONSTRUCTION MATERIALS	■		x	
5.	LOGISTICS	■		x	
6.	MANUFACTURING SYSTEMS	■		■	
7.	TECHNICAL MATERIALS		■	■	x
8.	FUNDAMENTALS OF MANUFACTURING		■		x
9.	MANUFACTURING TECHNOLOGY II.		■		x
10.	INNOVATIVE AND CREATIVE PROCESSES		■		x
11.	INDUSTRIAL SAFETY II		■		■
12.	TECHNICAL PREPARATION OF PRODUCTION		■		x
13.	SIMULATION AND OPTIMIZATION OF PROCESSES AND SYSTEMS		x		■

■ - Object in a given semester assessed
x - Object in a given semester not evaluated

As we can see above, the conditions for a comprehensive evaluation of the questionnaires were limited. There was little the same evaluated subjects which are learnt during the two academic years - only 5 of 13. The form of asking and doing the questioner was the same but it is unsatisfactoried for evaluation questionnaire. It is the best for its treatment that each question offers a possible answer. e.g. *yes,* or *no, I do* or *not know, meets, fail,* etc. Although there are some questions in the questionnaires from the winter term 2007/2008 academic year, with possible answers, but the overall comparison and evaluation is inadequate. Could be evaluated as part of the questionnaire.

To compare could be one subject - Industrial Safety II, which was evaluated in two academic years, one type of questionnaire. It was, however, that where the questions were not put up the possibility of answers. The evaluation of the possibility of self-questionnaire responses is difficult. Some students' answers to these questions are comprehensive, expressed in several sentences, others are brief, one-word.

4. Conclusions

Any process, if the improvements must be controlled. As mentioned above, for pedagogical process is applicable Deming PDCA cycle. Detection of student satisfaction with the quality of educational process - with lectures and exercises, with the availability of appropriate literature is actually a feedback in this process. Improving quality is of teaching at university is not feasible without a reliable and comprehensive information about its functioning. Selecting appropriate methods or techniques of quality management and improvement of educational process, this information may be obtained.

The Faculty of Environmental and Manufacturing Technology (FEVT) of Technical University in Zvolen was conducted a questionnaire survey of student satisfaction with the quality of teaching process in thirteen different fields of study subjects in two academic years 2007/2008 and 2008/2009 in both semesters.

The questionnaires are used for this survey, however, have the same form. The semesters were rated the same subjects, and they did the number of students who participated in the assessment was different. The questionnaires were formulated questions without answers. These factors made it difficult to compare and evaluate the overall questionnaire.

Finally, it may be noted that conducted the survey is beneficial for both parties. For teachers as well as for students. By that students are consulted to comment, is the light that they charge interest that are in the process of improving the quality of a very important article. Teachers in turn are able to know their students' views on various aspects of teaching that can help them to improve the quality of training, whether in lectures or exercises.

Questionnaire survey proved very useful tool for student satisfaction survey. One major handicap is inconsistency in the last row and the adequacy of the questionnaires. Therefore, in future, to frame a questionnaire, which would be easier to evaluate. Evaluation could be graphic, thereby visualize the entire process.

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[4] Replies to individual subject (Vyplnené dotazníky ku jednotlivým predmetom).

Tehnical artefacts in preservation of cultural heritage

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Abstract

This paper places the traditional tools, devices and accessories in a historical and ethnographical context. By browsing through different historical periods of Slavonia, one gets a picture of the native population and the influence of other nations on the territory of Eastern Slavonia throughout history, which ensured the cultural pluralism of the area.
Field research is intended to show the significance of earlier historical periods in the domains of material as well as spiritual culture, principally by acquisition of loan words in giving names to tools, devices and accessories. The value and authenticity of the field research, the statements acquired by talking to the collocutors – *the tellers*, is supported by literature.
In the hope that this paper work will contribute to the preservation of the cultural inheritance of the population of Eastern Slavonia, with the help of the *tellers*, a lexicon has been composed, which includes the names of the traditional tools, devices and accessories, their usage and the origin of the names, which makes a whole, together with the other parts of the paper.

Keywords: tradition, heritage, tools, devices, accessories, Slavonia

1. Introduction

The traditional farming jobs, in which people used various tools, devices and accessories present, by the origin of its name, historical periods which left their mark by introducing its material culture along with the advancement of technology. They have also left their mark in spiritual culture.

By getting acquainted with traditional tools, devices and accessories in order of processing certain materials, we also get acquainted with the life of the native population whose work is defined by the level of tecnological development through historical periods.

Agricultural way of life based on land-tilling and handicrafts is a characteristic of the traditional way of life in Eastern Slavonia.

The field work intends to show the importance of previous historical periods in fields of material and spiritual culture. This leads us to the goal of the research-identifying the impact of historical periods on life and language of indigenous Croatian population of Eastern Slavonia (*Šokaca*) with respect to their tools, devices and accessories' names and purpose. The purpose of the research is to familiarize with the traditional way of life in Eastern Slavonia and to try to preserve it.

Figure1. Presentation of group field works and needed tools

2. Methods

In order to determine the role and meaning of traditional tools, devices and accessories in the life of Eastern Slavonian native population, it was necessary to conduct a field research.

The photographing of traditional tools, devices and accessories, collecting photographs of massive devices, teller's statements about the names and usage of the tools, devices and accessories, was the starting point of our field work.

Special emphasis needed to be placed on:

- careful selection of the teller,
- the necessity to use the language similar to those of the tellers, that is, the particular local dialect,
- the necessity to record as many material as possible and to process it on the very spot.

We took special care when selecting our tellers. We wanted them to be true domicile residents, we wanted about equal number of men and women of different age because we wanted our work to gain authenticity.

When describing certain tools, devices and accessories, we consistently applied the same methodology in order to keep the parallel monitoring of the obtained results clear and transparent.

By presenting the village communal family's farming jobs, we presented the part of the traditional life of Eastern Slavonia. The lexic presented small inventory-traditional tools, devices and accessories.

The lexic is accompanied by pictures of tools, devices and accessories [7]. The photographs, made on Nenad Bainac's property in Račinovci and Native Museum of Stjepan Gruber in Županja, are edited in Adobe Photoshop CS3 Extended Version 10.0 computer programme for photo editing. The name and number of each photograph matches the picture number in the lexic chart.

Original language and stress are added to each word, according to Vladimir Anić – Ivo Goldstein, Veliki rječnik hrvatskoga jezika, Novi liber, 2006., Zagreb.

Names, provided by tellers, are distinguished by locations and have an addition of the place name this tool, device and accessory come from.

The data, shown parallel with the literature, by gaining the thesis through antithesis, that is, through substantiated field work, give this research accuracy and purpose.

Figure 2. Collected mass devices' photographs

The research was conducted during the second half of the 2008. and in the first half of the 2009.

3. Results

The lexic was obtained by field research and its accuracy was verified by literature connections. This lexic pictures historical and etnographical development of Eastern Slavonia through language sphere of native population and through those who influenced its development through history by importing its terminology of tools, devices and accessories.

The lexic is composed of less known words [7] for certain tools, devices and accessories, words that my tellers used and which are either less known in Croatian standard language or either do not belong to it, but are dialectal. The influence of foreign languages, escpecially German, Turkish and Hungarian is visible from the chart. It is, in fact, an account of historical events in the area of Eastern Slavonia which is particularly preserved in language.

Chart 1. An example of a processed dialectal term which in Croatian means „pila" (saw)

Figure 3. Tools' photographs, in this case, a saw, are an accompanying lexic content (P3120007, P8260120, P3120005, P8260123) [7]

We processed over 90 dialectal terms for tools, devices and accessories.

The majority of traditional tools, devices and accessories explain their usage by their names, like *prtenka* (to take a burden), hay-fork *snopača* (beam), but this is not the case with the wood-processing tools.

„…kolari, tišleri i pinteri imadu svoj verkštat (Germ. Werkstatt), *a drugi rade u sobi, u kojoj stanuju. Svi izučeni majstori zovu svoj alat nimački.* [6] "

We came to the conclusion that the part of the population took over names of certain tools from skilled craftsmen who called their tools by German names, but the ignorance of the language distorted the names of the tools.

This is supported by the act of the emperor Joseph II.

"As early as 1771... an act of better forest maintenance was brought, and from the highest position...."of Imperial Royal Highness" (Emperor Joseph II, the co-ruler of Empress Maria Teresia, or the Empress herself)…It states the necessity of better forest maintenance, and two machines (Maschinen, Modellenn)which should arrive are mentioned...for cutting trees. Moreover, it is said that the "Modell" is described in enclosed newspapers.…these are the machines (Maschinnen) of a particular model (Modellen). (The machines of a particular model are nothing but two saws (žage, zegere, testere, Germ. Säge, f.). [1] "

NAME:	**TËSTERA**
USAGE:	Sawing tool.Made out of wooden handle and iron jagged sheet metal. The handle is on its upper end made like a hook or a great bird's beak, and the blade used for sawing is inserted into the wood and fixed with two specific nails-*nitne*. Tinned jagged blade is a bit curved and it narrows towards the edge.
Origin: Dates to:	German language (Säge, f. – saw; Säger m. – sawer, cutter) end of 19. st.
Picture number:	P3120007. P8260120, P3120005, P8260123
ADDITION:	P3120007 – one handled saw P8260120 – double handled (American) saw (Vrbanja) P3120005 – craftsman saw (Račinovci) P8260123 – big (kranjska) six-workers saw (Račinovci)

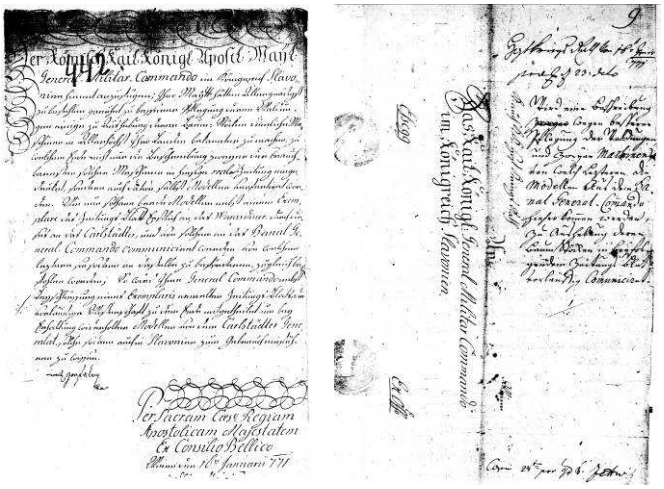

Figure 4. The order for better forest maintenance mentiones two devices whose models are described in the newspapers. 16. 1. 1771. HDA, Zagreb, SGK. 442-48-9. [1]

„By analysing rich and diverse material culture of the village population of županjska Posavina from the end of 19th and the beginning of 20th century, one can conclude that artefacts were of great importance for the life of the man of that period. Various applied textile, leather, hurdle, wooden and ceramic objects, and a part of tools are made at home in županjska Posavina since a long time ago. [8] "

As late as 18th century, separate craftsmen workshops are opened. The workshops offer the native population various craftsmen services and settle a part of the need of the village farming.

4. Conclusions

According to Veliki rječnik hrvatskoga jezika by Vladimir Anić, the term *heritage* marks a property which is inherited, a patrimony, or the totality of preserved and nurtured goods from the past-a legacy.

By explanation of the term heritage, it is seen that the term carries in itself a part of the past of certain residents, people, an area of living, but also a part of their present.

It seems that today's globalization trends are the complete opposite of any view that gives importance to heritage and tradition.

This work clearly illustrates and proves the value of multicultural living in the area of Eastern Slavonia through the sphere of names and usage of tehnical artefacts. In that way it is trying to preserve inherited cultural goods.

By exploring the literature connected to this work, one comes to conclusion that it is filled with topics which cover the farming part of life of Eastern Slavonian residents. However, by concentrating on tehnical artefacts alone, it does also perceive the absence of written materials. Because of that, the accounts of the tellers gained through field research, show their value even more.

Because of the absence of concrete literature connected to this topic, the work could not have been made without the image of the object, photographed during the field research and the account of the teller.

It should be emphasized that the research of scarce literature demands a full scale description of the traditional life of Eastern Slavonian native population through the sphere of traditional tools, devices and accessories. This kind of full scale description is not possible without a greater number of explorer scientists because of complexity of its content.

The job cannot be done without devices and accessories - *no trade, no tools* - the participants and creators of material and spiritual values have seen that.

5. Acknowledgments

This paper was made at The Faculty of Teacher Education in Osijek. It consists of theoretical part and research part. Our gratitude goes to our mentor, doc.dr.sc. Željko Ivandić who helped us in the realization of this work through his lectures. We would also like to thank to our tellers: Mr Nenad Bainac from Račinovci and Mr Ivan Čosić-Bukvin from Vrbanja, who try to preserve the tradition of living of Eastern Slavonian native population through their reserach and literary works. Through their work they also contribute to the preservation and protection of the whole Croatian cultural heritage.

We are also thankful to the curator of the Native Museum of Stjepan Gruber in Županja, Mrs Janja Juzbašić, who directed us to the existing, but also very rare literature on this subject.

We appreciate the help of The Faculty of Teacher Education in Osijek on whose web pages one can look at the video made during the field research. (www.ufos.hr).

Figure 5. We inherit our legacy

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Weed species distribution under different management strategies in cabbage

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Abstract

Weed control strategies for transplanted cabbage (*Brassica oleracea* var. *capitata*) production were studied in Brodsko-posavska county, at village Slobodnica. This study focused on how different weed management practice affect weed community composition. The recommended post-plant application was compared with mechanical option, straw mulch and untreated control in order to explore the response of weed community to different management practice. A relative abundance data of weed species present during the experiment were used to compare total community density by applied weed management strategies. Data were analyzing using multivariate technique. Weed community dominated by a few species that had high relative abundance value, while most of the species were of low abundance. The structure of weed community was significantly different in the mechanical weed control.

Keywords: plant protection, cabbage, weed control, species diversity, discriminant analysis

1. Introduction

Optimum production of cabbage depends on successful weed control. Weeds reduce yields by direct competition for nutrients, water and light [1]. Weed control is especially important early in the season when weed competition can substantially reduce vigor, uniformity and overall yield [2]. Production of cabbage depends very much on herbicide application world wide. However, the awareness of farmers and consumers of possible adverse side effects of chemicals has increased over recent decades. This had resulted in research programs on weed control in which the emphasis is mainly on the development and improvement of strategies that reduce or exclude herbicide use. Therefore, the development of alternative methods may contribute to the reduction of amount of weeds in the field during crop growth and thereby reduce the need for herbicide [3].

2. Methods and materials used for research

Field experiment was conducted in 2009 at village of Slobodnica, 7 km far away from Slavonski Brod, an administrative center of Brodsko-posavska county. Cabbage (*Brassica oleracea* var. *capitata*) cv. „Futoški“ was grown after red clover (*Trifolium pratense* L.) on pseudogley type of soil. Weather conditions during the experiment represent Fig. 1.

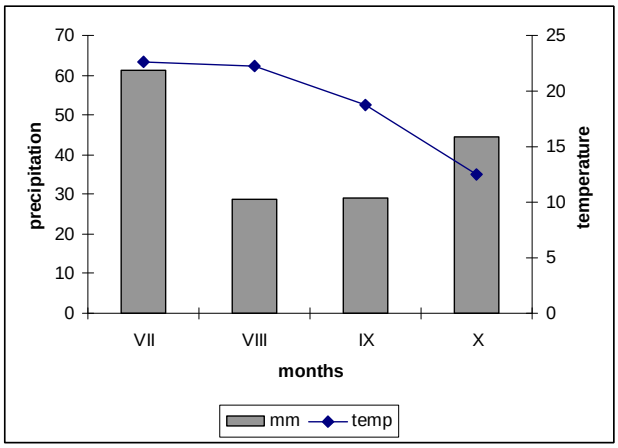

Fig.1. Weather conditions during the experiment

Transplants was planted into soil 4th of July 2009 in a 55 cm rows with 50 cm inter-row. A randomize completed block design with four replication was established in area highly infested with natural weed population. Individual plots measured 3,5 x 3,0 m. Experiment includes different management

options for weed control: i) chemical, ii) mechanical, iii) mulch and iv) untreated check (control). Post-plant application of herbicide metazaklor (Butisan S) was applied 10 days after transplantation as recommended with 2 l/ha. Mechanical inter-row cultivation was tested as a sole treatment 16th of August, and for mulch was used straw applied immediately after transplanting the cabbage. Control plots without herbicides or mechanical soil disturbance were also established.

Data were collect at the end of growing season (16th of September) after the effect of different weed management had become evident. Remaining weed community was sampled by means of four randomly selected quadrates (100 x 100 cm) at each plot. Weeds are cut at ground level, separated by species and counted.

The row density data for each species were used to calculate dominance diversity curves [4] in order to explore community structure visually. Cumulative relative abundance of each species found in different treatments and control plots were plotted against species rank to obtain dominance-diversity curve.

A multivariate analysis of relative community composition was performed (CDA analysis -using SPSS for Windows 15,0) to determine whether different weed control strategies affected weed community composition. For that purpose a relative abundance value for weed population was calculated as synthetic importance value in order to overcome a patchy nature of weed communities [5].

3. Results and achievements

The naturally occurring weed community found in the study areas consisted of a mix of annual and perennial grass and broad-leaved weeds. Twenty-seven different weed species, common in vegetable and row crop production, were identified during the experiment. Annual broad-leaved weeds predominated (23 species) compared to grass weeds (4 species).

Dominance-diversity curve display the relative abundance of the species within community. Weed community in each study treatment was dominated by a few species that had high relative abundance values, while most of the species were of low abundance per square meter, as represented by a dominance-diversity curve (Fig. 2.). Eight weed species were selected as dominant and represent a significant portion of all weeds present in the experiment (Table 1.). The dominant weed species

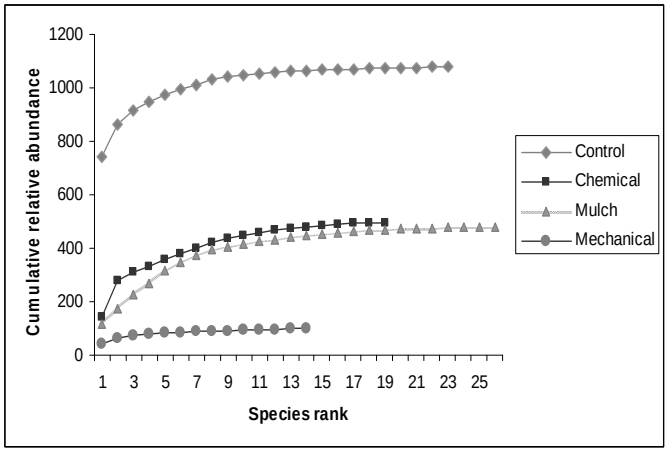

Fig. 2. Dominance-diversity curve for different weed management practice in cabbage

were *Cynodon dactylon* (L.) Pers., *Setaria glauca* (L.)

PB., *Digitaria sanquinalis* (L.) Scop., *Galinsoga parviflora* Cav., *Cirsium arvense* (L.) Scop., *Echinochloa crus-galli* (L.) PB., *Convolvulus arvensis* L., and *Sonchus arvensis* L. However, only annual dicot species *Galinsoga parviflora* Cav. appears in all treatments and in control plots. This weed is considered to be common weed in several crops including cabbage [6].

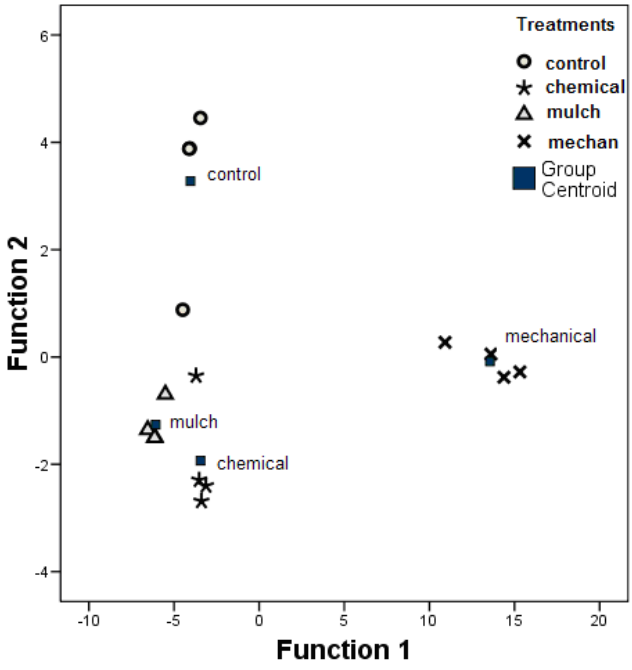

Fig. 3. Ordination graph (Canonical discriminant analysis - CDA) of weed data from different management practice in cabbage

Table 1. Relative abundance of dominant weeds under different weed management treatments

Weed species	Control	Chemical	Mulch	Mechanical
Cynodon dactylon (L.) Pers.	69	28	10	-
Setaria glauca (L.) PB.	11	28	-	-
Digitaria sanquinalis (L.) Scop.	5	-	10	-
Galinsoga parviflora Cav.	3	6	24	6
Cirsium arvense (L.) Scop.	-	5	10	19
Echinochloa crus-galli (L.) PB.	6	-	-	-
Convolvulus arvensis L.	-	-	-	42
Sonchus arvensis L.	-	-	-	11
% of total floristic composition	94	67	54	78

Moreover, it has ability to easy distribution and rapid establishment and in North-eastern Croatia it is consider as invasive and troublesome weed in vegetables [7].

Multivariate procedure based on floristic composition and weed management treatments have been used to explore whether investigated weed community differ in species richness and abundance among treatments. Canonical discriminant analysis (CDA) simultaneously examines differences in the floristic structure of weed community and indicates relative contribution of each variable (weed species) to floristic composition discrimination. By applying multivariate statistical methods it is possible to project the proportion of similarity of treatments by reducing the dimension and, therefore, explore the community structure and potential changes in treatments [8, 9].

It is clearly visible during our study that mechanical cultivation differs in floristic composition compare to treatments with herbicide and mulch and even control (Fig. 3.).

The first two canonical variates were significant ($P < 0,01$) and accounted for 98,3% among treatment variance (Table 2.). Each canonical variate is linear combination of the independent variables and is orthogonal to the order.

Table 2. Summary of canonical discriminant functions

Function	Eigenvalue	% Variance	Canonical correlation
1	82,958	92,3	0,994
2	5,353	6,0	0,918
3	1,539	1,7	0,779

The first canonical discriminant function (explained by a 92,3% of variance) significantly separate weed community under mechanical cultivation from all other treatments used in the experiment. The weed community was dominated by a two species with significant abundance (*Convolvulus arvensis* and *Sonchus arvensis*) that appears only in treatment with mechanical cultivation.

The second function is explained by a large portion of *Cynodon dactylon* (additional 6% of variance). This perennial grass species dominates in control plots, although has a significant abundance in treatments with mulch and with herbicide application.

The centroid values for the first two canonical discriminant functions for the four investigated weed control treatments were plotted (Fig. 3.) indicating similarity in floristic composition only between mulch and chemical treatments.

The results of our research also indicate the inadequacy of single treatment to provide season-long weed control [1]. Effective weed control should include a combination of management practices designed to suppress weeds during the entire vegetation season. There is a constant threat of increased competition from weeds caused by a higher weed plant survival and increased seed production by surviving weeds. Moreover, the critical weed-control period in cabbage is important in order not to affect cabbage yield [2]. Results suggest that cabbage has to be kept weed free for a minimum four weeks after transplanting to prevent yield reduction.

No significant differences were observed in floristic composition in plots with mulch and with herbicide application, as expected. However, they failed to control weeds although it was expected to have the greatest impact on weed community. They did

not generally provide significant in-season weed suppression.

4. Conclusions

During the cabbage vegetation period 27 different weed species were found with *Galinsoga parviflora* as common weed in all investigated treatments. Significant difference in floristic composition was observed among the investigated treatments. Only treatments with straw mulch and herbicide application were similar in floristic composition.

The results in the present study support previous findings indicating that many agricultural weeds react on different weed management practice. Therefore, the diversity of weed communities determines the strategies required, and changes in weed species may indicate weed management problem as was observed for *Convolvulus arvensis* and *Cirsium arvense* in plots with mechanical cultivation.

However, early season and single weed control was not adequate in cabbage production. In order to minimize cabbage yield reduction from competing weeds, additional weed control strategies needs to be explored.

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Apples quality evaluation after the harvest

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Abstract

Research of the quality factor for various apples cultivars (Golden Delicious, Gloster and Jonagold) with the main intent to determine the best cultivar for long term storage and consumption was recently performed at the Lačić Family Farm in Donja Vrba near Slavonski Brod, Croatia. Plantation was made in 1981, grafted on the MM106 rootstock and formatted in the modified singlefloor palmette with spindle-shaped top on 3.0 × 4.5 m distance (which gives plant density of 740 trees per ha). Using the standard methods for determine apples quality the following analysis and calculations were performed: average fruit weight, firmness, soluble solid contents, starch test and Streif index. Average fruit weight obtained for chosen cultivars was as lowest as it is characteristic for each cultivar. For the Jonagold cultivar fruits had the biggest average weight, the lowest firmness values and the lowest soluble solid content. Weight of the Golden Delicious cultivar was the lowest among the tested cultivars but the Golden Delicious fruits had the largest soluble solid content. Both starch and Streif maturity indexes showed overmaturity on cultivars in this research. Statistically significant differences in fruit firmness between the Jonagold cultivar and the other two cultivars were obtained. Also, statistically significant differences in soluble solid contents were founded for the Golden Delicious in comparison to the Jonagold and the Gloster cultivars. The Golden Delicious differs significantly in fruits weight compared to other cultivars examined. By analyzing maturity of apples it could be seen that the optimal harvest time had to be adjusted according to different cultivars.

Keywords: fruit, apple, quality, starch index, Streif index

1. Introduction

The main mission of Croatian apples producers is cultivation of high quality apple fruits to make a success in equally-chanced market in comparison to the fruits imported from abroad. Quality of apples fruits depends on many factors: geographic region, climate, cultivar and base, soil type and quality, density of planting, culture form and possibility of using water and soil nutrients.[1] Some of these factors (like agrotehnical and pomotehnical influence) are controllable but the others are less likely to be controlled, like climate.

Basic factors of apples quality identification that are commonly known in literature are: size, shape, colour, taste, odour, hardness, firmness and lack of any physical and visual defects. [2] Often fruits quality can be defined as the ultimate satisfaction of consumer with the chosen product.[3] Quality of the fruits is also defined as level of suitability for some defined purpose.[4] One of the most important factors in keeping the quality of apples fruits during the storage is the optimal time of harvest.[5,6] This relation comes from the fact that only apples picked at the optimal stage of maturity can be suitably stored for periods of six months or longer.[7] The main goal of optimal harvest time is keeping the best relations between general visual look and organoleptic qualities (colour, taste, sweetness). This provides great possibility of making the longer terms storages.

Apples (*Malus domestica* Borkh.) always come through the characteristic physiological changes which manifest like increased breathing during the maturation. With the approaching of full maturity stage cells within the apples grow, firmness of mesocarp gets smaller and starch decomposes to simpler sugars. Increase of the apple fruits size usually decreases its firmness [8] and it can cause decrease of fruits weight during the storage period.[9] Destructive methods are traditionally used for the fruit quality measurements.[7] Firmness, soluble solid content and total acidity are usually considered to be variables that are the best correlated with consumer acceptance and therefore serve as good indicators of texture, sweetness and tartness.[10-12]

The aim of this research was to determine differences in fruit quality among three chosen cultivars (Golden Delicious, Gloster and Jonagold), to find the best cultivar for the long term storage and to find the most suitable cultivar according to its consuming characteristics.

2. Methods and materials used for research

Apples taken for this research were from orchards at Lačić Familiy Farm in Donja Vrba (near Slavonski Brod, Croatia), positioned on slightly elevated plateau, 118 m above sea level, south exposition and in humid climate. The soil was middle-deep heavy pseudogley, based on diluvial ilovine of pleistocene. Apples cultivars (Golden Delicious, Gloster and Jonagold) were grafted on the MM106 rootstock and the plantation originated in 1981. Apple trees were established in the modified singlefloor palmette form with the spindle-shaped top on 3.0 × 4.5 m distance (which gives plant density of 740 trees per ha). Size of the orchards was 2 ha with 70% of the Idared cultivar and the rest was reserved for Golden Delicious, Jonagold and Gloster. Apple fruits of chosen cultivars (Golden Delicious, Gloster and Jonagold) were picked at October 21, 2009 and stored in storage at temperature 10 °C and air humidity 85%, until October 23, 2009 when the experiments were performed.

In research and commercial quality measuring of fruits instruments are more often used than the sensor-based evaluation.[13] With the standard methods to determine quality of the fruits the following analysis in laboratories of University of Applied Sciences of Slavonski Brod were done:

1. Fruit weight – we collected 10 samples of each cultivar. Each sample consisted of 10 apple fruits randomly chosen. Their total weight was measured on Ohaus AV 4102 C balance and the average weight for each cultivar was calculated.

2. Fruit firmness – for these tests penetrometer Effegi, type FT 327 with scale in kg/cm² and diameter of 11 mm was used. At the place of the apple's biggest diameter (cross cut) we removed the apples skin, pressed penetrometer into the apple fruits and read the values on the scale. 10 apple fruits for each cultivar were taken randomly. The results presented in this paper are the average values of four independent measurements.

3. Soluble solid content – the optical instrument refractometer Atago type A-297 was used. Refractometry is method based on physical law of light beam breaking between different environments (air – apple juice). Few drops of apple juice were dropped on the prism, covered down and the results were read on the Brix (°) scale. For each of 10 randomly chosen apple fruits two independent readings of soluble solid content were made and only average results for every single cultivar are reported in this paper. Before each reading refractometer was cleaned up with distilled water and carefully dried.

4. Iodine – starch test – 10 randomly picked apple fruits were cut in to two equal pieces and dived into iodine tincture. This test showed in which part of apple starch is mostly positioned. Index grades were assigned according to Blanpied and Silsby from Cornell University (New York, USA).[14] It contains 8 phases of apple growth based on different colours and these phases are expressed in percentage of coloured area at the cross cut of the fruits. Figure 1 shows two different stages of Jonagold apples maturity. The top fruit was overmatured with almost no coloured area (phase 8) while the bottom fruit had around 40 % of coloured area at the cross cut of the fruit (phase 6).

Figure 1.Two different stages of Jonagold apples maturity: phase 8 – top fruit and phase 6 – bottom fruit.

5. Streif index [15] – Streif index (S_i) was mathematically calculated on the base of fruit maturity parameters (*F* - firmness, *SSC* - soluble solid content and *SI* - starch index) by the following formula:

$$S_i = \frac{F}{SSC} \times SI \qquad (1)$$

Calculation of Streif index is fast and safe method to determine fruit maturity.[16] It suggests whether the harvest has been done at right time or not. This index has been successfully used to estimate the optimum date of harvest for various apple cultivars.[17] Streif developed the index to avoid mistakes in prediction of optimal date of harvest based only on single parameter.

Index value is specific for each cultivar and it is not strongly dependent on orchard management, soil and climatic conditions.[15]

The obtained data were statistically analysed using ANOVA and LSD test implemented into Statistika computer program.[18] The results were presented in Table 1.

3. Results and achievements

100 pieces of each cultivar were taken and average apple fruit weight was calculated. For the Jonagold cultivar average weight was 166 g, for the Gloster cultivar it was 156 g and for the Golden Delicious it was 122 g (Table 1). All three cultivars were belonging to the family of winter apple cultivars with large and very large fruits. Literature cited weight of the Jonagold cultivar was in range 130-315 g. In this research typical cultivar weight characteristics were confirmed. The Gloster cultivar was also within characteristic weight limits, 147-238 g. Average weight for apples of the Golden Delicious cultivar in this work was 122 g and it is only cultivar out of characteristic weight limits. According to literature weight should be 135-280 g.[19] Average weight of apple fruits was around the lowest values characteristic for each cultivar. Possible reason for observed results could be old plantation with very low vegetation activity.[20]

Table 1. Apple quality parameters for the following cultivars: Jonagold, Gloster and Golden Delicious.

Cultivar	Weight (g)	Firmness (kg/cm^2)	Soluble solid content (°Brix)	Starch index	Streif index
Jonagold	166 a	4,17 b	15,69 a	8	0,0332
Gloster	156 a	5,10 a	15,71 a	8	0,0464
Golden Delicious	122 a	4,97 a	17,86 b	8	0,0348

LSD 0,01.

Firmness is one of the most important factors in prediction of the optimal time of the harvest. Presented results of apples fruits firmness for each cultivar were calculated from four independent measurements. According to Streif [15] optimal values of firmness for the Golden Delicious cultivar should be between 6,5 and 7,0 kg/cm^2, but in this case obtained firmness had lower values. It meant that the harvest had been done too late. According to Streif [15] soluble solid content for the Golden Delicious cultivar should be 13,5 °Brix. Table 1 shows that the soluble solid content of the Golden Delicious were above that value and the average was 17,86 °Brix which was the highest value in presented research. It could also indicate lateness in the harvest. Common starch index value for the harvest of the Golden Delicious cultivar is between 6 and 7 on scale from 1 to 8.[15] Scale of 8 phases, developed by Blanpied and Silsby at Cornell University, was used as the reference scale in this work.[14] According to that scale it could be concluded that the apple fruits of this cultivar were picked too late and they were overmatured. Streif indexes of 0,085-0,012 for the Golden Delicious cultivar indicate optimum time for harvest. Average value obtained from these experiments was 0,0348. It also confirmed that the optimal harvest time had already passed.

Fruit firmness for Jonagold cultivar was 4,17 kg/cm^2 in average, which was the lowest value in comparison to other cultivars examined. For the same cultivar soluble solid content was 15,69 °Brix and Streif index was 0,0332. According to literature [21] Streif index for optimal harvest for Jonagold cultivar should be around 0,07-0,08. It meant that the harvest was also too late. According to other results published in literature [19] the Jonagold fruits should reach final consumers very soon after the harvest or they have to be picked in earlier stage of maturation. Apples from the Jonagold cultivar were the heaviest of all cultivars examined in this research.

Average firmness for Gloster cultivar was 5,10 kg/cm^2 and in this research it was the largest value obtained. Soluble solid content was 15,71 °Brix, starch index on scale from 1 to 8 was 7. Streif index for Gloster cultivar was 0,0464 but according to literature [21] for the optimal harvest time it should be 0,24-0,40. From all these results it can be concluded that the harvest in this case was also too late, but the Gloster cultivar quality parameters were the closest to the reference values. So far the storage capacities have not been tested enough, especially in different climate conditions.[19]

Statistically significant differences in apple fruits firmness were confirmed between the Jonagold cultivar and the other two cultivars. Also, there were statistically significant differences in soluble solid content between the Golden Delicious cultivar and other two cultivars examined. Weight of the Golden Delicius fruits statistically significantly differed in comparison to weight of the Jonagold and the Gloster cultivars fruits.

4. Conclusions

By analyzing apple fruits cultivars of Jonagold, Gloster and Golden Delicious on the MM106 rootstock

in Dona Vrba near Slavonski Brod, Croatia, taken at late October, it can be concluded that:

- Average apple fruit weight was the largest for the Jonagold cultivar apples (166 g) and smallest for Golden Delicious cultivar apples (122 g),
- Firmness was the largest for the Gloster cultivar with the value of 5,10 kg/cm^2 and smallest for the Jonagold cultivar with value of 4,17 kg/cm^2,
- Soluble solid content had the largest values for the Golden Delicious cultivar (17,86 °Brix) and the lowest value of 15,69 °Brix for the Jonagold cultivar,
- Starch index values for all three cultivars were at maximum reference level so it meant that starch had mostly undergone the decomposition to simple sugars,
- Streif indexes of maturity were smaller than the reference values for all three cultivars so it clearly indicated very late apple harvest as well,
- Results of maturity test methods showed large differences among cultivars at same time and place of the harvest. It could be concluded that the optimal harvest time have to be separately adjusted for each cultivar,
- The Golden Delicious cultivar, although picked at late, was the most convenient choice for the industrial production of apple juices, brandies and jams.

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Water release dynamics during the apple slices drying

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Abstract

From the producers point of view water content in fresh apples as well as water release dynamic during the drying are very important. Smaller water loss provides bigger profits for industry. Dynamic of water release from the apple mesocarp is related to speed and temperature of drying air, way of heating, size of fruit slices and the way the slices are made. By the decrease of water content during the apple slice drying at 105 ºC dynamics of apples drying is determined. Mechanical structures of all three cultivars were found to be similar, as well as their drying curves obtained by fitting the experimental data to the least-square polynomial. Water content which can be absorbed in 1 g of apple's solid content was statistically insignificant in all three cultivars examined. Cultivars Idared, Golden Delicious and Granny Smith could have very similar quality of dried product.

Keywords: fruit, apple, water release, dynamics, drying

1. Introduction

Intensive apple production and the storage related to it brought the need of refinement of fresh apples. One of possible refine processes is drying. Drying is a physical method of water removing. In groceries hostile environment for the microorganisms and metabolic activity of enzymes is produced during the drying.[1] At the same time, for the sensitive fruit cultivars drying can produce a big difference in final product's quality (for example in organoleptic senses).[2] Apple (*Malus domestica* Borkh) as one of most represented cultivars in Croatia offers great opportunities to food industry. By increasing consciousness of consumers about healthy food and dried groceries new market possibilities for domestic producers are being opened. At the same time drying of fruit in the developing countries increases.[3]

Dried apples in Croatia are often present in round shapes or as chips. From the producers point of view water content in fresh apples as well as water release dynamic during the drying are very important. Smaller water loss provides bigger profit for industry. Water content in fresh apples is usually 83–85%.[4] In drying process it is decreased to 8-30%.[4] Dynamic of water release from the apple mesocarp is related to speed and temperature of drying air, way of heating, size of fruit slices and the way the slices are made.[4-6] Temperature of drying air at the beginning should be 70-98 °C with air speed 1,3-4,0 m/s.[7,8] The most convenient apples cultivars for drying are those with lighter fruit meet. They contain higher total acid content and balanced rate of sugar to acids in final product.[5] However, the most important factor for drying the fruits is drying temperature.[9]

The aim of this research was to determine water release dynamic during the apple slice drying and make evaluation of each cultivar as raw material for dried market products.

2. Methods and materials used for research

This research was performed on the following apples cultivars: Idared, Golden Delicious and Granny Smith, taken at the optimal harvest time. The apples used for this research were from orchards at Lačić Familiy Farm in Donja Vrba (near Slavonski Brod, Croatia), positioned on slightly elevated plateau, 118 m above sea level, south exposition and in humid climate. The soil was middle-deep heavy pseudogley, based on diluvial ilovine of pleistocene.

In laboratories of University of Applied Sciences of Slavonski Brod similar apples of each cultivar were chosen for this research. The weight was determined with the balance Ohaus AV 4102C. During the

preparation of samples apples were washed, their skin was removed while unusable parts and seeds lodge were separated. According to that mechanical structure of all cultivars were calculated. The apples were cut to thin slices of around 3 mm as suggested in literature[5] and dried with dryer Memmert Celsius 2007. Since the drying was performed in 4 repetitions experimental results presented in this paper are the average values while the samples were in rough condition. Drying has been performed for 4 hours at the temperature of 105 °C. To determine changes in water contents of apple slices weight of the samples for each cultivar were measured every 20 minutes.

Water contents in apple slices were determined using mathematical expression:[10]

$$d = \frac{T_2 - T_3}{T_2 - T_1} \cdot 100 \quad (1)$$

where the symbols are as following:
d – water content in cultivar,
T_1 – weight of empty plate,
T_2 – weight of plate with sample,
T_3 – weight of plate with sample dried to the constant weight.

Water content (i, expressed in g/g) which can be absorbed in 1 g of apple's solid content was calculated using following expression:[10]

$$i = \frac{d}{100 - d} \quad (2)$$

Real loss of water was determined by formula:[10]

$$V = \left(1 - \frac{V_2}{V_1}\right) \cdot 100 \quad (3)$$

where the symbols are as following:
V – loss of water from 100 kg of apple fruits,
V_1 – solid content in fresh apple,
V_2 – solid content in dried apple.

The obtained data were statistically analysed using ANOVA and LSD test implemented into Statistika computer program.[11]

3. Results and achievements

Mechanical structure obtained for the cultivars Granny Smith, Idared and Golden Delicious grown at Lačić Family Farm in Donja Vrba, near Slavonski Brod, Croatia, are presented in Table 1.

Table 1. Mechanical structure of analysed cultivars.

Cultivar	Apple weight in g	Apple meet weight in g	Apple skin weight in g	Apple seeds lodge weight in g	Weight of unusable parts of apples in g
Granny Smith	128,7 a	108,2 a	10,5 a	8,2 a	1,9 a
Idared	135,5 a	115,9 a	10,9 a	6,9 a,b	2,0 a
Golden Delicious	128,4 a	107,2 a	12,3 a	5,6 b	2,4 a

LSD 0,01

Weight of the complete apple fruit was the largest for the Idared cultivar (135,5 g) and the smallest for the Golden Delicious cultivar but obtained differences were not statistically significant. Also weight of apple meet was the largest for the Idared cultivar and the smallest for the Golden Delicious cultivar but statistically there were no big differences in weight of the chosen cultivars. Weight of the apple skin was the largest for the Golden Delicious cultivar (12,3 g) and the smallest for the Granny Smith cultivar but the differences obtained were not statistically significant. The similar results were obtained for unusable parts of apples. The Golden Delicious cultivar had the largest values of the weight of unusable parts while the Granny Smith cultivar had the smallest values, although those differences were not statistically significant. Weight of apple seeds lodge was the largest for the Granny Smith cultivar (8,2 g) and the smallest weight was measured for the Golden Delicious cultivar (5,6 g). It could be seen that there were statistically slight differences between those two cultivars.

Water content in apples (d) was the largest for the Granny Smith cultivar (82,4%) while the Golden Delicious cultivar fruits had the smallest water content (81,6%). Statistically there were no significant differences between all three cultivars (Table 2). Water content (i) which can be absorbed in 1 g of apple's solid content was the smallest for the Golden Delicious cultivar and the largest for the Granny Smith cultivar. As it can be seen from Table 2 that the differences between all three cultivars examined were not statistically significant.

Table 2. Water content (*i*) which can be absorbed in 1 g of apple's solid content and real water loss (*V*) from the apples.

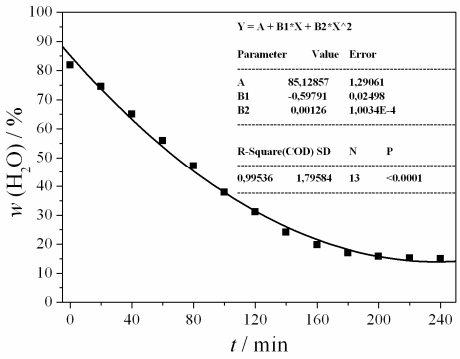
Cultivar	*d* (%)	*i* (g/g)	*V* (kg)
Granny Smith	82, 4 a	4,7 a	79, 6
Idared	82, 0 a	4,6 a	81, 7
Golden Delicious	81, 6 a	4,5 a	78, 7

LSD 0,01

Real water loss based on 100 kg of apple fruits for the Granny Smith cultivar was 79,6 kg, for the Idared cultivar was 81,7 kg (the largest loss in this research) and for the Golden Delicious cultivar water loss was 78,7 kg (the smallest water loss in this research).

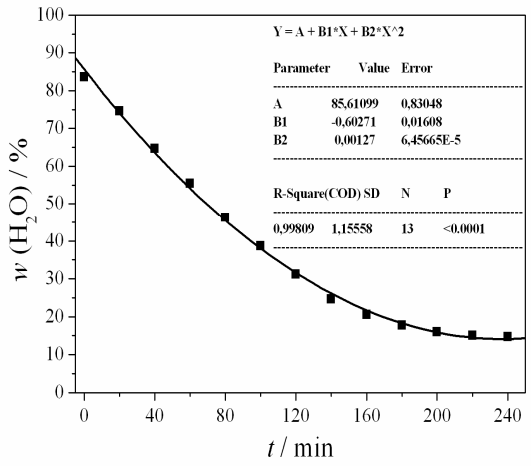
Results of the water release dynamics for all cultivars examined in this research are shown in Figures 1-3. During the 4 hour drying of slices of the Golden Delicious cultivar water content decreased form 81,6% to 15,0% (Figure 1). The obtained data were fitted to second order polynomial using least-square method implemented in Origin[12] and the results of fitting are shown in upper right corner of Figure 1. R^2 value of 0,99536 confirmed that the examined dynamic could be very well explained by the described model and that the constant water content has been reached.

Figure 1. Water release dynamics for the Golden Delicious cultivar.



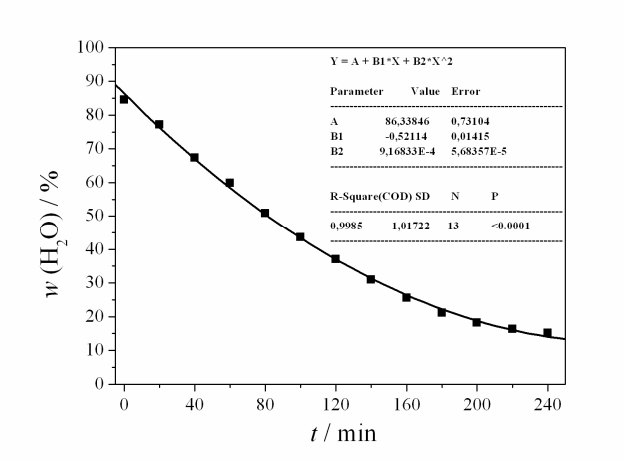
The experimental data obtained for the Granny Smith cultivar showed that the decrease in water content was form 82,4% to 14,7% during the 4 hours air drying at 105 °C (Figure 2). Constant water content has also been reached after 4 hours of drying. Second order polynomial fit resulted in R^2 value of 0,99809 which justified use of chosen model (upper right corner of Figure 2). Values of *A*, *B1* and *B2* parameters obtained for the Golden Delicious and the Granny Smith cultivars were very similar which undoubtly proved that there were no differences in water release dynamics for these two apple cultivars under the conditions described in Methods and materials used for research.

Figure 2. Water release dynamics for the Granny Smith cultivar.



During the 4 hours drying of slices of the Idared cultivar water content decreased from 82,0% to 15,2% (Figure 3). Although the starting and the ending values are similar to those of the Golden Delicious and the Granny Smith cultivars, the shape of the curve obtained by fitting data to second order polynomial using least-square method slightly differs. Numerical results of fitting are shown in upper right corner of Figure 3. R^2 value of 0,99850 confirmed that the examined dynamic could be very well explained by the described polynomial model. By the use of extrapolation procedure it can be estimated that the plateau of the curve would be reached shortly after the experiments were stopped and that the constant water content would not be much different than the one measured after 4 hours.

Figure 3. Water release dynamics for the Idared cultivar.



From the drying curves of all three cultivars examined it is reasonable to assume that the final dried products of each of them could be similar in quality.

4. Conclusions

Considering the characteristic of different apple cultivars and results obtained in this investigation it can be concluded that:

- Mechanical structure of all three cultivars examined were very similar,
- Statistically considerable difference in weight of apple seeds lodge was only between the Golden Delicious cultivar (5,6 g) and the Granny Smith cultivar (8,2 g),
- The smallest water content was observed for the Golden Delicious cultivar (81,6%) and the largest for the Granny Smith cultivar (82,4%),
- Water contents which can be absorbed in 1 g of apple's solid content for all three cultivars were statistically insignificant,
- Real water loss on 100 kg of apple fruits was the largest for the Idared cultivar (81,7 kg),
- Drying curves of all three cultivars examined were similar,
- Parameters obtained by the least-square fitting method in polynomial model did not differ for each of the cultivars,
- All three cultivars could have the similar quality of dried products.

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Nematode community structure in vineyard at two depth layers

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Abstract

Nematode community structure was analyzed in vineyard in order to determine the biodiversity of nematode community. Differences in nematode community structure were compared between two depth layers: 0-30 cm and 30-60 cm. Research was conducted in May, 2009, on the area of Martin, in Croatia. Nematode communities were analyzed to genus level. Total number of nematodes was significantly higher at 0-30 cm soil layer. Number of genera occurred in investigation was 32, while 30 occurred at 0-30 cm layer, and 24 occurred at 30-60 cm layer. All genera of plant parasitic nematodes were present at both depth layers in similar proportion. Increase in depth decreased the number of omnivorous nematodes and predators. MI, PPI/MI showed significant differences between depth layer, while PPI, H' E and F/B ratio, didn't differ significantly. It can be concluded that nematode community enhanced biodiversity at 0-30 cm soil layer compared to 30-60 cm layer.

Keywords: nematode community, biodiversity, bioindicators, vineyards

1. Introduction

Nematode community has characteristic that make them suitable for indication of the soil ecosystem quality. They could be ranged on different criteria: trophic group, c-p group - colonizers and perzisters, time of reproduction etc. In numerous studies, nematode communities showed possibilities to be good indicators of different kind of disturbances in ecosystems. Some groups of nematodes can survive under disturbed environmental conditions, while others cannot. There are differences in nematode feeding behavior [1] and predominantly, omnivore and predators have great sensitivity to disturbances [2, 3]. Above that, they play a great role in soil nutrient cycle, especially free-living nematodes [4, 5]. Structure of nematode communities can reflect differences in agroecosystem conditions [6], organic adding [7, 8, 9], heavy metal compounds [10], soil tillage system [11, 12, 6], air pollution [13], river pollution [14], and different kind of environmental monitoring [15, 16].

The objective of this investigation was to determine biodiversity of nematode communities in vineyards in two depth layer.

2. Methods and materials used for research

Research was conducted in May 2009, in Martin, near Nasice(45°30' N, 18°06'E). The nematode communities were investigated in vineyards at two depth layer:

1. Treatment: Sampling at the 0-30 cm depth ;
2. Treatment: Sampling at the 30-60 cm depth.

Sampling was done using a corer Ø 2 cm. There were 4 replicate plots of each treatment. Nematodes were extracted from 100 g subsamples of soil by the Seinhorst method [17], at the Faculty of Agriculture in Osijek, in the Laboratory of Nematology. Identification was done according to Bongers, Mai & Lyon and Andrassy [18, 19, 20, 21, 22]. Total number of nematodes and number of genera were determined and compared between treatments as well as Maturity index (MI), Plant parasitic index (PPI) and PPI/MI [23, 24], Shannon Weaver index [25], Evenness [26] and ratio between fungivorous and bacterivorous nematodes. Trophic structure was determined according to Yeates [1]. The data were analyzed statistically, using ANOVA and LSD test using computer program Statistica by Vukadinović [27, 28].

3. Results and achievements

Nematode communities were studied in vineyards in two depth layers. Statistically significant differences (P<0,01) occurred between treatments in total number of nematodes. Deeper soil layer in vineyards resulted with decrease of the abundance of nematodes as well as number of genera. Average abundance of nematodes was 456 nematodes/100 g of soil at the 0-30 cm depth layer and 78 nematodes/100 g of soil at the 30-60 cm depth layer. In average, 30genera occurred in 100 g of soil at the 0-30 cm depth layer, while at the 30-60 cm layer 24 different genera occurred. In investigation, 32 genera were determined. The list of genera is presented in Table 1.

Table 1. List of genera and their presence in depth layers

Nematode genera	Depth layer 0-30 cm	Depth layer 30-60 cm
1. Acrobeloides	+	+
2. Acrolobus	-	+
3. Alaimus	+	+
4. Anatonchus	+	+
5. Aphelenchoides	+	+
6. Aphelenchus	+	+
7. Aporcelaimellus	+	-
8. Axonchium	+	-
9. Diploscapter	+	-
10. Diphtherophora	+	+
11. Ditylenchus	+	+
12. Dorylaimellus	+	-
13. Enchodelus	+	+
14. Eucephalobus	+	+
15. Eudorylaimus	+	-
16. Filenchus	+	+
17. Helicotylenchus	+	+
18. Heterocephalobus	+	+
19. Malenchus	+	+
20. Mesodorylaimus	+	+
21. Metateratocephalus	-	+
22. Microdorylaimus	+	+
23. Mylonchulus	+	-
24. Paratylenchus	+	+
25. Pratylenchus	+	+
26. Psilenchus	+	+
27. Rhabditis	+	-
28. Rotylenchus	+	+
29. Tripyla	+	+
30. Tylencholaimellus	+	-
31. Tylenchorhynchus	+	+
32. Tylenchus	+	+

Diploscapter, Eudorylaimus, Aporcelaimellus, Dorylaimellus, Tylencholaimellus, Axonhium, Rhabditis and *Mylonchulus* occurred just at the 0-30 depth layer cm, while *Acrolobus* and *Metateratocephalus* occurred just at the 30-60 cm depth layer.

Trophic structure analyses showed similar patterns in both treatments (Figure 1.). Five trophic groups occurred (bacterivorous, fungivorous, plant-feeding nematodes, omnivorous and predators) in investigation. Plant - feeding nematodes were dominant in all treatments. Bacterial and fungal feeding nematodes were the next most abundant groups. Similar results in trophic structure were reported by numerous authors [6, 12, 9]. Omnivorous nematodes were present in 3-13%, while predators were present in 1-3%. The number of omnivorous and predatory nematodes decreased with increasing depth layer.

In terms of disturbances, higher values of MI showed less disturbed habitat, in opposite to PPI values. All indexes of disturbance and biodiversity are showed in Table 2.

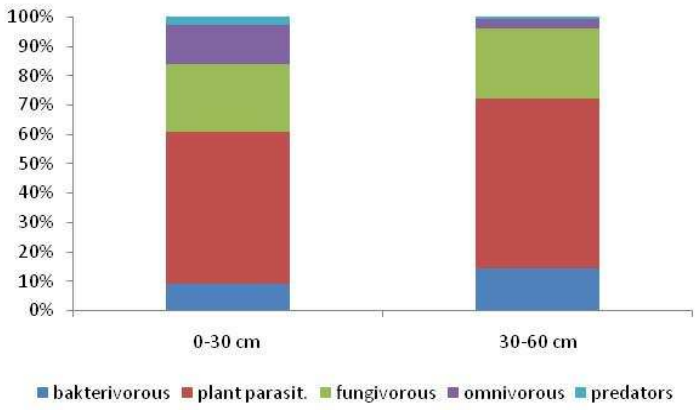

Fig. 1. Trophic structure of nematode community

Table 2. Indexes of disturbances and biodiversity

	H´	MI	PPI	PPI/MI	F/B	E
0-30 cm	1.28 a	2.94 a	2.32 a	0.79 a	2.55 a	0.79 a
30-60 cm	1.05 a	2.33 b	2.38 a	1.02 b	1.71 a	0.65 a

Columns with different letter differ significantly (LSD, P<0,05)

MI and PPI/MI showed statistically significant differences between treatments. Greatest values of MI and H' in upper soil layer reflect higher biodiversity and more stable ecosystem. Higher proportion of omnivorous nematodes and predators at the 0-30 cm depth layer, resulted also in higher values of MI, because omnivorous and predatory nematodes have higher c-p values. However, some authors obtained different results [29]. PPI did not differ significantly between treatments, which is closely connected with the proportion and structure of plant parasitic genera.

Similar proportions and structure of plant parasitic nematodes occurred at both depth layers. All genera of plant parasitic nematodes occurred at both layers (*Tylenchus, Filenchus, Psilenchus, Malenchus, Paratylenchus, Rotylenchus, Pratylenchus, Tylenchorhynchus, Helicotylenchus*).

Shannon diversity index, Evenness and ratio between fungivorous and bacterivorous nematodes did not show significant differences between depth layers.

4. Conclusions

Biodiversity of nematode community structure were studied in vineyard at two depth layer and it can be concluded that:

- Total number of nematode and number of genera occurred in depth layer 0-30cm were higher in compare to depth layer 30-60 cm,
- Trophic structure were similar in both depth layers, especially the proportion and structure of plant parasitic genera,
- Omnivorous nematodes and predators decreased in number with increasing depth layer,
- MI, PPI/MI showed the greatest sensitivity to distinguish the differences between depth layer,
- In opposite, H', E and ratio F/B didn't differ significantly between treatments,
- We can conclude that nematode community enhanced biodiversity at the 0-30 cm soil layer compared to the 30-60 cm layer.

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Influence of shelf height to the yield of button mushrooms

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Abstract

The button mushroom (*Agaricus bisporus*) is extraordinary food containing all proteins needed for normal nourishment. We could lead a normal life without any other source of proteins. They are produced on the floor or on the shelves in the controlled environment. The number of shelves can vary from two to six. Object of this experiment was to determine the dependency of the yield to the height of the mushroom production shelves. During the first flush that lasted five days the number and yield of mushrooms was that the shelf height influences the number of picked mushrooms, but has no significant influence to the yield.

Keywords: *Agaricus bisporus*, shelves, yield

1. Introduction

The mushroom is a form of plant life known as a fungus (plural, fungi) [1]. The mass production of *Agaricus bisporus,* known as the button mushroom started in the first half of the 20th century. Compost for cultivation of A.bisporus is prepared from a mixture of organic materials subjected to a composting process for making it selective for the mushroom [2]. After colonization of Agaricus mycelia in the substrate is complete, a 1.5-inch layer called casing, consisting of peat soil amended with calcium carbonate (to neutralize pH) and water (about 80 percent moisture), is applied on top of the compost bed. This layer is called the casing soil[3].Casing layer is one of the most important components of Agaricus spp production and it directly affects mushroomproductivity, size and mass[4]..Some fungi use light as their signal to form fruiting bodies, but not Agaricus bisporus[5. For instance in Budapest they are grown in the underground tunnels that were made by stone extraction for the building of the city. Due to this insensitivity to the illumination, high space efficiency can be achieved with production on shelf beds, whose number can vary from two to six, depending on the height of controlled environment space and the structure in use. Since the hot air goes up because it is lighter then the cold air, structured ventilation systems are obligatory in those controlled environment production facilities to provide the inflow of fresh air as well as air circulation in order to equalize the air temperature. However, the mushroom compost temperature is always higher on top shelves. This experiment examines the influence of the shelf height dependent temperatures on the yield and number of button mushrooms.

2. Materials and methods

This experiment was conducted on four shelves in the controlled environment production facility with 100 m² growing area. The object was to determine the difference of the yield and number of picked mushrooms to the height of the mushroom production shelves. The shelf height is as follows: 30cm for the first shelf; 100cm for the second; 170 cm for the third and 240cm for the fourth shelf. The experiment was conducted in the button mushroom (*Agaricus bisporus*) production company „Romanjek d.o.o.“ during the first flush which gives the highest yield along the course of the production process. The analysis was done on 36 kg of mushroom compost in eight repetitions. The mushroom compost temperature on the first shelf was 17,5°C-18°C. On the second shelf it was between 18°C and 19°C. On the third shelf it was 18,5°C-19,5°C, while on the fourth it fluctuated from 19°C to 20,5°C. In spite of constant ventilation and air circulation the

mushroom compost temperature is always higher on top shelves since the hot air goes up. Air temperature fluctuation in the mushroom growing facility was between 16°C and 18°C. The CO_2 level was 1280-1400 ppm. All shelf beds were watered equally according to the course of the production process.

3. Results and discussion

The experiment results showing the weight (yield) are shown in the table 1. If we observe the average weight of the picked mushrooms on the shelves we can see that the highest yield was on the fourth shelf (2435,75 g), while the lowest yield was on the first shelf (2053,75 g). The difference in the average weight of the picked mushrooms on the second shelf (2362,75g), the third shelf (2295,25g) and the fourth shelf (2435,75g) is statistically negligible. The difference in the average weight of the picked mushrooms on the first and on the fourth shelf is not statistically significant, as the analysis with ANOVA method proves.

Table 1. The weight of the picked mushrooms

	The weight of the picked mushrooms (g)				Average weight
Shelf	1. yield	2. yield	3. yield	4. yield	
1st shelf	1960	1823	2372	2060	2053,75
2nd shelf	1898	2462	2385	2706	2362,75
3rd shelf	1614	2537	2286	2744	2295,25
4th shelf	2260	2030	2964	2489	2435,75
Average weight	1933	2213	2501,75	2499,75	2286,67
LSD	Shelf	Yield			
	ns	Ns			

ns=no significant

Graph 1. The weight of the picked mushrooms

The experiment results regarding the number of the picked mushrooms are shown in table 2. Statistical method ANOVA results show that the highest number of the picked mushrooms was on the first shelf (185,5 mushrooms), while the lowest was on the fourth shelf (106 mushrooms). On the second shelf the average number of the picked mushrooms was 118,50 mushrooms and 111,75 mushrooms on the third shelf, what shows that there is no statistical difference in comparison to the fourth shelf. The first shelf has shown the significant statistical difference in comparison to the other shelves $P \leq 0,05$.

Table 2. The number of the picked mushrooms

Shelves	The number of the picked mushrooms	Average number

1st shelf	140	150	260	192	185,5
2nd shelf	102	118	114	140	118,5
3rd shelf	66	125	108	148	111,75
4th shelf	80	78	116	150	106
Average number	97	117,75	149,5	157,5	130,43

LSD	shelf	Yield
0,05	45,4643	32,1481
0,01	65,3222	46,1898

Graph 2. The number of the picked mushrooms

Table 3. The mushroom compost temperatures

	Position 1	Position 2	Position 3	Position 4	Position 5
1st shelf	17,5	18,0			
2nd shelf	18,0	18,5	19,0		
3rd shelf	18,5	19,0	19,5		
4th shelf	19,0	19,5	20,0	20,5	21,0

Graph 3. Mushroom compost temperature in dependence of shelf height

4. Conclusion

The experiment results clearly show that the shelf height (or the shelf height dependent temperatures) has no significant influence to the yield as far as the

weight of the picked mushrooms is concerned. However, the lower mushroom compost temperature on the first shelf resulted with the higher primordial development that led to the higher number of the picked mushrooms.

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Irrigation and Nitrogen Fertilization Impact on Inbred Lines and Hybrid Height

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Abstract

Field experiment was carried out at trial field of Agricultural institute in Osijek during growing season 2009. Research has been set up as split-split plot method in three repetitions. Four corn hybrids with similar vegetation length (OSSK 596, OSSK 617, OSSK 602 and OSSK 552) and four inbred lines (OS 438-95, OS 30-8, OS 6-2, OS 1-44) have been tested. Three variants of irrigation have been applied: A1 - control variant without irrigation, A2 - 60% - 100% of field water capacity, and A3 - 80%-100% field water capacity. Fertilization has been applied as follows: B1- control variant without fertilization, B2 - 100 kg N ha^{-1}, and B3 - 200 kg N ha^{-1}. The effect of irrigation and nitrogen fertilization on corn hybrids and lines were evaluated. Irrigation treatment and nitrogen fertilizer showed statistical significant effect on hybrid and corn lines growth as individual impact and as interaction as well.

Keywords: Irrigation; Fertilization; Hybrid; Inbred line; Height

1. Introduction

Corn is highly represented cereal on agricultural surfaces in Croatia. In decade period 1998-2007 maize harvested area in Croatia was, depending on year, from 288380 ha to 407272 ha [1]. Yield variation among years highly depends on whether characteristic, precipitation and temperatures regimes and their distribution during growing season as well [1]. The severe drought experienced during 2003 and 2007 contributed to significantly reduction of grain yield.

Generally speaking, corn is plant of warm climate. To achieve high yields, corn has high demands regarding air temperatures and he must be provided with optimal water amount during whole vegetation season. Sensitivity to drought varies by development stage, and the moisture stress occurring during different development stages of corn may reduce final grain yield according to Doorenbos *et al.* [2].

Corn belongs to a group of plants who tolerates the drought very well, but the yields are getting very low during such periods. This plant use water economically but because of the high grain yield, above biomass, and vegetation length, demands for water are very high [3]. Summer crops require irrigation when precipitation is insufficient to satisfy the crop water demand [4].

Several factors influenced the quantity and stability of maize yield; the most important are the nutrition supply, the hybrid and precipitation [5].

The objective of this study was to evaluate the hybrids and corn inbred lines growth, efficiency of irrigation as maize affected by different rates of N fertilization.

2. Methods and materials

The research has been conducted on trial fields of Agricultural institute in Osijek during growing season 2009. Four corn lines and four corn hybrids have been tested in irrigation and nitrogen fertilization conditions.

Trial has been set up as split-split plot method in three repetitions. Soil type on trial fields is non carbonate humofluvisol.

Main treatment includes three irrigation regimes. Variant A_1 was control variant without irrigation. Irrigation in A_2 variant - 60% to 100% field water capacity. A_3 variant – 80% to 100% field water capacity. On each variant of irrigation, water content in soil has been measured with Watermark (US company) device. Water content has been scanned

every second day. Irrigation started when water content in soil is 60% of field water capacity (FC) in A_2 variant (25,0%) and 80% field water capacity (FC) (30,8%) on A_3 variant. The corn crops were sprinkler irrigated with a linear move system.

Three rates of the nitrogen fertilizer (B_1 – control variant without fertilization, B_2 variant – fertilization with 100 kg N ha^{-1}, and B_3 variant – fertilization with 200 kg N ha^{-1}) were used.

Four corn inbred lines have been tested (C1- OS 438-95, C2- OS 30-8, C3- OS 6-2, C4- OS 1-44).

Four different hybrids have been analyzed (D1- OSSK 596, D2- OSSK 617, D3- OSSK 602 and D4- OSSK 552) with similar vegetation length (FAO 500 and FAO 600). Some of the inbreed lines where parental plants for creation of tested hybrids.

Plant height development was determined by measuring (from soil surface to the top of the tassel) ten plants for each plot every ten days in July. Last measuring corresponded to the late vegetative and early reproductive growth stages.

For the analysis of the weather conditions (precipitation quantity and mean air temperatures), dates from Osijek Weather Bureau have been used [6].

Statistical analysis has been given with analyze of variance. Given results have been tested with LSD test at 0.05 and 0.01 level of significance was calculated to test difference between treatments means.

3. Results and achievements

In generally for Osijek region, mean air temperatures in June, July and August 2009 where above average. Supplied month where extremely warm and dry [6].

Mean air temperatures and precipitation quantities are illustrated in Figure 1. It seems that temperatures in Croatia are rising and precipitation quantity is getting lower thru years. Extremely weather cases such as drought and heat are getting more often. The climate conditions on the experimented period were unfavorably for maize production. Lack of rainfall in correlation with high temperatures contributes to a reduction in soil moisture, and drought.

Water stress leads to lower crop growth rate and plant height as well [7]. All this facts are pointing out on the significance of irrigation practice.

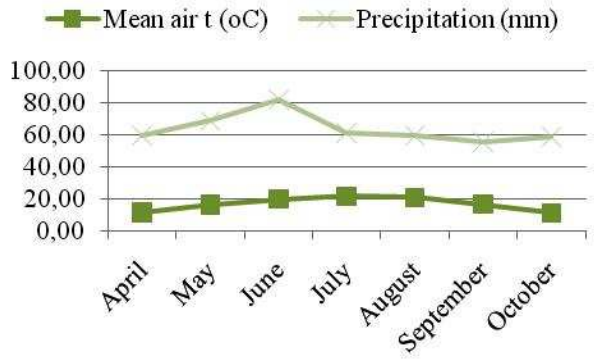

Figure 1. Mean air temperatures (^oC) and precipitation (mm) during growing season 2009

Analyses of variance showed different impact of tested factors: hybrid, inbred lines, irrigation and nitrogen application on plant growth.

Results showed the significant effect ($P < 0.05$) of irrigation application during hybrid growth. Very significant effect on hybrid growth showed nitrogen fertilization ($P < 0.01$), and hybrid ($P < 0.01$).

Results obtained from the study concerning the effect of irrigation on corn height are comparable with Cakir [7] results who say that applied irrigation dramatically accelerated plant growth and the effect was obvious as several days after water application.

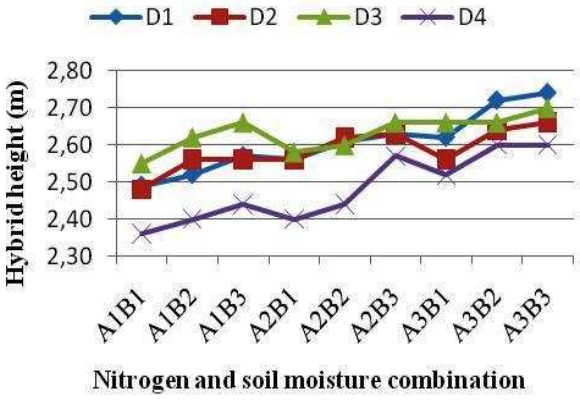

Figure 2. Hybrid height development by different nitrogen and soil moisture combination

Hybrid and irrigation interaction showed statistical significant ($P < 0.05$) effect on plant growth.

Table 1. Impact of irrigation and nitrogen fertilization on hybrids height

Hybrid height (m)												
	A1				A2				A3			
	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4
Interaction ABD												
B1	2.49	2.48	2.55	2.36	2.46	2.56	2.58	2.40	2.62	2.56	2.66	2.48
B2	2.52	2.56	2.62	2.40	2.61	2.62	2.49	2.44	2.72	2.64	2.70	2.60
B3	2.57	2.56	2.66	2.44	2.63	2.63	2.66	2.57	2.74	2.66	2.76	2.60
XAD	2.53	2.53	2.61	2.40	2.56	2.61	2.57	2.47	2.69	2.62	2.71	2.56
XA	2.53		2.51		2.58		2.52		2.65		2.64	
Interaction AB							B					
2.48	2.45	2.51	2.49	2.59	2.57		3.77					
2.54	2.51	2.62	2.46	2.68	2.65		3.86					
2.56	2.55	2.69	2.62	2.65	2.64		3.92					
Interaction AD									F – test (P <0.01, P < 0.05)			
	B1	B2	B3	XD								
D1	2.52	2.61	2.65	2.59					A		10.976 *	
D2	2.53	2.61	2.62	2.58					B		18.564 **	
D3	2.59	2.60	2.69	2.63					D		30.033 **	
D4	2.41	2.48	2.54	2.47					AD		2.458 *	

A1 = control variant without irrigation, A2 = 60% - 100%, A3 = 80% - 100% field water capacity. B1 = control variant without fertilization, B2 = 100 kg N ha^{-1}, B3 = 200 kg N ha^{-1}
D1 = OSSK 596; D2 = OSSK 617 ;D3 = OSSK 602; D4 = OSSK 552
* = 0.05, ** = 0.01 signification

Plant height development for the different nitrogen and soil moisture combinations is illustrated in Figure 2. for hybrids.

The results are comparable to Plavšić [8] results. According to his results, plant height was statistically very significant (P < 0.01) affected by nitrogen fertilization. Among fourth hybrids, D4 (OSSK 552) reaction was very negligible to irrigation and nitrogen treatment. This result match Plavšić results from 2009. Among his tested hybrids, D4 hybrid showed lower height and lower reaction to nitrogen fertilization.

The irrigation and nitrogen fertilization impact on hybrids height is showed in table 1.

Analysis of variance showed statistical significant effect of irrigation treatments on corn lines height development (P < 0.05). Irrigation treatment and corn inbred line interaction was statistical significant (P < 0.05). Statistical very significant was nitrogen effect (P < 0.01).

Inbred line of corn showed statistical very significant effect (P < 0.01) on plant height. Unlike hybrid height, interaction of irrigation and nitrogen fertilization was statistical very significant (P < 0.01) by line height.

Plant height development for the different nitrogen and soil moisture combinations is illustrated in Figure 3. for corn lines.

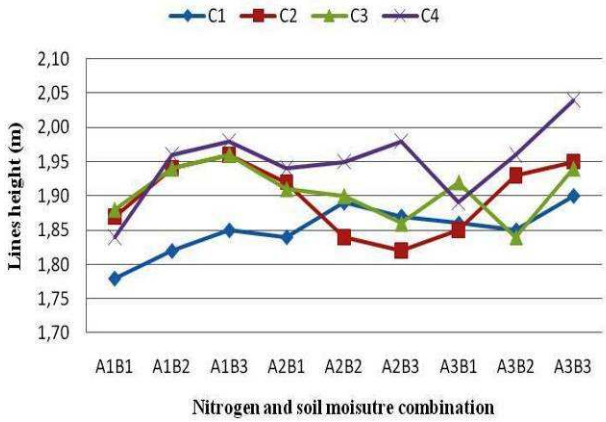

Figure 3. Lines height development by different nitrogen and soil moisture combination

Plants where significantly smaller when no nitrogen fertilizer where applied. Plants growth also shows clearly the influence of soil moisture on plant height and growth. As soil moisture content increased there was subsequent increase in plant height.

Table 2. Impact of irrigation and nitrogen fertilization on inbred lines height

Inbred line plant height (m)												
	A1				A2				A3			
	C11	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4
Interaction ABC												
B1	1.78	1.87	1.88	1.84	1.84	1.86	1.75	1.82	1.86	1.85	1.92	1.89
B2	1.82	1.94	1.94	1.96	1.89	1.84	1.90	2.04	1.85	1.93	1.84	1.86
B3	1.74	1.82	1.85	1.86	1.87	1.82	1.86	1.88	1.90	1.95	1.94	1.95
XAC	1.78	1.87	1.89	1.88	1.86	1.84	1.84	1.91	1.87	1.91	1.90	1.90
XA	1.83		1.88		1.85		1.87		1.89		1.90	
Interaction AB							B					
1.83	1.86	1.85	1.78	1.85	1.91		1.85					
1.88	1.95	1.86	1.97	1.89	1.85		1.90					
1.78	1.85	1.85	1.87	1.93	1.95		1.87					
Interaction AC									F – test (P <0.01, P < 0.05)			
	B1	B2	B3	XC					A	10.012 *		
D1	1.83	1.85	1.83	1.84					B	21.919 **		
D2	1.86	1.90	1.86	1.87					C	4.449 *		
D3	1.85	1.89	1.88	1.87					AC	2.617 *		
D4	1.85	1.95	1.89	1.89					AB	21.330**		

A1 = control variant without irrigation, A2 = 60% - 100%, A3 = 80% - 100% field water capacity. B1 = control variant without fertilization, B2 = 100 kg N ha^{-1}, B3 = 200 kg N ha^{-1}
C1 = OS 438-95, C2 = OS 30-8, C3 = OS 6-2, C4 = OS 1-44
* = 0.05, ** = 0.01 signification

Irrigation improves the efficiency of nitrogen fertilizer. Quaye [9] in his results points out on interaction between irrigation applied and nitrogen fertilizer. He reported when no nitrogen fertilizer was applied, maize plants grown on soils maintained at FC > 60% grow taller than those who have been grown without irrigation applied. Also, when nitrogen fertilizer where applied plants where significantly taller on irrigated plot. Soliman *et al.* [10] reported significant impact of corn inbred lines on growth parameters like plant height.

4. Conclusions

This paper shows that corn production will benefit from applied irrigation and nitrogen fertilizer**,** especially at dry years. Positive impact is concerning hybrids and corn inbred lines as well.

The response of maize to applied nitrogen fertilizer level has been found to be governed by the moisture stored in the soil, or moister from applied irrigation.

Maize has high potential and responds well to different management practices.

Irrigation and nitrogen nutrition play a significant role in realizing the maximum potential of the crop.

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Application of Lacto-Corder in the control of milkability properties of dairy cows in Croatia

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Abstract

Control of dairy cows production in Croatia consists of two steps: measurement of milk amount after the milking and taking of milk samples for the chemical analysis. This kind of control gives a very few information about production. On the other hand, for several years other countries use sophisticated devices, such as Lacto-Corder, for monitoring of many parameters important for production and selection of cows. Lacto-Corder is measuring device for production control and collecting of milk samples. Research work was conducted on Holstein cows (n = 457). Cows were in the range from first to third lactation. Thirteen production parameters were measured. Duration of main milking phase (*dMFR*) was 4,51 min. The average amount of milk in that time (*MY*) was 10,18 kg. Average milking in minute (*AFR*) was 2,27 kg/min. For quick and efficient milking it is desirably that cows have a long and persistent plateau phase, while ascending and descending phase should be as shorter as possible. From the environmental factors affecting milking properties, farm factor had the biggest influence while lactation order and stage were less significant. The results showed that the milking properties of cows were not adjusted to machine device milking. With the Lacto-Corder measuring device many valuable data can be obtained for the purpose of cattle selection in Croatia. The only obstacle for use of Lacto-Corder in Croatia today is very high selling price.

Keywords: Lacto-Corder, production control, milkability, cows, technology

1. Introduction

Milkability, as one of secondary goals, defines udders characteristics and milking flow.[1] This characteristic is getting special importance in transfer from hand to mechanical milking. Milkability means cow ability to be milked fast, equal and entirely with correct milking procedure.[2] Milkability testing in cattle breeding has a following goal: to improve cow privilege for milk process during breeding-selection choice. Milking accounts for about 50 % of work during milk production and because of that from the productivity viewpoint milkability has the large economical importance.[3, 4]

The first research results performed by Lacto-Corder in Germany were used to define the value of certain milk flow curve parameters. For a future, selective aim were suggested for cows which had a high maximal milk flow.[5] Then, the desirable maximal milk flow extent of 3,0 to 4,5 kg/min was defined and also the main milking phase duration of ≤ 6 min.[6] Establishing the connection of the milk flow and the health udder, the maximal milk flow value of 3,5 to 4,0 kg was suggested for the somatic cell count in milk and it was the least value. A very important role had the udder's sucking canal whose width influenced the milk flow speed, as well as the udder's health.[7]

The aim of this research is to study milkability properties with sophisticated device Lacto-Corder that is used for the first time in control of milkability properties in the Republic of Croatia. The specific target is to determine if there is an influence of certain environmental factors on investigated milking properties.

2. Methods and materials used for research

The research was conducted on 457 Holstein breed cows in the range from first to third lactation. The measurements were performed according to German regulations [8] with a mobile Lacto-Corder unit, ser no. 16842, SW-Version: 93004, (manufacturer WMB AG, CH-9436 Balgach). In 1999 the unit received an international recognition by ICAR (International Committee for Animal Recording) for quantity

measuring and milk sample taking by machine milking.

Lacto-Corder has a possibility of graphical recording of the milk flow curve from first milk flash till the milking end (Figure 1.).

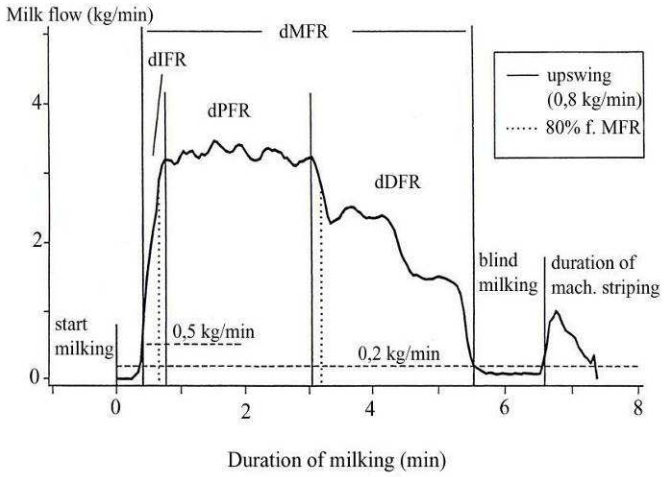

Fig. 1. Graphic scheme of the milk flow curve with individual phases

Following parameters were used for the statistical analysis:

MY – the milk yield per milking (kg),

MFR – the maximum flow rate (kg/min),

AFR – the average flow rate (kg/min),

dS500 – the time from the beginning of measurement to point at which the flow rate is 0,50 kg/min (min),

dIFR – the duration of increasing flow rate (min),

dPFR – the duration of peak flow rate (min),

dDFR – the duration of decreasing flow rate (min),

dMFR – the duration of main flow rate (min),

Statistical analysis was carried out by the least squares method and maximum likelihood general program for mixed models procedure of the Statistica.[9] A general linear model with fixed effects of farm, lactation, stage of lactation and their interactions with each other was used to identify the main sources of variation for studied traits in preliminary statistical analyses. Interactions were excluded from the final statistical model, since they were not statistically significant.

Fixed linear model that was used had the following form:

$$Y_{ijkl} = \mu + F_i + L_j + SL_k + e_{ijkl} \quad (1)$$

where:

Y_{ijkl} = observed characteristic
μ = general average
F_i = fixed effect of i farm (1, 2, 3 and 4)
L_j = fixed effect of j lactation order (1, 2 and 3)
SL_k = fixed effect of j lactation stage (1, 2 and 3)
e_{ijkl} = random error

Multiple comparisons of average values were made using the Post Hoc Tests and Fisher LSD method, with following levels of the significance ($P < 0,05$ and $P < 0,01$).

3. Results and achievements

For quick and efficient milking it is desirable that cows have a long and persistent plateau phase, while ascending and descending phase should be as shorter as possible.[6] These stages are directly related to the form of milking flow curves and they are one of the key factors of their appearance.

Table 1. Total average values of investigated parameters for the Holstein breed cows at all lactation stages.

Trait	$\bar{x}$	sd	min	max
MY (kg)	10,18	3,66	5,00	20,14
MFR (kg/min)	3,49	1,27	0,89	10,51
AFR (kg/min)	2,27	0,79	0,59	5,48
dS500 (min)	0,21	0,23	0,01	4,29
dIFR (min)	0,75	0,55	0,04	4,48
dPFR (min)	1,67	1,36	0,05	9,99
dDFR (min)	2,14	1,27	0,05	10,97
dMFR (min)	4,51	1,88	0,61	19,37

In Holstein cows *dMFR* lasted on average around 4,5 minutes (Table 1). The longest lasted phase, characterised with *dDFR* = 2,14 min, as a negative property of selection, indicated abnormal udder index for the examined cows, while *dPFR* had shorter value of 1,67 min. From the selection point of view it would be desirable that the obtained values are vice-versa ordered. The milk flow of the main phase (*AFR*) of Holstein cows had average value of 2,27 kg/min while MY was 10,18 kg milk per milking and *MFR* was 3,49 kg/min.

With the exception of *dS500*, influence of farm factor was highly significant for all the milking parameters examined (Table 2). Milking was the longest lasted at the fourth farm (*dMFR* = 5,50 min) and the shortest lasted at the third farm (*dMFR* = 3,83 min). *AFR* had the largest values at the second farm where also the largest production per milking values was measured.

Table 2. Influence of farm factor on examined properties (LSM - Least squares means).

Trait	Farm				P value
	1. *n*=109	2. *n*=109	3. *n*=114	4. *n*=125	
	LSM	LSM	LSM	LSM	
MY	9,53^{ac}	11,08^{b}	9,30^{ac}	10,69^{ab}	**
MFR	3,16^{a}	4,17^{b}	3,83^{b}	2,88^{a}	**
AFR	2,17^{acd}	2,64^{b}	2,34^{ac}	1,97^{ad}	**
dS500	0,21	0,24	0,21	0,18	N.S.
dIFR	0,56^{a}	0,79^{bc}	1,00^{bd}	0,64^{ac}	**
dPFR	1,75^{a}	1,38^{ab}	1,05^{b}	2,38^{bc}	**
dDFR	2,03^{ab}	2,08^{abc}	1,88^{ab}	2,48^{bc}	**
dMFR	4,35^{a}	4,25^{a}	3,83^{a}	5,50^{b}	**

For Table 2., 3. and 4. $^{a, b, c, d}$ means within the same row and not sharing the same superscript letter are significantly different ($^{*}P < 0,05$; $^{**}P < 0,01$), NS: not significant.

Table 3. Influence of lactation on examined properties (LSM - Least squares means).

Trait	Lactation			P value
	1. *n*=157	2. *n*=113	3. *n*=187	
	LSM	LSM	LSM	
MY (kg)	9,22^{a}	9,84^{a}	11,18^{b}	**
MFR (kg/min)	3,22^{a}	3,44^{ab}	3,74^{b}	**
AFR (kg/min)	2,12^{a}	2,21^{a}	2,43^{b}	**
dS500 (min)	0,22	0,22	0,21	N.S.
dIFR (min)	0,71	0,73	0,72	N.S.
dPFR (min)	1,71	1,71	1,63	N.S.
dDFR (min)	2,04	2,01	2,24	N.S.
dMFR (min)	4,46	4,45	4,59	N.S.

Influence of lactation was significant in terms of milk amount, average flow rate and maximum flow rate (Table 3). The values of these parameters increased with increasing number of lactation order. In third lactation the maximum milk amount per milking (*MY* = 11,18 kg) and the highest milk flow rates (*MFR* = 3,74 kg/min and *AFR* = 2,43 kg/min) were obtained. This increase of parameters' values was highly expected. It can be conveniently explained by the fact that the milk production of Holstein cows has increasing values until the third lactation when these cows reach their maximum production. It has to be mentioned that the number of lactation order did not influence other milk flow parameters that were examined in this paper.

Table 4. Influence of lactation stage on examined properties (LSM - Least squares means).

Trait	Stage of lactation			P value
	1. *n*=93	2. *n*=86	3. *n*=278	
	LSM	LSM	LSM	
MY (kg)	11,84^{a}	11,49^{a}	9,22^{b}	**
MFR (kg/min)	4,25^{a}	3,57^{b}	3,21^{c}	**
AFR (kg/min)	2,75^{a}	2,38^{b}	2,07^{c}	**
dS500 (min)	0,19	0,20	0,22	N.S.
dIFR (min)	0,66	0,74	0,78	N.S.
dPFR (min)	1,59	1,90	1,62	N.S.
dDFR (min)	2,01	2,21	2,15	N.S.
dMFR (min)	4,26	4,86	4,49	N.S.

Similarly as it was obtained by investigation of lactation order number, influence of lactation stage was significant only for following parameters: *MY*, *MFR* and *AFR* (Table 4). These parameters reached their maximum values at the first lactation stage (11,84 kg; 4,25 kg/min and 2,75 kg/min, respectively) when production of milk in lactation reached its peak. After that, continuous decrease in milk production was observed. Other milk flow parameters that were examined in this paper were not significantly different between lactation stages.

Although the obtained results (Tables 3 and 4) showed that certain milking properties are not dependent on lactation order and stage they are extremely important. Investigations performed so far confirmed that the connection between the milking characteristics and the health udder is derived from a physiological connection of the udder anatomy and infection resistance. The somatic cell count in milk grows with the shortening of the milking time and increasing of the milk flow,[6] what should be taken into consideration by selective animal choosing. Naumann and coworkers [10] found also influences between the relation of *dMFR* to *dDFR* and *dDFR* to somatic cell count. The authors suggest that the correlation could be strengthened if a milk quantity correction were performed.

Implying a modern measuring technique (Lacto-Corder) in controlling the bovine productivity would significantly improve the breeding selective success.[7] This preventive procedure in selection would surely have a positive shift in creating more resistant cows from mastitis.[11] Further research should establish genetic parameters of milking characteristics and define desirable milk flow curve with referring to cow's health udder.

4. Conclusions

The studies have shown that improvement of milkability properties had a positive effect on productivity in mechanical milking, udders health and milk quality. Relevant institutions that create and implement the cattle breeding program in the Republic of Croatia should include milkability properties in cattle selection index. Influence of examined parameters on milking properties is important and further more specific studies for certain milking properties parameters are necessary. Also more detailed link between milking properties parameters and cow udder health should be established. Lacto-Corder measuring device provides high quality and effective surveillance of great number of milking properties simultaneously. Taking that into account, it is highly recommendable for research and usual controls of cattle milking properties in Croatia.

Further research must be focused on the study of genetic parameters for certain milkability properties. Besides at the selection of bull's mothers, milkability properties should be taken into account when conducting the progeny test of young bulls where for the start the minimum conditions for the milk flow should be established.

5. Acknowledgements

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Villa "Brlićevac" Traditional Garden as Basis and Determinant for Specific Landscape of Brodsko Brdo

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Abstract

Villa "Brlićevac" with historical garden is an only still authentic preserved example of countryside Villa with garden from period of romanticism in the area of Slavonski Brod. This complex is protected by Ministry-of-culture as cultural heritage of Croatia. With a view to properly protect and upgrade this historical, cultural, botanical and ecological important site, as an unique inheritance of landscape architecture of suburban cultivated landscape of Slavonski Brod dating from 19. Century, scientific and systematic inventory, analysis and valorisation were made. As an outcome, Map of Present Situation was made, with detailed Morphogenesis Analysis and Analysis of Vegetation included. Outcome of this research indicates historical determinant of land use, landscape planning and design of Brodsko Brdo – the foothill region of Slavonski Brod, also providing traditional basis and guideline for landscape planning of Brodsko Brdo in the future.

Keywords: Landscape Architecture, "Villa Brlićevac", Traditional Landscape, Suburban Landscape, Historical Garden

1. Introduction

Villa "Brlićevac", countryside villa of noble family Brlić from Slavonski Brod, is located on foothill region of Dilj hill, on slopes called Brodsko Brdo, nearby Slavonski Brod.

Complex of Villa and Garden is registered as Croatian cultural heritage with protection of Ministry-of-culture [1]. According to Decision of protection dating from 1980., only Villa was defined as cultural welfare. Complex of Villa and Garden is registered as cultural welfare according to Revised Decision of protection dating from 05. November 2009.

Villa "Brlićevac" was built in 1880., according to conception made by Fanika Brlić Daubachy [2]. In that period were popular the spirit of romanticism and its philosophy of "humanity returning to the nature". Boundless, wild and varied nature was exceptionally admired [3]. In accordance with specified characteristics of stylistic period of romanticism, gardens around the world were designed. In suburban area of Slavonski Brod, as an implementation of romanticist pattern, noble families were building their countryside villas too. Villas were situated on sunny south slopes of Dilj hill, designed in complex with vineyard, orchard, rosary and decorative and allochthonous vegetation [2].

Besides exceptional value in the field of landscape architecture, this complex has unique cultural and historical importance too. World wide famous writer Ivana Brlić Mažuranić, known also as an expert in botany, was strongly banded with this site [2]. In her Herbarium [4], that today is museum archive material, is collection with numerous herbs found in this garden. Writer has left her mark through choosing seedling material and designing and maintaining this garden. The complex of Villa and garden was an inspiration for numerous Ivana's tales. The oldest herbs are still living remains of original vegetation that was by Ivana Brlić Mažuranić in person selected, introduced and cultivated in this garden.

With an intention to preserve this unique site as historical value, and also as a basis, determinant and guideline for landscape planning and landscape design of this area, scientific and systematic approach in its protection was initiated.

2. Methods and materials used for research

Research implied few job steps: Fieldwork, making Map of Present Situation, Literature and Archival Material studying and Analysis and Valorisation according to historical characteristics, morphogenesis, botanical content, usage and environmental and scenery factors.

2.1 Fieldwork

Fieldwork was performed from September 2008 until November 2009. Because of whole-year monitoring it was possible to exactly identify every single herb and to describe it in every-season aspect.

Fieldwork consisted of digital photography, sketching, analogous importing field-data in Specific Geodesic Map, determination of herb species [5], [6], [7], describing vegetation condition and noting garden structures.

2.2 The Map of Present Situation

The Map of Present Situation was manufactured by using Cad Program. First a Digital Model of Terrain, with Terrain Profile was made. Then into the Specific Geodesic Map garden structures and vegetation were imported. Displayed vegetation was classified in different Layers according to species.

2.3 Literature and Archival Material studying

Studying historical material was obligate part of this research. Monograph with old photographs, postcards and letters was browsed. It was the main source of historical information. Valuable source were written memories of Ivana's heiress too. Herbarium made by Ivana Brlić Mažuranić was important literature for describing present vegetation and to link it with vegetation characteristic to this garden in the past.

2.4 Photo-Library forming

Photo-Library was formed by collecting photographic data. Each photo was numbered and named, with added Map showing the place of shooting. Photo-Library covers entire area inside protection boundary.

2.5 Analysis and Valorization

Analysis of historical and stylistic period was performed according to comparison of garden forms and structures with data in literature sources.

Morphogenesis was analyzed by decomposition of garden form. Main characteristics of garden - basic elements and compositional typology were described.

Botanical analysis included herbal species determination, herbal material allocation, description of each species habitat, displaying quantity of each species, calculation of percentage of appearance for each species, extraction depending on age, selection according to use, origin and ambient value.

Equation used for calculation (1) of percentage of appearance for each species was following:

$$y = \frac{x * p}{100}\% \qquad (1)$$

y = number of certain herb
x = number of all present herbal material
p = percentage

Zonal analysis contained decomposition of garden in specific units with different purpose and elements. In this analysis utility of vegetation was noticed too.

Ambience analysis was conducted depending on variety of impressions and scenery through the seasons of the year.

3. Results and achievements

3.1 Historic basis

Romanticism, the stylistic period characteristic for 19 century when the Villa was create, is manifested in garden through vegetation forms and design characteristics. Sequence from cultivated lawn and decorative solitary trees via clumps with climax in wilderness-alike border scrub, typical for romanticism, is evident. It is possible to spot continuity of appearance for some garden elements, as are axisymmetry, stairways, terraces, old fruit trees, timber shed overgrown with *Wisteria*, old vineyard, rosary and conifers, from days of their creation until nowadays.

According to archive sources, complex of Villa and garden has undoubtedly strong historic basis that makes this site especially valuable.

3.2 Garden composition and morphogenesis

There are three relief-determinate terraces; north, central and south terrace. Vertical axis of symmetry, reinforced with stairways and lane, divides garden into equal, east and west, parts. Basic structural elements of this garden (Table 1) are main vertical axis, secondary horizontal axes, terraces, central lane, stairways, timber shed, solitary trees, shrub, rosary, vineyard and orchards.

Villa "Brlićevac" (Fig. 1) stands in the middle of the highest, north terrace. Approach route comes to the entrance of the Villa from the east side, between two outhouses (servant house and barn). Near approach route still stands old well, according to archive sources only well in this area at that time. Along south border of approach route formerly were sequence of trees and shrub. Southern front side of Villa is covered with lawn. In the west, under old conifers, is open-air dining place and in the east is intimate sitting area in shade. In the north side of this terrace is old orchard with several exceptionally old fruit trees.

Figure 1. Photo of Villa "Brlićevac"

Central terrace is open lawn space with lane in the middle. Approach from the north terrace is led through stairway and timber shed (Fig. 2) overgrown with *Wisteria* that has I.B. Mažuranić herself planted. Along central lane are bench and solitary decorative red-leaf tree. Along north border between north and central terrace are decorative shrub planted. South border of central terrace is reinforced with horizontally sited lane and sequence of ancient, approximately century old rosary.

Second stairway leads into third, lowest, south terrace. Here are old vineyard in the east side and old orchard in the west side.

Figure 2. Timber shed overgrown with *Wisteria*

Table 1. Structural elements of garden

No	Item	Function – description
1.	Vertical axis – Central lane	Basis for garden composition
2.	Horizontal axes – lane, roses sequence	Sectioning garden composition
3.	Terraces	Relief determined
4.	Villa	Dominant element
5.	Stairways	Constructed garden element – connection between terraces
6.	Timber shad	Constructed garden element – ambiental value
7.	Solitary trees	Accent
8.	Clumps of vegetation and Shrub	Symbol of wilderness
9.	Lawn	Open space that points out Villa
10.	Well	Constructed garden element – utility and ambiental value
11.	Vineyard and Orchard	Traditional elements of this landscape

3.3 Vegetation

Table 2. Dendritic material

No	Species	units	%	Utility	Autochtonous	No	Species	units	%	Utility	Autochtonous
1.	*Prunus domestica*	32	17.4	*	*	18.	*Prunus laurocerasus*	1	0.54	-	-
2.	*Malus domestica*	25	13.6	*	*	19.	*Pinus sylvestris*	2	1.09	-	*
3.	*Juglans regia*	24	13.05	*	*	20.	*Abies sp.*	2	1.09	-	*
4.	*Prunus avium*	3	1.63	*	*	21.	*Picea sp.*	2	1.09	-	*
5.	*Cydonia oblonga*	1	0.54	*	*	22.	*Taxus baccata*	1	0.54	-	*
6.	*Prunus cerasus*	1	0.54	*	*	23.	*Rosa sp.*	10	5.4	-	*
7.	*Prunus cerasifera "Atropurpurea"*	1	0.54	-	-	24.	*Rosa canina*	4	2.17	-	*
8.	*Prunus sp.*	1	0.54	-	-	25.	*Cornus sanguinea*	25	13.6	-	*
9.	*Magnolia sp.*	1	0.54	-	-	26.	*Wisteria sinensis*	1	0.54	-	-
10.	*Syringa sp.*	4	2.17	-	-	27.	*Euonymus sp.*	3	1.63	-	*
11.	*Sambucus nigra*	1	0.54	*	*	28.	*Corylus avellana*	11	6	*	*
12.	*Morus alba*	1	0.54	*	*	29.	*Salix viminalis*	1	0.54	-	*
13.	*Robinia pseudoaccacia*	10	5.4	*	-	30.	*Forsitia europaea*	1	0.54	-	*
14.	*Tilia cordata*	1	0.54	*	*	31.	*Chaenomeles japonica*	2	1.09	-	-
15.	*Quercus sp.*	1	0.54	-	*	32.	*Ficus carica*	1	0.54	*	-
16.	*Carpinus betulus*	2	1.09	-	*	33.	*Vitis vinifera*	75 vines		*	*
17.	*Betula pendula*	8	4.3	-	*						

There are 33 dendritic species recognized, 24 (72.72%) autochtonous species and 9 (27.28%) alochthonous species. Their location is imported into Map of Present Situation (Fig. 3). In Table 2 is their list with basic characteristics included. Majority of 44.05% belong to utilitar autochtonous fruit species. Alochthonous species have mostly decorative purpose. Autochtonous species are organized mostly in geometric, linear forms. Alochthonous, decorative species are coming as solitary trees or forming clumps.

Diversity of dendritic material results with yearlong variety of scenery through seasons. Spring is characterised with blossom of fruit trees and light green young leaves. In the summertime white, rosy, pink, red and purple roses are dominant. Autumn is season of yellow, orange and brown leaves, dark blue grape and red apples. Wintertime is snowy and white, with dominant dark green conifers and *Prunus laurocerasus.*

Figure 3 Map of Present Situation

According to analysis of age, it was realised that exceptionally old and valuable dendritic material is equally distributed around garden site, confirming historical authenticity and value of this garden.

3.4 Functionality Zones

Map of Functionality Zones (Fig. 4) is made according to analysis of dominant purpose for each particular fragment of garden. North and south utility zones are mostly productive, with vineyard and orchards. Central zone has residential function, composed from numerous smaller subareas with different purpose of use. Communication zone passes through central part of garden.

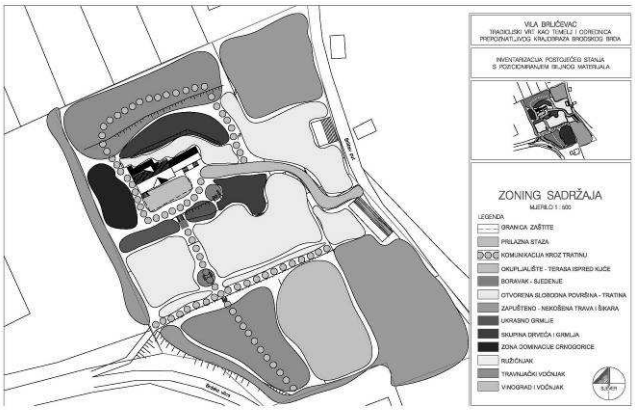

Figure 4 Map of Functionality zones

4. Conclusions

Result of this research is knowledge about historical basis, morphogenesis, basic elements and valuable dendritic diversity of this important historical garden. It is outstanding and, in area of Slavonski Brod, only preserved example of landscape architecture from the time of romanticism, when it was constructed. Nowadays while value of historical and cultural heritage is increasing, its importance is amplifying. Aim of this research was to indicate significant importance of this site and to support with facts reasons for its devoted protection.

Villa “Brlićevac” and belonging garden are integral element of “the image of the city” of Slavonski Brod. Results of this research can be helpful guideline, basis and determinant for future Landscape planning and Landscape design of wider area of Brodsko Brdo also, based on proven firm traditional and authentic foundation.

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Irrigation Soil Suitability on Ivankovo Area

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Abstract

The main objective of this research was to determine irrigation soil suitability in an area of 321 ha near Ivankovo, County of Vukovar-Srijem, Eastern Croatia. Soil map and irrigation soil suitability map were made on the basis of data from field and laboratory tests. On the researched area three suitability classes for surface irrigation (moderately suitable soils, limited suitable soils and temporarily unsuitable soils) were determined. Moderately suitable soils (S2) are spread on the 217 ha and main limiting factors are: higher clay content, lower infiltration rates, low air holding capacity, moderate compaction in surface and high in subsurface layers, very low content of available phosphorus, low content of available potassium and low organic matter content. Limited suitable soils (S3) were found on 56.5 ha with following main limiting factors: high density of the surface and subsurface soil layers, low infiltration rates, alkalinity, high level of soil alkaline carbonates, high clay contents, low air capacity, very low content of available phosphorus, low content of available potassium and low organic matter content. Temporarily unsuitable soils (N1) are spread on 48.2 ha and main limiting factors were: high level of ground water, high compaction, high clay content, low infiltration rates and soil alkalinity.

Keywords: irrigation, soil, suitability classes

1. Introduction

About 40% of world food are producing on 250 mil ha irrigated land (17% of total arable land). [1] Acording to data from Croatian agricultural register of 2003 there are 9246 ha of irrigated soils and 54% of those is on private housholds. From the same register we estimate that only 0.86% of all arable land in Croatia is irrigated, mostly in County of Dubrovnik-Neretva and County of Split-Dalmatia and the least irrigated soils are in County of Lika-Senj. At the County of Vukovar-Srijem, where the exploration was take place, from the totally 121 077 ha of land only 772 ha or 0.64%, were irrigated [2], although 68 329 ha belongs to class of highly suitable soils (S1) for irrigation. Also, 27 284 ha are moderatly limited suitable (S2), 41 630 ha are limited suitable (S3) and 26 468 ha belongs to N1 and N2 classes (temporarily and permanently unsuitable soils for irrigation). [3] However, due to the great demand for market of agricultural products and adopting of National irrigation plans few years ago, there are number of projects in Couny of Vukovar-Srijem of which some were realized. The main objective of this research was to determine irrigation soil suitability in an area of 321 ha near Ivankovo, County of Vukovar-Srijem.

2. Methods and materials used for research

The research was carried out at 321 ha of the Ivankovo area. Field and laboratory tests were performed and on the basis of those data, soil map and irrigation soil suitability map were made. Edelman auger probes were used for soil unit determining and soil type distribution. In total 52 auger hole were done. On specific sites 7 soil profiles were open on which ectomorphological (relief, vegetation, altitude, geographic coordinates) and endomorphological (soil depth, sequence and thickness of soil layers, colour, content of alkaline carbonates) properties were determined.[4,5] After describing the profiles, samples has been taken in a natural shape in cylinders of 100 cm^3 volume from every soil layer in 3 repetitions. Samples for determining the chemical and physical soil properties were collected (1.5-2 kg per sample).

The main soil physical and chemical properties were determined by standard methods [6]. The soil pH (M KCl, 1:5 v/v) were determined according to ISO [7], plant available phosphorus and potassium by ammonium-lactate extraction [8], soil organic matter content by sulfocromic oxidation [9], clay contents and texture by ISO [10]. Infiltration rates by double ring infiltrometer, bulk density, water and air holding

capacity and wilting point were determined according to Škorić.[11]

Pedologyc maps were made by the criteria used for detailed maps.[12,4] Soil units map and irrigation soil suitability map were made by GIS tool ARCVIEW 3.3.

Evaluation of soil suitability for irrigation is in accordance with the modified criteria for soil evaluation.[13,14] Orders determine suitability (S) or unsuitability (N) of soil for irrigation, classes determine suitability degree or S-1, highly suitable soils, S-2 moderately limited suitable soils, S-3 limited suitable soils, N-1 temporarily unsuitable and N-2 permanently unsuitable soils for irrigation and multipurpose use. Limitations that determine subclasses of suitability and unsuitability of the soils for irrigation in this case includes: effective depth, soil acidity, soil alkalinity, low level of nutrients, drainage, water holding capacity, bulk density, clay content, temporarily high level of underground water in soil layer, stagnated surface water, floods, terrain sloop, expenses for keeping fertility of the soil during irrigation.

3. Results and achievements

3.1. Soil properties in the investigated area

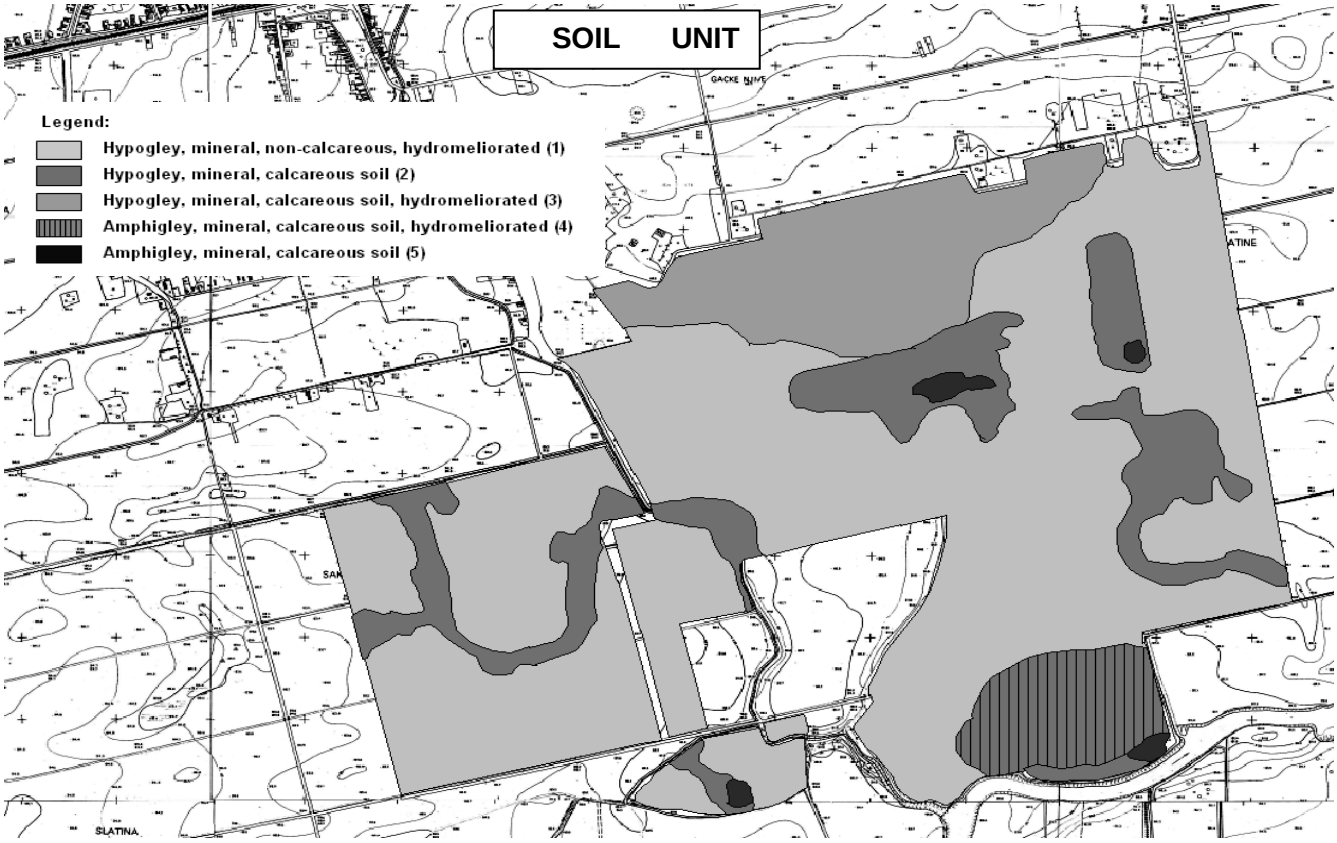
The investigated soils are hidromorphic soils, class gleysoil, soil type eugley. They are low acid to alakaline (pH_{KCl} 5.3 to 7.6) and shows low supplies of phosphorus and moderate supplies of potassium. Soil organic matter content was from 1.99 to 2.76 in surface horizons (Table 1.). Soil texture is silty clay loam with 31.0% to 39.5% clay. Moderate water holding capacity and very low air holding capacity were determined in all surface horizons (Table 2).

Table 1 Soil chemical properties

Soil unit	Horizon	pH (KCl)	$CaCO_3$ (%)	AL-P_2O_5 mg/100g	AL-K_2O mg/100g	OM (%)
Hypogley, mineral, non-calcareous, hydroameliorated	**Ap**	5.9-6.8	2.49-3.22	6.4-13.2	13.50-15.39	1.99-2.51
	Gso_1	6.5-7.2	2.49-4.99	2.1-3.9	13.89-15.42	0.95-1.14
	Gso_2	7.7-7.8	14.96-21.2	0.2-1.2	10.70-13.51	0.60-0.83
Hypogley, mineral, calcareous soil	**Ap**	7.5-7.6	9.48-26.19	9.0-15.5	18.66-21.38	2.30-2.76
	Gso	7.9-8.0	26.6-39.49	0.3-0.4	8.83-9.94	0.69
Hypogley mineral, calcareous soil, hydroameliorated	**Ap**	7.6	17.48	19.5	20.45	2.37
	AGso	7.7	18.71	1.2	14.27	1.32
	Gso	8.1	36.58	0.1	10.10	0.75
Amphigley, mineral, calcareous soil, hydroameliorated	**Ap**	5.3	2.82	6.4	17.0	2.7
	Gr	6.2	2.49	4.1	13.4	0.87
	Gso	7.5	23.69	0.5	9.68	0.59

Table 2 Soil physical properties

Soil unit	Horizon	Bulk density, ρv (g/cm^3)	Holding capacity		Wilting point, Tv (% vol.)	Clay (%)	Infiltration (mm/h)
			Water, Kv (% vol.)	Air, Kz (% vol.)			
Hypogley, mineral, non-calcareous, hydroameliorated	**Ap**	1.34-1.45	40.4-43.1	4.7-5.5	18.3-18.7	31.5-37.1	14.3-16.0
	Gso_1	1.49-1.54	39.7-41.9	2.3-5.5	19.8-22.2	33.9-39.5	
	Gso_2	1.55-1.58	40.1-41.2	0.9-1.3	14.3-17.1	19.0-24.7	
Hypogley, mineral, calcareous soil	**Ap**	1.52-1.54	39.8-40.6	2.6-4.4	19.1-20.0	31.3-33.0	10.3-11.0
	Gso	1.60	40.1-40.6	1.2-1.3	15.0-16.3	19.5-22.4	
Hypogley mineral, calcareous soil, hydroameliorated	**Ap**	1.48	40.20	4.26	18.87	31.08	14.7
	AGso	1.57	40.26	2.21	19.34	30.36	
	Gso	1.56	42.12	0.40	18.31	27.10	
Amphigley, mineral, calcareous soil, hydroameliorated	**Ap**	1.44	42.84	3.12	20.92	39.50	12.0
	Gr	1.54	39.52	5.16	22.99	41.82	
	Gso	1.56	40.53	2.22	15.55	21.64	



Picture 1 Soil unit map

Soil units map (Picture 1) has been made during determining soil properties on the localities chosen for a detailed pedological research. On that map the distribution of soil units has been shown and that classification has been made by the pedogenetic principals according to contemporary soil classification. [15]

Table 3 Review of area according to soil units and classes of irrigation soil suitability

No	Soil unit	Area, ha	Suitability classes
1	Hypogley, mineral, non-calcareous, hydromeliorated	216.99	S-2
2	Hypogley, mineral, calcareous soil	45.70	N-1
3	Hhypogley mineral, calcareous soil, hydromeliorated	40.19	S-3
4	Amphigley, mineral, calcareous soil, hydromeliorated	16.38	S-3
5	Amphigley, mineral, calcareous soil	2.50	N-1
	Total:	321.76	

3.2. Irrigation soil suitability

S-2 Moderately limited suitable soils

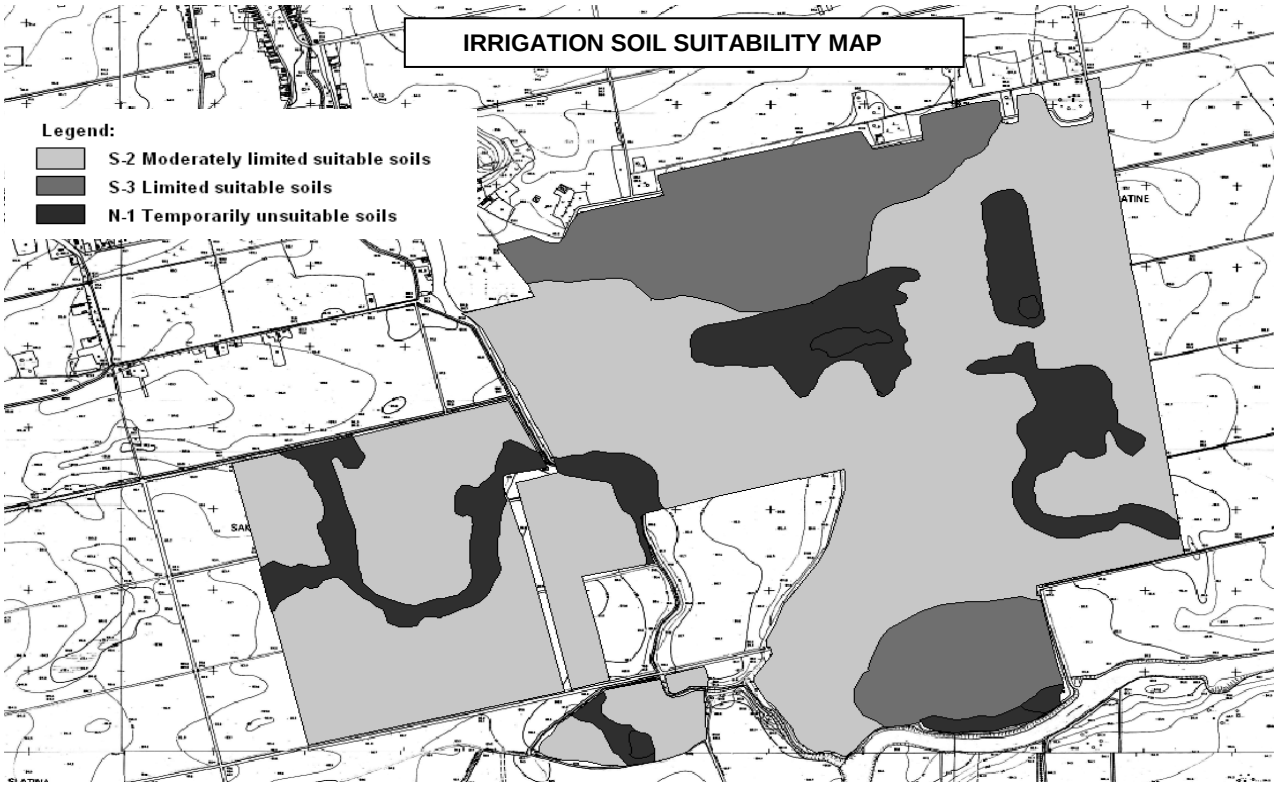
There were 217 ha moderately limited suitable soils. Limitation factors of this soil are high clay content, lower infiltration, low holding air capacity, medium density in surface soil layers and high one in subsurface layers. Very low content of available phosphorus, low content of available potassium and low level of organic mater are also limitation factors for irrigation. Because of the physical properties of these subsurface soil layers which refer to poor drainage a measure of repair is subsurface tillage every 5 years. Because of the increasing intensity of agricultural production on irrigated areas it is necessary to keep in mind fertilization of this areas because they belong in class of soils with very low concentrations of P and K so one needs to hold with references for fertilization of arable crops.

S-3 Limited suitable soils

There are 56.5 ha of limited suitable soils. Limitation factors on amphigley area are high content of clay particles, low infiltration rates, very low air holding capacity and high bulk density up to 60cm depth. Chemical properties of the soils, very low content of available phosphorus and low content of available potassium are also a limitation factors for irrigation due to increase of the crop so one needs to pay attention to fertilization. On the hypogley areas high bulk density of subsurface layer, low infiltration rates, soil alkalinity and high content of soil alkaline carbonates were determined, as well as higher level of organic mater. Because there are possibilities of alkalization and salinization on these soil, it is necessary to take care of water quality for irrigation.

N-1 Temporarily unsuitable soils

There are 56.5 ha of temporarily unsuitable soils for irrigation. Limited factors are alkalinity and high content of soil alkaline carbonates in surface layer. High bulk density, clay content around 31% and low level of infiltration rates indicate high soil compaction. These soils are spread on the lowest topographic position with high level of ground water, what is the main limited factor for surface irrigation.



Picture 2 Irrigation soil suitability map

4. Conclusions

On the researched area three suitability classes for surface irrigation (moderately suitable soils, limited suitable soils and temporarily unsuitable soils) were determined. Moderately suitable soils (S2) are spread on the 217 ha and main limiting factors are: higher clay content, lower infiltration rates, low air holding capacity, moderate compaction in surface and high in subsurface layers, very low content of available phosphorus, low content of available potassium and low organic matter content.

Limited suitable soils (S3) were found on 56.5 ha with following main limiting factors: high density of the surface and subsurface soil layers, low infiltration rates, alkalinity, high level of soil alkaline carbonates, high clay contents, low air capacity, very low content of available phosphorus, low content of available potassium and low organic matter content.

Temporarily unsuitable soils (N1) are spread on 48.2 ha and main limiting factors were: high level of ground water, high compaction, high clay content, low infiltration rates and soil alkalinity.

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Liming and fertilization impact on winter wheat components

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Abstract
The aim of this study was to determine the impact of liming, different rates of mineral NPK fertilization and their combination on winter wheat grain and straw yield and some morphological traits and yield components. The field trials were setup 2003/2004 in a randomized block design in three replicate on two sites in the eastern Croatia, on the district luvisol with low pH and low nutrients availability. The most of investigated traits were more influenced by fertilization alone or in combination with liming, than liming itself. Liming raised winter wheat grain and straw yield and plant height, but didn't affect spike length, number of spikelet per spike and harvest index, while considerable fertilization impact was observed for grain and straw yield and all yield components except for harvest index.

Keywords: liming, fertilization, wheat, yield components

1. Introduction

In Croatia there are around 1.6 million hectares of acid soils [1] (Bogunović et al. 1997) some of which are distributed throughout the east part of the country. Liming is one of the usual recommendations for acid soil improving, together with increased mineral and organic fertilization. Depending on amount and source of liming material, winter wheat grain yield has been raised for 0.26 up to 1.52 t ha^{-1} [2]. Organic and mineral fertilization combined with liming in amphygley reported to be the most effective for high wheat yield. [3] It is well known that different yield components have direct or indirect impact on grain yield. The plant height is important in the meaning of resistance to lodging and harvest index.

The aim of this study was to determine the impact of liming, different rates of mineral NPK fertilization and their combination on winter wheat grain and straw yield and some morphological traits and yield components, such as plant height, spike length, spikelet number per spike and harvest index.

2. Methods and materials used for research

The field trials were setup in a randomized block design in three replicate on two sites in the eastern Croatia (Zelčin and Donji Miholjac). The soils on both sites were determined as a dystric luvisol with low pH and low nutrients availability (Table 1.). The soil pH (H_2O and M KCl, 1:5 v/v) were determined according to ISO [4], plant available phosphorus and potassium by ammonium-lactate extraction [5], hydrolytic acidity by Na-acetate extraction and soil organic matter content by sulfocromic oxidation [6].

Table 1 Soil chemical properties (0-30 cm)

	Miholjac	Zelčin
pH H_2O	5.23	5.37
pH KCl	3.91	4.09
P_2O_5(mg kg^{-1})	102.2	70.1
K_2O(mg kg^{-1})	151.5	182.2
Humus (%)	1.28	1.45
Hy (cmol (+) kg^{-1})	4.15	3.92

In the autumn of 2002 soils were limed with 10 t ha^{-1} carbocalc (total Ca content 344 g kg^{-1}) on the soil depth up to 30 cm. Next year plots were fertilized with three different nutrient amounts what resulted in five different treatments:

O – no fertilization and no liming (control)
Ca – liming (10 t ha^{-1} carbocalc)
NPK- mineral fertilization (160 kg N ha^{-1}:150 kg P_2O_5 ha^{-1}:200 kg K_2O ha^{-1}),
Ca+NPK - liming with mineral fertilization
Ca+$N_2P_2K_2$ - liming with doubled mineral fertilization (240 kg N ha^{-1}:300 kg P_2O_5 ha^{-1}:300 kg K_2O ha^{-1}).

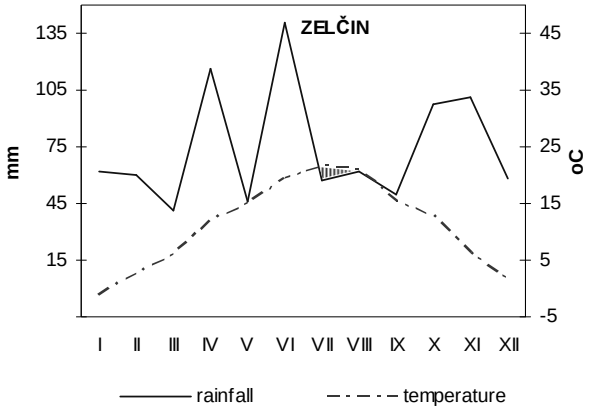
The plots size measured 70 m^2. The harvest area of each plot was 2 m^2 (4 x 0.50 m^2). Grain yield were calculated on 14% moisture basis. Samples of 25

plants were taken from harvested area for plant height determination, number of spikelet per spike and spike length. Statistical analyses for all data were performed by analysis of variance using PC applications Microsoft Excel and StatSoft Statistica.

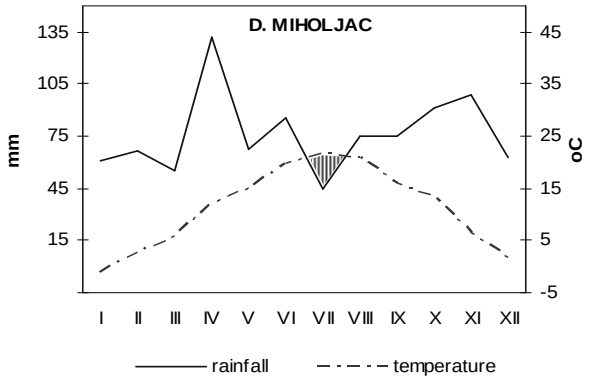
3. Results and discussion

3.1. Weather conditions

For a better understanding of the efficiency of liming and fertilization, the weather conditions during the trial should be described.



Picture 1 Walter climate diagram for Zelčin



Picture 2 Walter climate diagram for D. Miholjac

Rainfall is one of the most important climate indicators and the main input data for the soil water balance. Based on twenty-year average (1985-2004) annual amount of precipitations for Donji Miholjac is 733 mm and for Zelčin is 700 mm. Total rainfalls in 2004 was 916 mm and 891 mm for Donji Miholjac and Zelčin, respectively, what is about 200 mm higher from averages. Month with the highest amount of rainfall in Zelčin (140 mm) was June (Picture 1) while the most rainfall in Donji Miholjac (132 mm) was recorded during the April (Picture 2).

Monthly air temperatures were at the level of the averages, except in May when significantly lower value, compared to the average, were recorded. Above-average air temperature (Valpovo 12.9 ^{o}C, D. Miholjac 13.2 ^{o}C) was in October on both localities.

3.2. Winter wheat grain and straw yield

The grain and straw yield of wheat was influenced by both, fertilization and liming. Significantly ($P<0.05$) highest winter wheat grain and straw yield was on $Ca+N_2P_2K_2$ treatment. Standard fertilization increased average wheat grain yield (from 2.74 to 6.27 t ha^{-1}) more than liming, although at liming treatment wheat yielded also significantly higher (Table 2). Similar results were obtained by many authors. [7,8,9] Significantly lower wheat grain yield (in average for about 1.0 t ha^{-1}) on the Zelčin site was achieved, what could be related to high soil water content (above soil water capacity) during the March and April. Marton [10] also indicated negative effect of wet year on the wheat grain yield. The average straw yield also was somewhat lower in Zelčin (Table 2). Averaged over treatments straw yield ranged from 3.17 t ha^{-1} (control) to 8.13 t ha^{-1} ($Ca+N_2P_2K_2$). Concerning the effect of a particular treatment, similar trend as for grain yield was observed.

Table 2 Liming and mineral fertilization impact on winter wheat yield [11]

	0	Ca	NPK	Ca+NPK	Ca+ $N_2P_2K_2$	Mean
Grain yield t ha^{-1}						
Miholjac	2.92	4.12	6.87	6.61	7.32	**5.57 b**
Zelčin	2.56	3.27	5.68	5.55	5.84	**4.58 a**
Mean	**2.74 a**	**3.69 b**	**6.27 cd**	**6.08 c**	**6.58 d**	
Straw yield t ha^{-1}						
Miholjac	3.21	4.81	7.40	7.62	8.11	**6.23 ns**
Zelčin	3.13	4.15	7.21	7.08	8.14	**5.95 ns**
Mean	**3.17 a**	**4.48 b**	**7.31 c**	**7.35 cd**	**8.13 d**	

*differences between values with the same letters are not significant at the 5% level

3.3. Liming and fertilization impact on yield components

In general, the investigated traits were more influenced by fertilization alone or in combination with liming, than liming separately.

Table 3 Liming and fertilization impact on plant height (cm)

Treatment	Miholjac	Zelčin	Mean
0	54.8	56.6	**55.7 a**
Ca	57.3	62.4	**59.9 b**
NPK	70.2	76.9	**73.6 c**
Ca+NPK	68.7	81.0	**74.8 c**
Ca+$N_2P_2K_2$	72.0	81.2	**76.6 c**
Mean	**64.6 a**	**71.6 b**	

*differences between values with the same letters are not significant at the 5% level

Considering plant height, significant differences between two sites were found (Table 3.). Plants in Zelčin were in average for 7 cm higher than in Miholjac. The highest plants (76.6 cm) were determined on Ca+$N_2P_2K_2$ treatment, but on the same significance level as NPK and Ca+NPK treatments. Liming itself also significantly increased plant height on both localities, compared to control. Dogan [12] determined negative direct effect of plant height on grain yield.

Table 4 Liming and fertilization impact on number of spikelets per spike

Treatment	Miholjac	Zelčin	Mean
0	13.4	11.9	**12.6 a**
Ca	13.6	12.5	**13.1 a**
NPK	16.4	16.5	**16.4 b**
Ca+NPK	15.2	15.9	**15.6 b**
Ca+$N_2P_2K_2$	16.4	16.4	**16.4 b**
Mean	**15.0 n.s.**	**14.6 n.s.**	

*differences between values with the same letters are not significant at the 5% level

It has been reported that spikelet number per spike were significantly correlated with grain yield. [13] Average number of spikelets per spike ranged from 12.6 to 16.4, but it was on the same statistical level at the both site (Table 4). Liming didn't affect the investigated yield component, although on the control treatment lower value was achieved. The lowest spikelet number per spike (11.9) was determined on control and the largest (16.5) on the NPK treatment in Zelčin. Overall, significantly higher values were ascertained on all treatments which included NPK fertilization, with or without liming

Table 5 Liming and fertilization impact on spike length (cm)

Treatment	Miholjac	Zelčin	Mean
0	4.9	4.6	**4.8 a**
Ca	5.0	5.1	**5.0 a**
NPK	6.3	6.7	**6.5 bc**
Ca+NPK	6.0	6.5	**6.3 b**
Ca+$N_2P_2K_2$	6.5	6.8	**6.6 c**
Mean	**5.7 n.s.**	**6.0 n.s.**	

*differences between values with the same letters are not significant at the 5% level

Between localities, as well as between liming (Ca treatment) and control there was no significant difference for spike length (Table 5). The shortest spike was measured in Zelčin on control (4.6 cm) and the longest was on Ca+$N_2P_2K_2$ treatment on the same locality (6.8 cm). The highest value for average spike length (6.6 cm) was determined at the combination of liming and doubled mineral fertilization, but the same significance level was achieved on the standard fertilization without liming (NPK treatment).

Table 6 Liming and fertilization impact on harvest index (%)

Treatment	Miholjac	Zelčin	Mean
0	47.60	45.21	**46.41 n.s.**
Ca	46.13	44.03	**45.08 n.s**
NPK	48.16	44.06	**46.11 n.s.**
Ca+NPK	46.58	43.88	**45.23 n.s.**
Ca+$N_2P_2K_2$	47.45	41.77	**44.61 n.s.**
Mean	**47.19 b**	**43.79 a**	

*differences between values with the same letters are not significant at the 5% level

As regards the harvest index, statistically higher value was recorded on Miholjac locality, what is probably consequence of higher plants in Zelčin. Average harvest index varied from 44.6 (Ca+$N_2P_2K_2$ treatment) to 46.4 (control), but difference between any treatment was not statistically proved.

4. Conclusions

In general, the most of investigated traits were more influenced by fertilization alone or in combination with liming, than liming itself. Liming raised winter wheat grain and straw yield and plant height, but didn't affect spike length, number of spikelet per spike and harvest index, while considerable fertilization impact was observed for grain and straw yield and all yield components except for harvest index. The highest mean grain yield (6.58 t ha^{-1}) was achieved at the combination of doubled mineral fertilization with liming. For better wheat production on the acid soils the combination of liming with higher nitrogen, phosphorus and potassium amounts could be recommended.

Acknowledgements

This research is part of the final work graduates Gordana Drinić.

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The effect of height to the nozzle on the surface field distribution of liquid

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Abstract

The paper presents research results of surface and volume distribution of water, their flow and working at heights for two agricultural sprayer nozzles. Research was conducted at 11004 marks nozzles made of brass, from the company "Andric" and "Mlaz".
The nozzles "Andric" achieved an average value of the flow test at 2 bar pressure from a value of 0.815 $lmin^{-1}$, the standard deviation from 0.0602 and coefficient of variation 7.38%. In addition, the company nozzles "Mlaz" at the same pressure achieved an average value of the flow 1.30 $lmin^{-1}$ achieved standard deviation of 0.0155 and coefficient of variation of only 1.19%. The working pressure 3 bar nozzles by company "Andric" produced a flow of only 1.00 lmin-¹ nozzles and the company "Mlaz" 1.583 $lmin^{-1}$, which is expected because the indicated op ISO 10625.Therefore, "Andrić" nozzles marked 11004 is wrongly marked because the flow values correspond to tag 110025
The nozzles, "Andric" at working pressure of two bars and a working height of 40cm achieved an average width of 96.25 cm from the spray and the working height of 60 cm achieved an average width of 128.43 cm spray. At working pressure of three bars and a working height of 40cm, width of the spray was 94.06 cm, while the average width of the spray working height of 60 cm was 135.31 cm. The nozzles type "Mlaz" at working pressure of two bars and a working height of 40 cm achieved an average width of 131.25 cm from the spray and the working height of 60 cm and the same working pressure have an average width of the crossover from 176.56 cm. At working pressure of three bars and a working height of 40 cm, width spray was 134.37 cm, while the average width of the spray working height of 60 cm was 174.68 cm.
The nozzles "Mlaz" achieved, after the triple covering of the average values, distribution of liquid in the working pressure of 2 bar and a working height of 40 cm, the width of the strip of 50 cm from 67.52 ml with a coefficient of variation of 29.63%, while the same working pressure and a working height of 60 cm measured was 65.33 ml with the coefficient of variation of 27.62%. At working pressure of 3 bar and a working height of 40 cm was measured amount of water from 85.15 ml with coefficient of variation of 18.39%, and at a height of 60 cm measured was 78.24 ml with a coefficient of variation of 28.76 %.
The nozzle at the company, "Andric" after the triple covering the average values of the width of the strip of 50 cm, the working pressure of 2 bar and a working height of 40 cm, measured the amount of water from 41.38 ml with coefficient of variation of 21.18%, while at the same pressure and the working height of 60 cm measured was 40.48 ml with a coefficient of variation of 19.52%. At working pressure of 3 bar and a working height of 40 cm was measured amount of water from 50.12 ml with coefficient of variation of 19.42%, and at a height of 60 cm measured was 49.68 ml with a coefficient of variation of 11.96 %.

Keywords: nozzle, the coefficient of variation, a triple overlap, working width

1. Introduction

Everyday use of pesticides in agriculture raises the need to establish larger number of factors that directly or indirectly affect the biological efficiency. Technical factors in the process of development are of crucial importance for the balanced spray distribution on agricultural surface. When the technical errors are caused in, the production process it is best to immediately identify an error made in the application

process and that following are reduced to a minimum. Each nozzle is determined by its colour that indicates its flow according to ISO standards. (ISO 10625) If the pressure changes, changes the flow and the working width of nozzles. Working width depends on the spray as well as the working angle and height of the subject of protection.

So, with the nozzles label 11004 working theory spray width with a height of 50 cm, according to the author Banaj and Šmrčković (2003.) Amounts to 143 cm at 2.756 bars in reality, she does not have the breadth of theoretical, the authors, but we get the nozzle, which is somewhat narrower. According to Banaj, et.al. (2000.) the nozzles perform the important function that is missing the default amount of liquid in time unit, scatter, forming liquid droplets of appropriate size and form the stream of the appropriate forms. Banaj et.al. (2009) state that research in pure water nozzles by company Kovin, 110-04 labels, they can spray 3000 ha, or have 180 hours and that when it is not crossing the border wear than 5 or 10% increase in flows at working pressure of 2.756 bar. Controlling the distribution of surface further affecting the increase of the effect of action of pesticides applied, and can work on reducing the dose or amount of applied pesticides.

2. The task and the aim of the research

The task of testing the application of standard methods to check the two working pressure and the two working level, whether the tested nozzle comes to changes, fluctuations, the distribution of surface shape, width, and come to the knowledge based on the gained results that the nozzles are of better quality and are tested from a scientific point of view that we recommend for usage in our region of agriculture.

3. The materials and methods

Research is carried out in the Department for agricultural machinery in University Josip Juraj Strossmayer in Osijek. The Institute has a test - table for testing of the nozzle, which is made by the model of the test-table test, which owns the laboratory Hardi companies in Denmark. The nozzles set to control the carrier vertically above the present's partition for the plate test table. On the carrier, there are five seats for the nozzles, which have their own bracket and can be changed without removal. Immediately, over the nozzle is a 100 mm diameter gauge with the accuracy of grade 06, which shows the pressure during testing. At the end of partition plate there are located test tube table whose width is 25 mm which are sorted out next to each other, the length of 2 meters so that the liquid that comes to the table width of 25 mm is directed to control test tube where there are signs by 1 ml. Measurements of the surface distribution were performed 5 times on 5 nozzles randomly at working pressures 2 and 3 bar and working heights from 40 to 60 cm. Air temperature amounted to 20 to 23 ˚ C and the water temperature was 19.6 to 22.3 ° C, while the relative humidity was below 65%.

Figure 1. Tested nozzles by companies "Andric" and "Mlaz"

4. Research results

4.1 The results obtained by flow values

After the test, it can be concluded that the companies "Andric" nozzles achieved an average flow of the pressure 2 bars only from 0.815 $lmin^{-1}$. The same nozzle at 3-bar increase to 1.004 $lmin^{-1}$ failed, the standard deviation of 0.0642 and coefficient of variation of 6.39%. The nozzles "Mlaz" achieved an average value of flow at a pressure 2 bar 1.30 $lmin^{-1}$ and 1.58 $lmin^{-1}$ at working pressure 3 bars. Above

mentioned flow nozzles "Mlaz" type flow, at a pressure of three bars reached with a standard deviation of 0.0316 and coefficient a variation of only 1.99%. The combined display of statistical values is shown in Table 1.

Table 1. The statistical test value depending on the flow of fluid pressure for the tested nozzle

Nozzle company „Andric“				Nozzle company „Mlaz“		
Operating pressure (bar)	Flow ($lmin^{-1}$)	s.d.	CV (%)	Flow ($lmin^{-1}$)	s.d.	CV (%)
2	0,815	0,0602	7,38	1,300	0,0155	1,19
3	1,004	0,0642	6,39	1,583	0,0316	1,99

4.2 The results of the surface distribution

The obtained results are the average distribution of the liquid at the surface of the tested nozzles, depending on working pressure and the amount of work, which is show in the following figures.

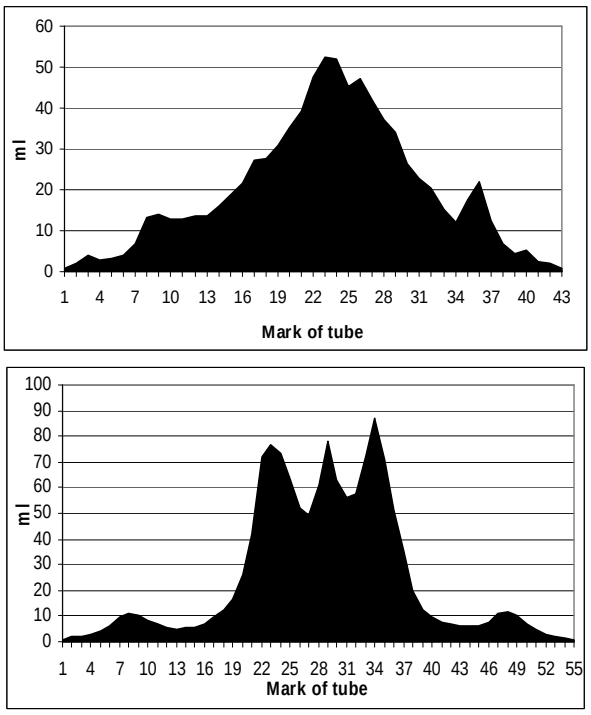


Figure 2 The average value of the distribution of liquid at the nozzle of companies, "Andric" and "Mlaz" at a pressure of 2 bars and the working height of 40 cm.

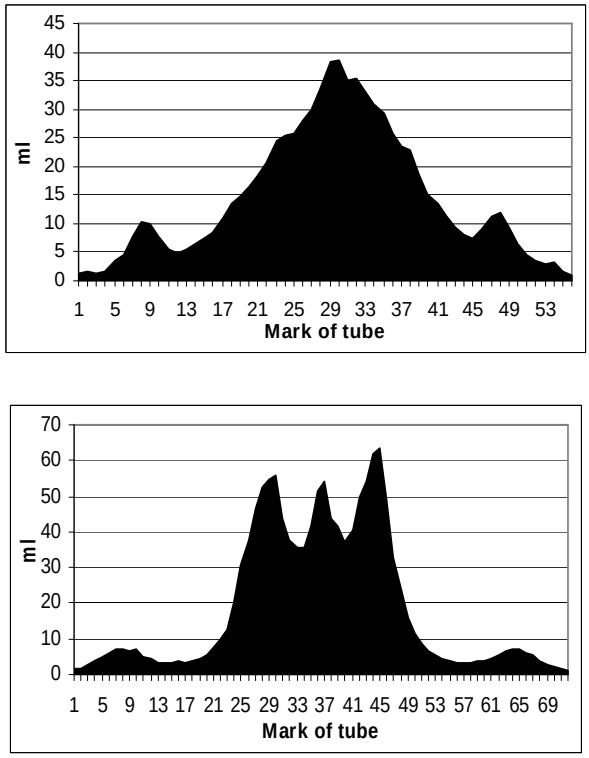


Figure 3 The average value of the distribution of liquid at the nozzle of companies, "Andric" and "Mlaz" at a pressure of 2 bars and the working height of 60 cm

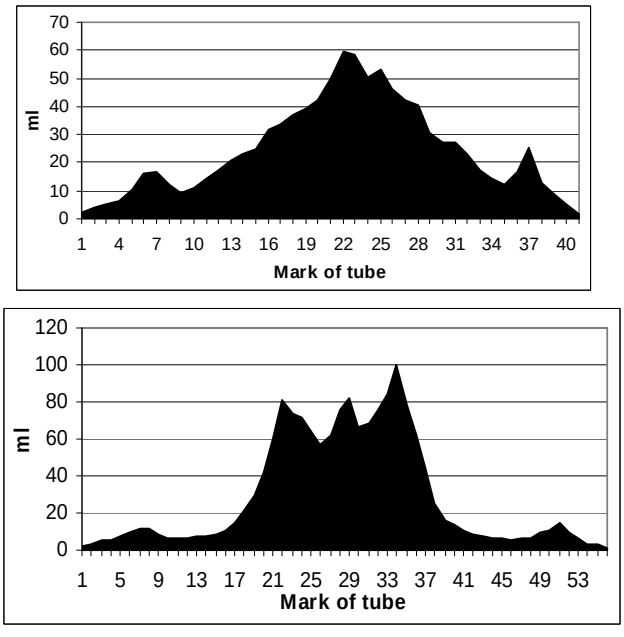
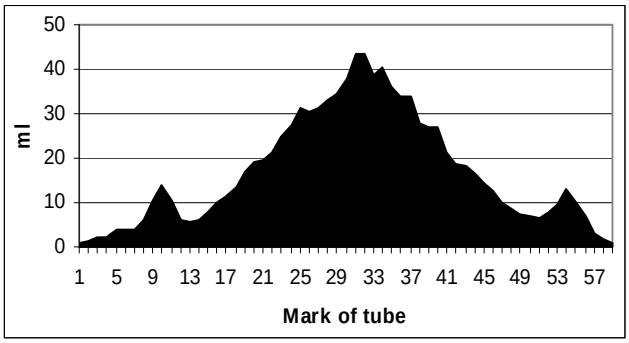


Figure 4 The average value of the distribution of liquid at the nozzle of companies, "Andric" and "Mlaz" at 3 bar working pressure and working heights from 40 cm



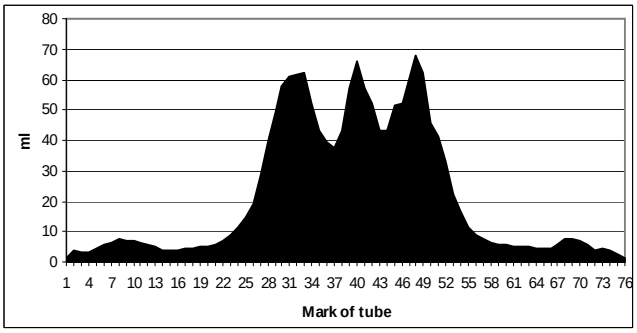


Figure 5. The average value of the distribution of liquid at the nozzle of companies, "Andric" and "Mlaz" at 3 bar working pressure and working heights from 60 cm

4.3 The results of determining the width of the tested nozzle

The results of determining the width of the tested nozzle was carried out simultaneously with measurements on the surface by distribution of liquid and bulk results are shown in the following table.

Table 2 Statistical test values depending on the working width and height of working pressure at the nozzle tested

	Working Height					
	40 cm					
	2 bars			3 bars		
	Work. width (cm)	stedv	CV (%)	Work. width (cm)	stedv	CV (%)
Andrić	**96,25**	**9,24**	**9,60**	**94,06**	**6,23**	**6,63**
Mlaz	**131,25**	**1,02**	**0,77**	**134,37**	**2,39**	**1,78**

	Working Height					
	60 cm					
	2 bars			3 bars		
	Work. width (cm)	stedv	CV (%)	Work. width (cm)	stedv	KCV (%)
Andrić	**128,43**	**7,86**	**6,12**	**135,31**	**7,38**	**5,45**
Mlaz	**176,56**	**2,13**	**1,20**	**174,68**	**11,60**	**6,64**

4.4 The results of determining the distribution of surface liquid (at triple the average values of overlapping nozzle) on the working width of a 50 cm line

The allocation of water in the central area from 50 cm in three overlapping nozzles with an average distribution of the liquid is shown in the following figures.

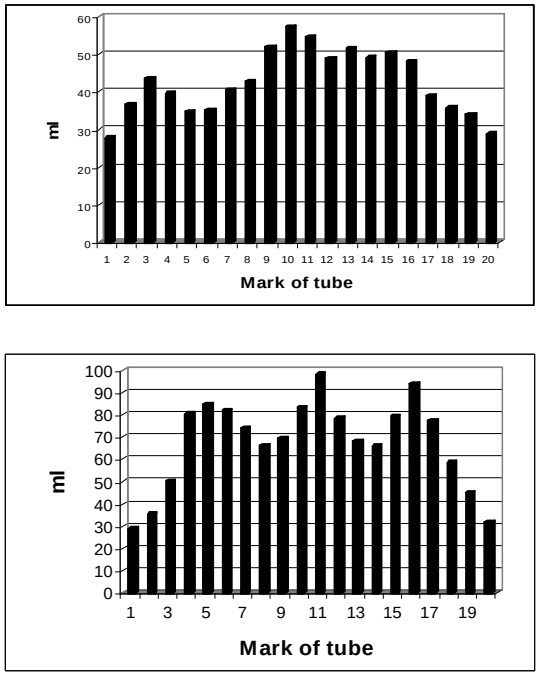
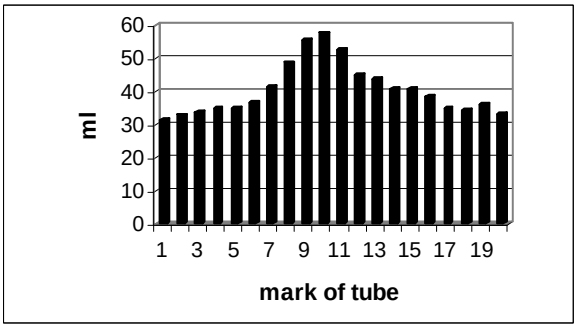


Figure 6. The average value of the water distribution in the central area of 50 cm in three overlapping nozzles with an average distribution at a pressure of 2 bars and the working height of 40 cm at the nozzle companies, "Andric" and "Mlaz"



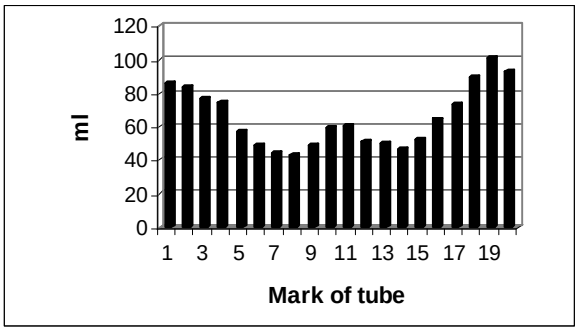
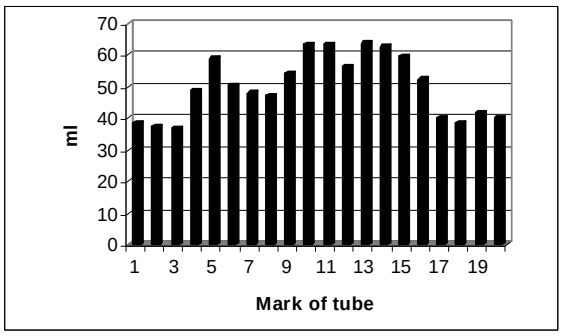


Figure 7 The average value of the water distribution in the central area of 50 cm in three overlapping nozzles with an average distribution at a pressure of 2 bars and the working height of 60 cm at the nozzle companies, "Andric" and "Mlaz"



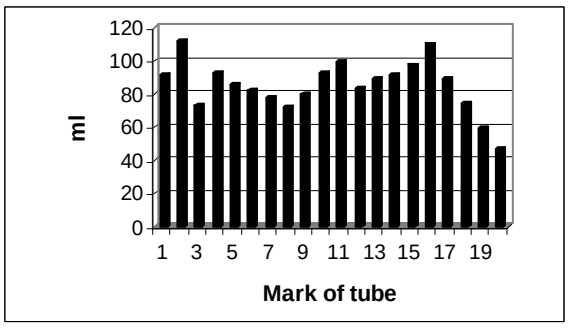
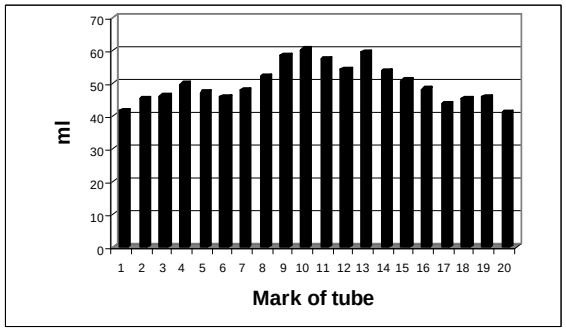


Figure 8 The average value of the water distribution in the central area of 50 cm in three overlapping nozzles with an average distribution at a pressure of 3 bars and a working height of 40 cm at the nozzle companies, "Andric" and "Mlaz"



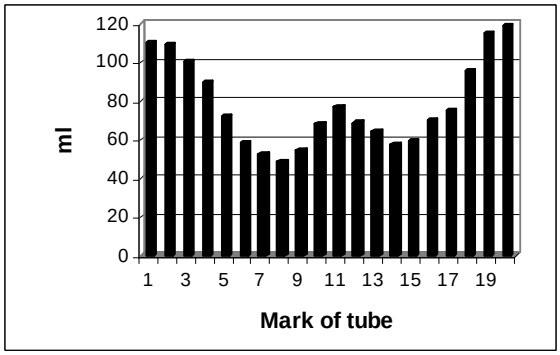


Figure 9 The average value of the distribution of water in the central area of 50 cm in three overlapping nozzles with an average distribution at a pressure of 3 bars and a working height of 60 cm at the nozzle companies "Andric" and "Mlaz".

The statistical value combined display of the test is shown in the following table.

Table 3 The statistical test values of the surface liquid distribution on the width of 50 cm

	Working height					
	40 cm					
	2 bar			3 bar		
	Average (ml)	stdev	CV (%)	Avr (ml)	stdev	CV (%)
Andrić	**41,83**	**8,86**	**21,18**	**50,12**	**9,73**	**19,42**
Mlaz	**67,52**	**20,0**	**29,63**	**85,15**	**15,66**	**18,39**

	Working height					
	60 cm					
	2 bar			3 bar		
	Average (ml)	stdev	CV (%)	Avr (ml)	stdev	CV (%)
Andrić	**40,48**	**7,90**	**19,52**	**49,68**	**5,94**	**11,96**
Mlaz	**65,33**	**18,05**	**27,62**	**78,24**	**22,50**	**28,76**

5. Conclusion

Based on the above, we can make the following conclusions:

The nozzles "Andric" achieved an average value of flow at working pressure of 2 bar 0.815 $lmin^{-1}$ with standard deviation of 0.0602 and coefficient of variation of 7.38%

The same nozzle at the working pressure of 3 bar missed only 1.004 $lmin^{-1}$ and does not match the tag "11004" by which it is marked.

The nozzle "Mlaz" achieved an average flow (3 bar) of 1.58 lmin-1, with a standard deviation of 0.0316 and 1.99% variation coefficient

The nozzles, "Andric" achieved an average width of spray 96.25 cm at working pressure of 2 bar and a working height of 40 cm, while at the same working pressure and a height of 60 cm achieved an average width of the spray 128.43 cm

Also, the company nozzles from "Andric", with the working pressure of 3 bar and a working height of 40 cm achieved an average width of 94.06 cm from the spray, while working at a height of 60 cm and the same pressure achieved an average width of the spray from 135.31 cm

The average results of the liquid surface distribution nozzles investigated by the company "Mlaz" at 2 bar and a working height of 40 cm indicated that their working spray was 131.25 cm, and at 134.37 cm 3 bar

Also, these nozzles at working pressure of 2 bar and a working height of 60 cm indicated that their working spray was 176.56, and at 3 bar 174, 68 cm

After achieving a triple covering the average liquid value nozzles, "Andric" reached by 2 bar and 40 cm working height (width 50 cm strips) variation coefficient 21.18, and 19.42 % at 3% bars.

Also, these company nozzles, after a triple covering of the working pressure 2 bar and a working height of 60 cm, achieved variation coefficient 19.52%, and at 3 bar and the same work time amount of 11.96%

The nozzle company "Mlaz" after the triple overlay, in the overlap area and in the width of 50 cm work at 2 bar pressure and by 40 cm working height, where the variation coefficient is measured 29.63%, and at the 60 cm working height the variation coefficient is measured 27.62%

The coefficient values remained high and at the 3 bar working pressure and a working height of 40 cm, where the measured variation coefficient is 18.39%, and at the working height of 60 cm the variation coefficient is measured from 28.76%

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Sustainable agriculture with emphasis on nitrogen management in family farm

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Abstract

Concept of sustainable agriculture is often present in public. There are also doubts about the sense of this term. We tried to explain these concepts on easy and simple way. Too large amounts of nitrogen as other nutrients applied in the fields can pose a threat to the environment. Losses of nitrogen from crop system may thus be an important source of ground water pollution. The prevailing part of the agrarian structure in Croatia is family farm. This paper aims at investigating the concepts of sustainable nitrogen management may be applied in the family farms. Results presented show to solving these problems lies in adopting environmental regulations and implementing good agricultural practices such as the presented on the example of Belgium. The results presented in this paper are derived from articles published in the scientific journals, books and on the web.

Keywords: agricultural sustainability, nitrogen, family farms

1. Introduction

Modern agriculture is faced with the challenge to meet the growing needs of the world population for quality food on the way that their activities do not disturb the balance of the environment. There are many aspects of the influence of agriculture on the environment such as eutrophication, pollution, deforestation, and loss of productive soil through erosion and soil mining. Today, agricultural production based on the use of fossil fuels and other renewable resources. This causes growing concern that continued use of external inputs, including environmental problems in the end may reduce agriculture's productivity. There is fear that agriculture is not "sustainable". [1]

The core of sustainability is presented in a report from the World Commission on Environment and Development as: "to meet the needs of the present without compromising the ability of future generations to meet their own needs". [2]

Among of all nutrients nitrogen has the strongest impact on quality an amount of the crop yield. Growers often apply large amounts of nitrogen fertiliser to obtain high yields of good quality.

High application rate of nitrogen as other nutrients can pose a threat to the environment and in extreme cases to the fertility of the soil itself. Losses of nitrogen from crop system may thus be an important source of ground water pollution. [3]

The prevailing part of the agrarian structure in Croatia is family farm . Therefore, it would be marked as the primary place where farmers implement measures for sustainable agricultural practice.

This paper aims at investigating the concepts of sustainable nitrogen management may be applied in the family farms.

2. Methods and materials used for research

The results presented are derived from articles published in the scientific journals, books and on the web.

3. Results and achievements

3.1. Sustainable agriculture what is it

The many definitions associated to sustainability and sustainable agriculture has been referred to in literature. [4] One of the widely quoted was published by the American Society of Agronomy: "A sustainable agriculture is one that, over the long term, enhances environmental quality and the resource base on which agriculture depends; provides for basic human food and

fibber needs; is economically viable; and enhances the quality of life for farmers and society as whole".[5]

It is interesting more detailed definition given by United States Congress that defined sustainable agriculture in public law: "Sustainable agriculture means integrated system of plant and animal production practices having a site- specific application that over that long term will:

- Satisfy human food and fiber needs.
- Enhance environmental quality and the natural resource base upon which the agricultural economy depends. Make the most efficient use of non-renewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls.
- Sustain the economic viability of farm operations.
- Enhance the quality of life for farmers and society as a whole. "[6]

The member states of the European Union have been used different terms to describe ˝more environmental friendly˝ form of farming, e.g. in the Netherlands the term biological often was referred to organic farming, whereas the term ecological was referred to organic plus environmental. The term integrated is used both in The United States and in Europe to refer to a system, which can demonstrate some aspects of sustainable agriculture but may or may not fit the other parts of the sustainability. [7]

However, since 2005 Europe has its own in detail described definition of sustainability in agriculture.

A document named "European integrated farming framework as guideline for sustainable development of agriculture". Publication from the European Initiative for Sustainable Development in Agriculture (EISA) offers a definition of integrated farming as "a whole farm system enabling farmers to successfully manage their land whilst providing consumers with the reassurance of environmental protection, animal welfare, and the quality, safety and traceability of their food." [8]

Framework also offers a management tool, which may help farmers to improve everyday practice on farm.

From the aforementioned it can be concluded that sustainability as a system depends of its effects on the environment but and economic viability. Sustainability implies both high yields that can be maintained , and agricultural practices that have acceptable environmental impacts.

3.2. Nitrogen pollution

Nitrogen has an essential nutrient that play a key role in increasing crop production and in many cases, it may be considered the most common growth limiting factor. Growers usually apply large amounts of nitrogen fertilizer to obtain high yields of good quality. Often, large amounts of nitrogen remain in the soil after a vegetable crop is harvested. This nitrogen includes residual soil mineral nitrogen, and nitrogen present in crop residues. Both nitrogen sources may have a harmful effect on the environment. They pollute groundwater quality through nitrate leaching, and air quality through nitrous oxide emission. Nitrogen pollution contributes to ground level ozone, acid rain and acidification of soil and surface waters, disruption of forest processes, coastal over-enrichment and other environmental issues. [9]

On chemical level, the acid-forming nature of nitrogen fertilizers was established by work of W.H. Pierre in 1920's and early 1930's. The following reactions are common presented to explain how nitrification generates acidity:

$NH_4NO_3 + 2O_2 ==> 2H^+ + 2NO_3 H_2O$ Ammonium nitrate

$(NH_2)_2CO + 4O_2 ==> 2H^+ + 2NO_3^- + H_2O + CO_2$ Urea

$NH + 2O_2 ==> H^+ + NO_3^- + H_2O$ Ammonia

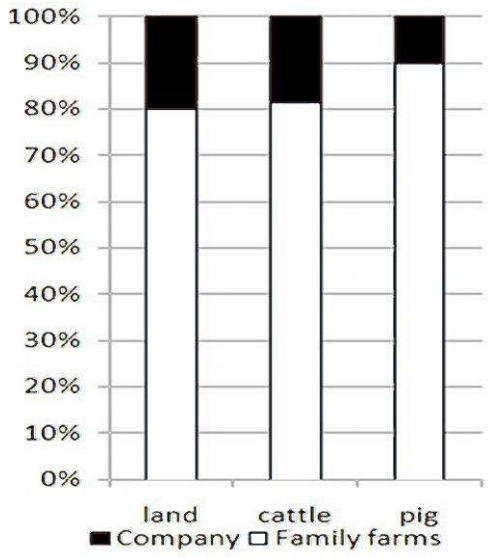
For ammonium nitrate, urea, and anhydrous ammonia, frequently used nitrogen fertilizers, proton production is stoichiometrically equal to nitrate production. It is no matter if N is supplied as organic N (including manures) or biologically fixed N (e.g. by legumes): for every mole of NO_3^- leached out of the root zone, there is one mole of H^+ left in the soil, which induces acidification. [10]

Sustainable nitrogen management should aim at supplying sufficient nitrogen for optimum crop growth and development, while keeping losses to the environment to a minimum.

3.3. Family farm role

In Republic of Croatia, as well as in other European countries family farms have important place in national economy. According to the agricultural register 2003, family farms are using the biggest part of agricultural capacity in Croatia.[11] The some significant data are presented in Graph 1.

Thus, the family farms are playing a key role in implementation of agricultural sustainability in the country. Farmers are chiefs managers of their arable lands. Their ability to think ecologically and ability to implement good agricultural practice define success of sustainable agricultural development. Making the transition to sustainable agriculture is a process. For farmers, the transition to sustainable agriculture requires a series of small, realistic steps. On this road, they need technical support and financial assistance.



Graph 1. Ratio of family farms land use and ownership of livestock between the family farms and company in the Republic of Croatia

3.4. Inadequate nitrogen application in practice

Farmers frequently apply the entire nitrogen plant need in form of fertiliser because they usually neglect other sources of nutrients, such as the nitrogen present in the soil, crop residues, and nitrogen released by nitrogen fixation by microorganism. They also do not take into account processes in soil that compete with the plants for nitrogen.

No rarely, the problem is that farmers inadequately manipulates with organic solid and fluid manure, storage and applies them inappropriately. All of this leads to the surplus or deficit of nitrogen to crop plants, and may have strong negative environmental impact.

To avoid these problems it is necessary to educate farmers.

Lack of nitrogen may be harmful to farmers income, bat not to the environment. In this paper, we are focusing to situation about implementation of unnecessarily large amounts of inorganic and organic sources of nitrogen. We also will consider measures can be applied to regulate this problem..

3.5. The good sustainable practice

Recognizing the problems of water pollution arising from intensive application of nitrogen, particularly organic fertilizers from the EU adopted a nitrate directive [12], which regulate amount of nitrogen from livestock manure that is allowed to be applied per hectare during one year. That regulation required of a general land-spreading limit of 170 kg N ha^{-1} yr^{-1} for nitrogen from livestock manure, this is considered equivalent to the output from two dairy cows. However, Member States can apply for a derogation to allow higher amounts in appropriate cases, in example where soil or climactic conditions are such that the higher amount will not cause water pollution. Let see how that regulation has been implement in practice.

We take Belgium as an example, especially Walloon region as a good example of implementation of the nitrate directive in practice.

First, the government has established zones, vulnerable to possible contamination with nitrogen. The annual quantities of manure allowed to be spread on a farm parcels depend on the location of the farm (in or outside vulnerable zones) and its land use (grasslands and crops area). In doing so, takes into account the ˝Soil Link rate (LS)˝ indicator; the ratio between the organic nitrogen produced annually on the farm and the amount of organic nitrogen allowed to be spread annually on the same farm. This ‘soil link rate’ is calculated every year for each of the 18,000 farms of the Walloon region by the administration in charge of the environment. Program predicted a period of application of fertilizers, as well as the period when the application of fertilizers is not allowed. Regarding the manure application period the Walloon administration made differences between fast acting and slow acting manures as fallowed:

Fast acting manures are slurries, poultry manure, and their spreading. They spreading are not allowed

during the winter period. Slow acting manure is solid manure. Forbidden period for application on crops is the summer, because the nitrogen from this manure are mineralising in slower pace. However, if there is a crop, sown directly after application of manure, staying in place throughout the winter, application is tolerated.

Storage capacities are not forgotten, also. For liquid manure, the storage tanks of a particular farm must hold a minimum of six months manure production and must be fully waterproof. The investment needed is quite high concerning the financial capabilities of our farmers and is partly supported by the regional authorities. For solid manure, a platform with collecting drains is required. Storage in the field is tolerated if manure is dry enough. However, in this case the place must change every year.

in the regulations was considered and mineral nitrogen, that can be applied. Law also restricts nitrogen used for fertilization the total quantity (organic + mineral) applied in a field. The upper limit depends on the type of crop and is ranging from 30 kg $N.ha^{-1}.yr^{-1}$ for common pea to 330 kg $N.ha^{-1}.yr^{-1}$ for sugar beat with a restriction of 250 $kg.ha^{-1}.yr^{-1}$ on the total arable land surface of the farm. On grassland, the total nitrogen applied must not exceed 350 $kg.ha^{-1}.yr^{-1}$. The Walloon region is using dense networks with more than 950 measuring points for underground water and 300 points for surface water on such a small territory.

To practically implement this legislation, a non-profit organisation named "Nitrawal" has been set up and is funded by the regional government .This organisation consist of expert which advise and control farmers to strictly follow the regulations. Farmers participating to the Quality Approach' will have to submit to a close and personalised follow-up by the non-profit organisation "Nitrawal". The farmers have to : provide all data relevant to nitrogen flows, at farm and a the field level apply a series of good agricultural practices in order to limit the nitrate leaching below the root zone. Amongst other measures farmers have to systematic use a nitrate catch crops after harvest of the cereals, peas, early maturing potatoes and other crops if no winter crop follows. These catch crops are plants growing fast, with a strong rooting system and valuing well nitrates. The application of a quantity of nitrogen fertiliser resulting of a balance between the needs of the plants and the nitrogen mineralised, left in the soil by the previous crop. The cattle-stocking rate on grassland must be limited before winter, as urine patches leave a substantial amount of nitrate and the vegetation cannot value too much nitrogen during this period. More precisely, the stocking rate must not exceed 150 Livestock Unit.$day.ha^{-1}$. If, for a particular class, a farm registered in the 'Quality Approach' exceeds of more than 30 kg N -$NO_3.ha^{-1}$ the reference value, the farm is penalised by receiving a negative point (or 2 negative points if the excess is over 60 kg N-$NO_3.ha^{-1}$). The farmer will have then to improve its agricultural practices in regard to nitrogen management. The duration of the programme is four years. If a farmer still receives a negative appreciation in the fourth year (or on the average of the three other years), he/she is excluded from the program.

4. Conclusions

The sustainable development and sustainable agriculture is no longer just a phrase that is frequently repeats in various media and the public. These terms have become an integral part of European and international documents, and even law. However, there are doubts in the public and often among the experts, what it is the exact sense of these terms. We presented several existing definitions that easily explain the concept of agricultural sustainability. We have also presented the importance of nitrogen management to prevent pollution of environment and showed the importance of the family economy in this process. Finally, we have offered practical solutions to regulate aforementioned problems through the presentation of existing legislative and practices solutions implemented in the EU. Speaking on this theme, we provided the possibility for further research in this area. [13]

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Surface distribution of the liquid nozzle field

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Abstract

The paper presents research results of the surface distribution liquid in two agricultural sprayer nozzles at working pressure 2 and 3 bar, and working at heights 40 and 60 cm. Research was conducted at 11004 marks nozzles made of brass, the company "Mlaz" and "Kovin. It was found that the company "Mlaz" nozzle flows achieved average test value at 2 bar pressure from a value of 1.30 l min-¹ at the standard variation coefficient 0.015 deviation of 1.19%, while the 3 bar realized value 1.58 lmin-¹, the standard deviation is 0.0316 and variation coefficient 1.99% Also, the company "Kovin" nozzles achieved an average flow value at 3 bar 1.61 lmin-¹ with the implementation of the standard deviation 0.012 and variation coefficient of only 0.75%, and at 2 bar 1.33 lmin-¹ with 0.0136 standard deviation of variation coefficient 1.01%.

The water surface allocation of the nozzle from the company "Mlaz" take the average working width spray at 2 bar working pressure and 40 cm working height that was 131.25 cm, and 60 cm working height for average spray width which was 176.56 cm. At 3 bars working pressure and 40 cm working height, average spray width was 134.37 cm, and at 60 cm working height, average spray width was 174.68 cm.

The company "Kovin" nozzles at 2 bar working pressure and 40 cm working height have an average 106.25 cm width from the spray and the 60 cm working height achieved an average 151.56 cm width sprout. At 3 bar working pressure and 40 cm working height, average spray width was 109.68 cm. Also, and 60 cm working height was 153.12 cm.

Furthermore, the triple covering these nozzles achieved liquid distribution strip of 50 cm width. The company, "Mlaz" nozzles, at 2 bar working pressure and 40 cm working height achieved 29.63% variation coefficient. In addition, the 60 cm working height made 27.62% variation coefficient these nozzles at 3 bar working pressure and 40 cm working height achieved 18.39% variation coefficient, and with the 60 cm working height and the same working pressure they achieved 28.76% variation coefficient.

The company "Kovin" nozzles at 2 bar working pressure and 40 cm working height managed much lower variation coefficient for the 50 cm strip width (with a triple overlap) of only 5.16%, and the 60 cm working height made 5.49% variation coefficient. The same nozzle at the 3 bar working pressure and 40 cm working height achieved 11.51% variation coefficient, and the 60 cm working height and the same working pressure at the triple overlay achieved only 4.30% variation coefficient. So, according to the scientific knowledge we certainly recommend the company "Kovin" nozzles for usage in the protection of field crops.

Keywords: nozzle, the flow, variation coefficient, a triple overlap, ISO standard

1. Introduction

The protection of agricultural crops in most countries in our surroundings, and in Croatia, is mostly done by chemical means. The most precise application of chemicals in agriculture is carried out using a sprayer and spray with which the plant protection is performed. Although today's sprayers and measuring aerosols possess regulatory systems, they cannot control the surface distribution but only sprinkle out the liquid amount in time unit. The validity of the new nozzles is important to conduct equitable distribution of pesticides. The emerged technical errors in the production process it is best to immediately identify in order to reduce the application process to a minimum. Each nozzle is determined by its colour that indicates its flow according to ISO standards. (ISO 10625) When the pressure changes, so does the flow and nozzle working width. Working width depends on the spray as well as the working angle and height of the subject of protection. In addition, 11004 working theory spray width with a 50 cm height, according to Banaj and Šmrčković, (2003.) amounts 143 cm at 2756 bars.

In reality, the nozzle does not have a theoretical breadth, but we get the nozzle, which is considerably narrower. The constructor strive should be directed towards the construction of the nozzle where the actual width of the spray was as close to the theoretical. Just the realization of this goal provides a wider overlap and gets smoother coverage of the surface liquid. If the actual spray width is small or irregular, the

irregularities occur in the nozzle overlapping which is evidenced in large variation coefficient and poor distribution especially for fan-shaped nozzles. The nozzles, according to Banaj et.al. (2000), perform the important function i.e. sprang default amount of liquid in time unit, scatter, forming liquid droplets of appropriate size and form the stream of the appropriate forms.

According to research by Banaj, et. al. (2000), of 180-tested 30%, examined tractor sprayers do not satisfy in terms of horizontal distribution. Thus, the authors Banaj et. al. (2009) indicate that 60% of field sprayer nozzles contain installation errors with different flows on the structural reinforcements. The same authors state that during the test surface distribution they found in 50% of the tested sprayer 20 % higher variation coefficient and classified them into the category of poorly distributed.

The sprayer testing in Europe led to system knowledge, which are mostly exposed to changes. The largest number of tests (> 70000) was conducted in German regions, state the authors Reitz and Gamzlemeier (1998.), where 19% of the total number of tested sprayer did not pass in review, and the cause were defective nozzles.

Langenakens and Pieters (1999.) referred that in the province of Flanders in northern Belgium in the period from 1995. to 1998. 17 466 sprayer were tested whereby 86% of them were invalid due to nozzle or gauge. Authors Banaj et.al. (2009.) for the first time in Croatia began investigations of the surface distribution of the three new nozzles from different manufacturers that are commonly used in agricultural sprayers.

According to the obtained results, they indicated that only the nozzles from Lechler companies fully meet their properties. First, extremely low variation coefficient during the triple 3.67% overlap. The company nozzles "Lesko" and the nozzles "Wiscom" are not recommended because the variation coefficient is from 28.44% to 66.14%. Banaj et. al. (2009) state that research made in pure water for the company "Kovin" nozzles 110-04 can spray 3000 ha, or can have 180 hours and if they have not crosses the limit can wear from 5 to 10% increase in flows at 2.756 bar working pressure. The nozzles lose their original properties by working, stated Tadic and others (2008) and the spending of nozzles after spraying 2000 hectares with clean water are still within the class with up to 5% variation coefficient. When controlling the distribution of surface we further affect the increase of the action effect for pesticides applied, and we can work on reducing the dose or amount of applied pesticides.

2. The task and the aim of the research

The task of ensuring unique conditions at the time of testing with the two nozzle of the same type will reach findings which of the investigated nozzles provide the best distribution of the surface liquid so we can recommend them for usage in our agricultural region.

2.1 Materials and methods

The research is carried out in the Department for agricultural machinery in University Josip Juraj Strossmayer in Osijek. The department has a test - table for testing of the nozzle, which is made by the model of the test - tube table that has a laboratory company, "Hardi" in Denmark (Figure 1). The controlled nozzles are set in the carrier vertically above the partition plate in test table. On the carrier, there are five seats for the nozzles, which have their own bracket and can be changed without removal. Just above the nozzle, there is a gauge diameter of 100 mm accuracy grade 06, which shows the pressure during testing. Liquid that comes in the nozzle pump brings the maximum capacity of 65 $lmin^{-1}$. At the end of partition plate, there are test tubes whose width are 25 mm and are placed next to each other, in the length of 2 meters so that the liquid that comes to the table with width of 25 mm is directed to control test-tube where there are markings by 1 ml. In addition, besides the pump water, the nozzle testing can be lead through the city's network via the pressure regulator. Measurements of surface distributions are carried out randomly 5 times in 5 nozzles at a 2 and 3 bar pressure and at 40 cm to 60 cm working height. Air temperature amounted 20 to 22 ˚ C and the water temperature was 19.6 to 22.3 ° C, while the relative humidity was below 65%.

Figure 1. Test table, which determines the surface distribution of liquid nozzles

Figure 2. The nozzle 11004 tags made of brass company by "Mlaz" and "Kovin"

3. Research results

3.1 The results obtained flow values

After the conducted testing it can be concluded that the company's nozzles "Mlaz" achieved an average flow of the 2 bar pressure of 1.30 $lmin^{-1}$ with a standard 0.155 deviation and 1.19% variation coefficient, and at the 3 bar working pressure made the 1.58 $lmin^{-1}$ flow of the standard deviation of 0.031 and 1.99% variation coefficient.

3.2 The results of the surface distribution

The obtained results are the average distribution of the liquid at the surface of the tested nozzles showing the following figures. As you can see the nozzles from the company "Mlaz" at 2 bar working pressure and 40 cm working height achieved an average width of the spray from 131.25 cm to 1.02 standard deviation and 0.77% variation coefficient (Figure 3), and at 2 bar pressure and 60 cm working height achieved an average width of 176.56 cm from the sprayer to the standard 2.13 deviation and 1.20% variation coefficient (Figure 3).

At 3 bar working pressure and 40 cm working height, the nozzles "Mlaz" achieved an average width of 134.37 cm sprayer with and standard 2.39 deviation at 1.78% variation coefficient, while at the same operating pressure and 60 cm a height achieved an average width of 174.68 cm from the sprayer to the standard 11.60 deviation and 6.64% variation coefficient, Figure 4.

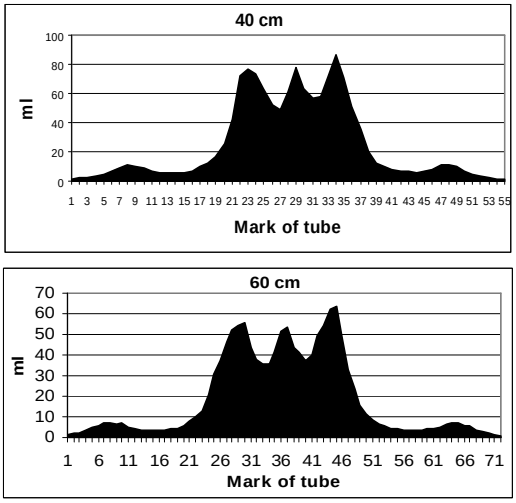


Figure 3. The average nozzle tested values from company "Mlaz" at 2 bars working pressure and from 40 to 60 cm working heights

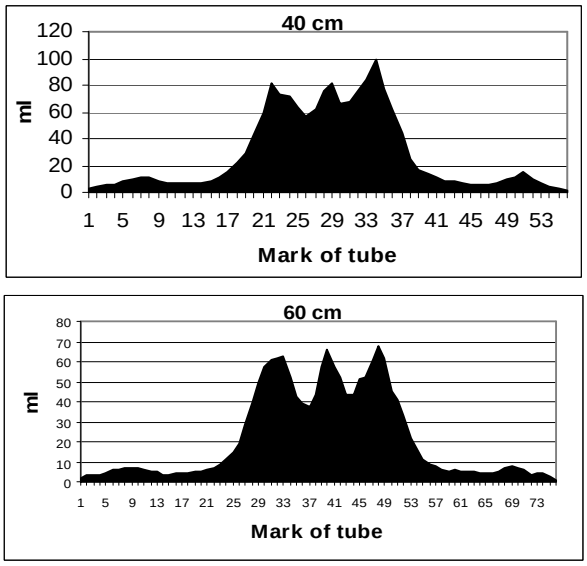


Figure 4. The average nozzle tested values from the company "Mlaz" at 3 bar working pressure and from 40 to 60 cm working heights

The company nozzles "Kovin" at 2 bar working pressure and 40 cm working height of achieved an average 106.25 cm width spray with a standard deviation of 2.04 and 1.92 variation coefficient, while at the same working pressure and 60 cm working height achieved an average 151.56 cm width sprout with a standard 5.80 deviation and 3.83% coefficient of variation, Figure 5. These nozzles at 3 bar working pressure and 40 cm a working height achieved an average 109.68 cm width spray with a standard 1.19 deviation and 1.09% coefficient of variation, while at the same working pressure and the 60 cm working height achieved an average 153.12 width with a crossover standard 3.60 deviation and 2.35% variation coefficient, Figure 6

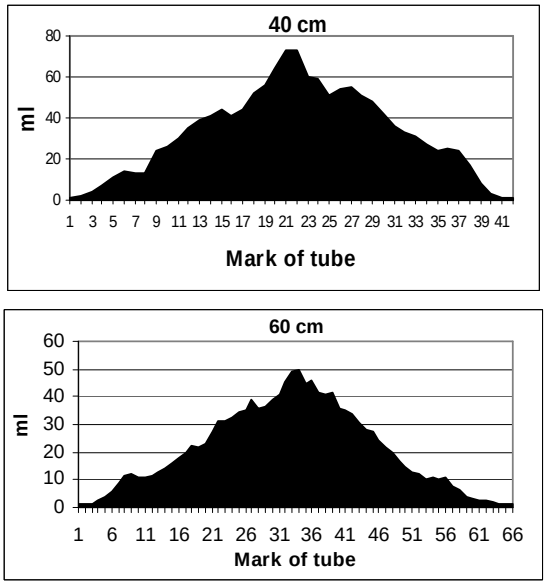
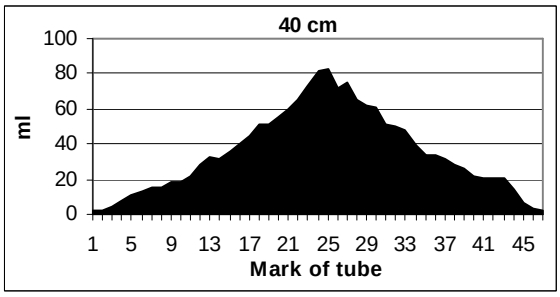


Figure 5 The average nozzles value tested from the company "Kovin" at 2 bar working pressure and 40 l to 60 cm working heights



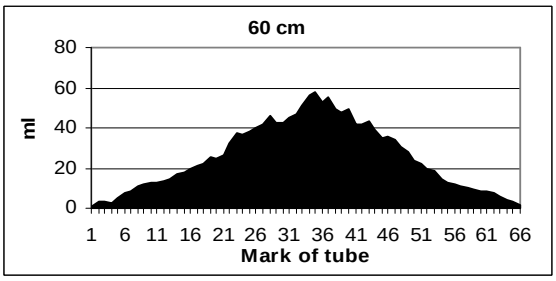


Figure 6. The average values of the test nozzles Company "Kovin" at working pressure of 3 bar and working heights 40 to 60 cm

3.3 The results of determining the distribution of surface liquid (at triple the average values of overlapping nozzles) on the 50 cm working line width

The allocation of the liquid in the 50 cm central area in three overlapping nozzles with an average liquid distribution is shown in the following figures and displayed as statistical values in Table 1

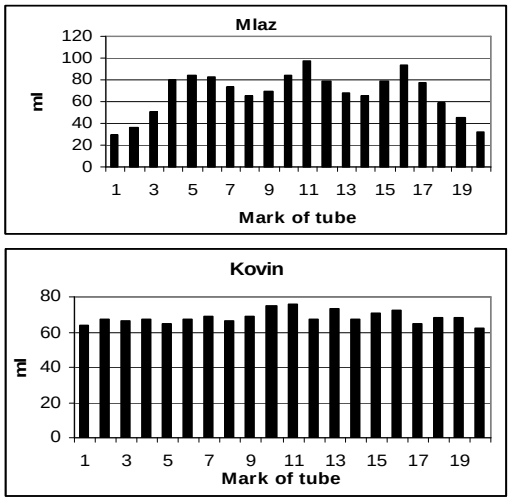


Figure 7. The average value of the liquid distribution in the 50 cm central area in three overlapping nozzles with an average pressure distribution at 2 bars and the 40 cm working height at the nozzle company "Mlaz" and "Kovin"

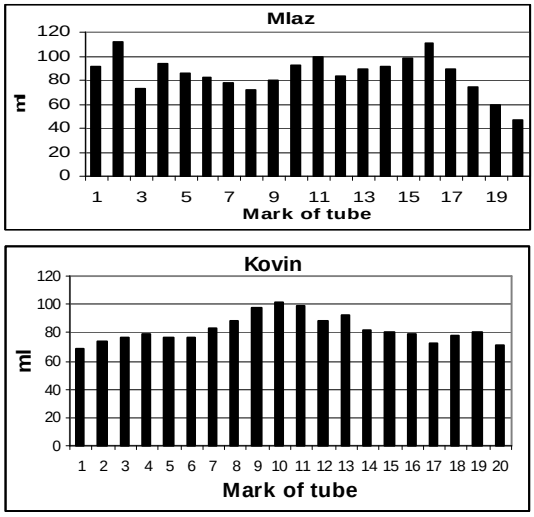


Figure 8. The average value of the liquid distribution in the 50 cm central area in three overlapping nozzles with an average pressure distribution at 3 bars and the 40 cm working height at the nozzle company "Mlaz" and "Kovin"

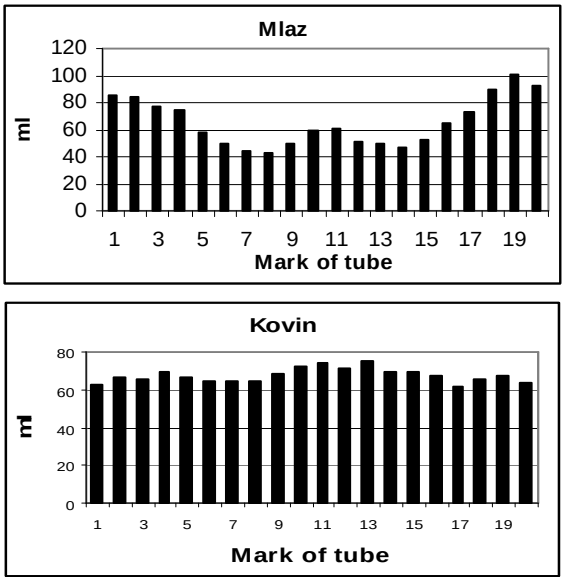
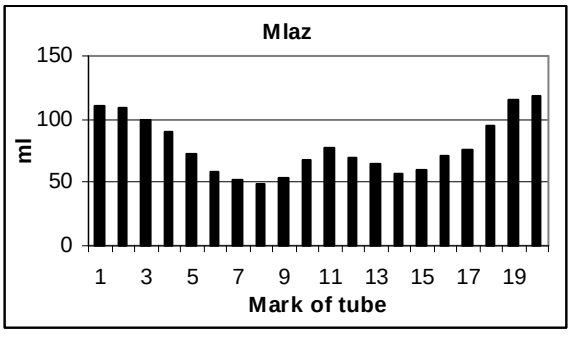


Figure 9 The average value of the liquid distribution in the 50 cm central area in three overlapping nozzles with an average pressure distribution at 2 bars and the 60 cm working height at the nozzle company "Mlaz" and "Kovin"



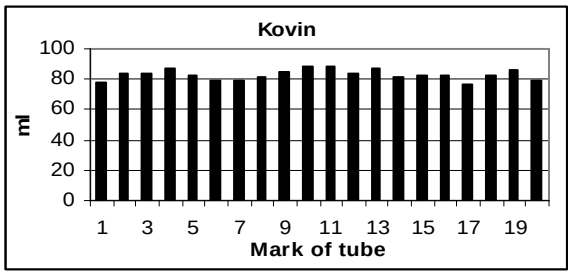


Figure 10 The average value of the liquid distribution in the 50 cm central area in three overlapping nozzles with an average pressure distribution at 3 bars and the 60 cm working height at the nozzle company "Mlaz" and "Kovin"

The combined statistical value display of the test is shown in the following table:

Table 1 The statistical test values of the liquid surface distribution on the 50 cm working width of 50

	Working Height					
	40 cm					
	2 bars			3 bars		
	Average (ml)	stdev	CV (%)	Avr (ml)	stdev	CV (%)
Mlaz	**67,52**	**20,0**	**29,63**	**85,15**	**15,66**	**18,39**
Kovin	**68,26**	**3,52**	**5,16**	**82,24**	**9,46**	**11,51**

	Working Height					
	60 cm					
	2 bars			3 bars		
	Average (ml)	stdev	CV (%)	Avr (ml)	stdev	CV (%)
Mlaz	**65,33**	**18,05**	**27,62**	**78,24**	**22,50**	**28,76**
Kovin	**67,51**	**3,70**	**5,49**	**82,89**	**3,56**	**4,30**

4. Conclusion

Based on the above, we can make the following conclusions:

The company nozzle "Mlaz" achieved an average 2 bar flow at 1.30 $lmin^{-1}$, while at 3 bar flow realized from 1.58 $lmin^{-1}$

The company nozzle "Kovin" achieved an average 2 bar flow at 1.33 $lmin^{-1}$, and with the 3 bar working pressure nozzles achieved an average 1.61 $lmin^{-1}$ flow.

The average results of the nozzle surface liquid distribution investigated by the company "Mlaz" indicated that their working width spray at 2 bar working pressure and 40 cm working height was 131.25 cm, and the 60 cm working height was 176.56 cm.

In the same nozzle at the 3 bar working pressure and 40 cm working height achieved an average 134.37 width of 134.37 cm from the spray, and at the same working pressure and 60 cm height achieved an average 174.68 cm width from the crossover.

The average results of the nozzle surface liquids distribution investigated by the company "Kovin" indicated that their working width spray at 2 bar working pressure and 40 cm working height was 106.25 cm, and the 60 cm working height average crossover width was 151.56 cm.

In the same nozzle at the 3 bar working pressure and 40 cm working height achieved an average 109.68 cm width from the spray, and at the same working pressure and 60 cm height achieved an average 153.12 cm crossover width.

The company nozzles "Mlaz" after the triple overlay, the overlap area in the 50 cm work width at 2 bar pressure and 40 cm working height measured the 29.63% variation coefficient, and at the 60 cm working height measured 27.62% variation coefficient.

The value of the variation coefficient remained high and the 3 bar working pressure and 40 cm working height, where it is measured 18.39% variation coefficient, and the 60 cm working height measured 28.76% variation coefficient.

The company nozzles "Kovin" after the triple overlay shows small variation coefficient of 5.16% and 11.52% (at 40 cm working height, and the 2 and 3 bar working pressure) and from 5.49% to 4.30% (60 cm working height and 2 and 3 bar working pressure).

So, according to the scientific knowledge we certainly recommend the company "Kovin" nozzles for usage in the protection of field crops.

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Energy cost management in the manufacturing process

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Abstract

Every activity that needs to be done for accomplishment of income usually implies certain costs. So costs are a normal thing in business activity of every business system. It is incorrect to give negative connotation to business costs, because they by themselves are not a negative figure. When creating products, certain costs appear, which are a result of the material consumption and other factors of the manufacturing process, like: labor force, tools, energy, spending basic assets and so on…

One of the most important items in the manufacturing process is cost of energy-generating product. When speaking about energy consumption we have to bear in mind the quality functioning of the system, which is impossible without energy consumption. The conclusion is that all economic decisions are based on costs, so we need to pay particular attention on cost management. Respectively, it's not possible to manage a business and avoid costs. [1]

This paper suggests the allocation of indirect costs of energy-generating products according to work orders with the purpose of embedding costs of energy-generating products into the product (work order) and only which are spent according to work orders and in the end optimal energy consumption.

Keywords: Cost management; Indirect costs; Costs of energy-generating products; Allocation of costs

Generally about costs

Costs are the center of economy and in economic literature they take main position. It's because, term of economy is specific for sucesses of the company that depends about costs.

Costs are generally arrenged to categories: [2]

- Basic or natural group of costs
- Economic and non economic costs
- Directs and indirect costs
- Costs according to places and carrier
- Incalculated, realised and paid
- Real planned and standard costs
- Absorbed, too much absorbed and non-absorbed indirect costs
- Short term and long-term costs
- Controlled costs and non-controled costs
- Manufacturing costs and costs of turnover
- Fixed and variable costs

For our analysis we sorted them into: (figure 1) [3]:

- Direct costs and
- Indirect costs

Direct costs are also known as individual costs because they can directly sort to products and services in the accountancy of a firm.

It's possible to arrange the costs as soon as they arise because it is already then known which product or service they refer to. Direct costs are, for example, direct wage costs of the manufacture, auxiliary devices and manufacturing material, and in certain cases , costs of fixed assets.

Indirect costs are also known as overhead. Indirect costs are costs which in the moment of the emergence can not directly arrange to particular products, and services. They are the common costs of the same place, workhouse, machinery or common for all bussines.

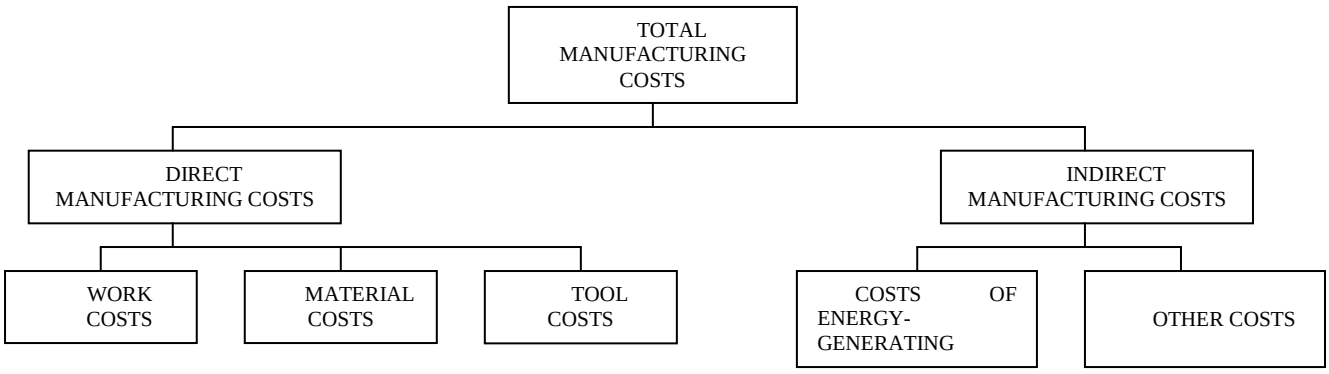

Figure 1.

Model for allocating indirect costs of energy – generating product

Classic methods for allocating indirect costs according to work orders are not suitable for certain categories of costs like energy-generating products. In every manufacturing process, a huge number of energy-generating products (electric energy, warm energy and natural gas) is turned into waste, which depends on the industrial branch and the type of machines and manufacturing equipment.

In the sense of consumption, energy-generating products, with costs of basic materials (raw material) and supplementary material, and costs of the manufacturing work, form the 3rd integral part in size in planned calculation according to work orders. Considering that basic and supplementary materials and work on construction belong to the group of indirect costs, their collecting according to certain work orders doesn't present such a huge problem.

However, unlike (already mentioned) costs, collecting indirect costs of energy-generating products according to work orders is a serious problem. One of possibilities to solve this problem is embedding measuring equipment for registration consumption certain energy-generating products on load. The mentioned possibility does not pay out because of the need for embedding large numbers of measuring equipment (for every load).

Second possibility for solving the problem of allocating the costs of energy-generating products by working orders is developing a model that would use available data in the manufacturing.

Based on that data it would be possible to calculate the associated part of the costs of energy-generating products (electric energy, thermal energy, gas) for each working orders that was in the manufacturing process in the related time period.

A model for allocating indirect costs of energy-generating products by working orders (shematic representation can be seen in picture 2) is based on the following theses:

- Consumption of the energy-generating products is always controlled according to two criteria: according to every working order and every appliance. The term appliance can imply a technological line and/or a group of machines and/or a single machine.
- The monitoring of the energy-generating product consumption is carried out on a monthly basis, namely every day (up to 31 days per month), and in line with the duration of the manufacturing process (up to 24 hours a day), which depends on the technological process.
- The consumption of energy-generating products that relate to the lighting and office equipment (informatical and byrotechnical) is not monitored, nor is the heating of the manufacturing and office space, because the mentioned should again be allocated according to working orders.

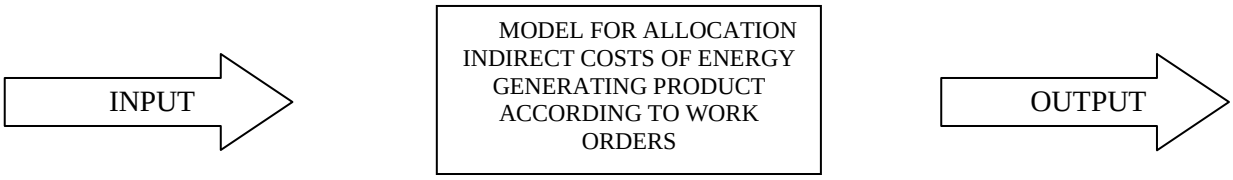

Figure 2.

Indirect costs of energy-generating products for the month "j" that are a part of working order "l", are calculated according to the expression (1):

$$ITE_j RN_l = \frac{\sum_{k=1}^{n} Q_j T_k RN_l}{\sum_{k,l=1}^{n} Q_j T_k RN_l} \cdot R_j \qquad (1)$$

Where:

ITE_jRN_l – indirect costs of energy-generating products for the month «j» that belong to working order «l»

$Q_jT_kRN_l$ – the amount of energy-generating products for the month «j» that has been spent by the appliance «k» on working order «l»

R_j – overall bill amount (without the value added taxes) for each energy-generating product in the month «j»

What is correlated in this expression are: the sum of the spent amount of energy-generating products in a measure unit for all appliances on one working order and the sum of the spent amount of energy-generating products in a measure unit for all appliances and for all working orders.

Thereafter is the given result multiplied with the total amount of invoice, but without the value added taxes for specific energy-generating product. Described procedure is repeated for each work order in that month and for each energy-generating product.

The spent amount of energy-generating products for the j-month and k-appliance according to working order (1) is calculated (2):

$$Q_j T_k RN_l = \sum_{i=1}^{31} (h_i T_k RN_l \cdot KfT_k RN_l) \qquad (2)$$

Where are :

$Q_jT_kRN_l$ - stands for the amount of energy-generating products for the month «j», which has been spent by the appliance «k» on working order «l»

$h_iT_kRN_l$ – stands for the number of working hours per day «i» for the appliance «k» on working order «l»

Kf T_kRN_l – stands for the correlative factor of the appliance «k» for working order «l»

According to this, formula calculates the sum of multiplied numbers of working hours per day for the each appliance according to working orders and correlative factor for every appliance and every work order.

This calulation is performed every day and especially for every appliance and work order. Collecting data on hours of work of the each appliances according to work orders can be implemented in the monitoring of productivity in production lines and machinery. There are already collected data on the duration of individual activities with regard to work orders and the position of the manufacturing product. It's only necessary to add together all the time working operations that are performed on each production lines apropos machinery for the one work order.

Stands for the correlative factor of the appliance «k» for working order «l» is calculated (3) :

$$KfT_k RN_l = \frac{ThRN_l}{\sum_{l=1}^{n} ThRN_l} \cdot NPT_k \qquad (3)$$

Where:

Kf T_kRN_l - stands for the correlative factor of the appliance «k» for working order «l»

$ThRN_l$ - manufacturing technology in hours for «l» working order

NPT_k – rated power of the appliance «k»

This expression puts into correlation: the manufacturing technology in hours for each working order, and the sum of manufacturing technology for all working orders. The given result is multiplied with the rated power of each appliance. The procedure is repeated for each of the appliances and for every working order. The data about the rated power for each appliance is situated in a database about the installed capacities of the company.

The manufacturing technology in hours for the working order «l» is calculated (4) :

$$ThRN_l = \sum_{m=1}^{n} Th\,\mathrm{Pr}_m \qquad (4)$$

Where:

$ThRN_l$ – stands for manufacturing technology in hours for the working order «l»

$ThPr_m$ – stands for manufacturing technology in hours for the product «m»

This expression represents the sum of manufacturing technologies in hours for all products on one working order. The calculation is repeated for each of the working orders separately. The data on the time period of the manufacturing, apropos the manufacturing technologies are situated in planned calculations.

Conclusion

This model allows monitoring the consumption of energy-generating products by working orders and there is a possibility of embedding the energy-generating product costs unambiguously into the working order.

It is possible to use the same model for manual data processing with a smaller number of working orders and technological lines. With a very large number of working orders, products and technological lines, and the consumption of various types of energy-generating products, the model becomes complex because of a great number of data, and the data would be computer-processed, which would greatly decrease the amount of spent time with data processing.

Based on given data, even in the phase of the production of the technological procedure, there is a possibility of selection of the technological lines for manufacturing by specific working orders, and finally-optimal consumption of energy.

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Financial Management and Control in Public Sector

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Abstract

We are all aware of the importance of proper and ethical uses of the public resources. Recent changes in the legislation and implementation of the Internal Controls in the Public Sector in the Republic of Croatia were main motivators for the paper. In this paper we will present the main requirements set by the Croatian Law and the importance of respecting them.

Keywords: Control, Budget, Audit, Reporting, Responsibility

1. Introduction

The system of internal financial controls in the public sector includes the parts of principle of legal gains established by the European Union as a whole and integrated system of internal financial controls for good management of public funds regardless of the source from which they originate. Compliance with mentioned principles as well as implementation of all necessary measures needed for adjustment and development of normative definitions that will establish compliance with best practice of the European Union is recommended to the Republic of Croatia and all candidate countries.

The system of internal financial controls in the public sector is the entire system of financial and other controls established by the budget users' leaders with the aim of successful management and tasks accomplishment of the budget users.

2. Law on Internal Financial Control Systems in the Public Sector

Law on Internal Financial Control Systems in the Public Sector (hereinafter the Law) came into force on 04th January 2007 (Official Gazette no. 141/06) and is used for further development of this system in the Republic of Croatia. The Law prescribes a comprehensive system of FMC that all budget owner leaders are required to implement for the successful management of the public funds and for the achievement of quality set business targets of budget users. The main objectives of the Law are control, auditing, and reporting on the use of budgetary resources.

2.1. Law Implementation

Implementation of the Law on Internal Financial Control Systems enables:

- Greater accountability of the leaders in charge of the establishment, development and implementation of internal Financial Control
- More successful management and achievement of the budget users' tasks
- Greater transparency and efficiency in the management and control of public revenues, receipts, expenditures and expenses and assets and liabilities
- Increase level of confidence of taxpayers in the public administration and
- Corruption suppression.

Provision of the Article 8 of the Law stipulates that except for leaders, both managers and coordinators of financial management and control are responsible for the establishment, implementation and development of FMC.

Transferring authority means transferring responsibility, but it is important to mention that transferring authority does not exclude responsibility of the leaders. In addition to the leaders who are responsible for the establishment and development of financial management and control, all employees are responsible for its implementation.

Establishment of FMC prescribes:

- business processes,
- determines responsibility for the implementation of certain activities in the process and periods in which they are required to be implemented and
- subject of certain controls that are established in a particular business process

System establishment ensures business transparency and determines which controls are established and which need to be established in order to ensure achievement of set business objectives and improve operations.

Financial management and control and internal audit are two components of a comprehensive system of internal financial controls for whose establishment, development and implementation budget user leader is responsible.

Financial management and control is a comprehensive system of internal controls established and led by budget user's leaders who by managing risk, provide reasonable assurance that in goal achievements budgetary and other resources will be used properly, ethically, economically, effectively and efficiently, i.e. in accordance with the laws and regulations, protecting assets from loss, misuse and damage.

This system covers all business transactions, particularly those related to revenue / receipts, expenditures / expenses, tendering and contracting procedures, return of the amounts erroneously paid, assets and liabilities.

Internal control system is implemented by leaders and all employees. Regardless of the name "financial management and control", this system covers the entire business, and business processes, not just financial ones.

Financial management and control is carried out in accordance with international standards for internal control through five interrelated components, namely:

a) control environment
b) risk management
c) control activities
d) information and communication
e) monitoring and evaluation system

The five components, which are based on international standards for internal control, should always be linked to the achievement of individual and general objectives of internal control, regardless of organizational level at which they want to achieve.

3. Internal Control in Public Sector

3.1. Purpose of Internal Control in Public Sector

The purpose of introducing and implementing financial management and control in public sector (PIFC - Public Internal Financial Control) is to improve financial management and decision-making in order to achieve the general goals set in front of each budget user. The general objectives laid down by the provisions of Article 6 of the Law are:

1. Conducting business in a proper, ethical, economical, efficient and effective manner,
2. Compliance of the business with laws, regulations, policies, plans and procedures,
3. Protection of asset and other resources from losses caused by poor management, unjustified spending and frauds
4. Strengthening accountability for the successful task achievements,
5. Timely financial reporting and tracking of business results.

Internal audit is the second component of a comprehensive system of internal financial control. It is an independent and objective activity of giving expert opinion and advice with the aim of adding value and improving operations of the budget users.

It is organized on the highest level and it is governmentally and functionally directly responsible to the budget user leader and cannot be involved in executions of direct functions of budget users.

Activities that must be taken for the successful establishment and development of FMC are:

1.Define vision that shows a long-term development direction. It is necessary to create a vision that is actively related to the changes and respects internal determination and demands of the environment. It should be ambitious but realistic. Vision statement describes what the company wants to accomplish, and achieve long-term.

2. Determine the mission, which defines the main reason for the existence and activities of the company. It consists of areas of action, values and goals that are pursued. It answers the questions of "who we are", “what we do”, "why we exist" and "whom we serve." Mission is based on business activities development, effective and economical management of public funds. The mission statement elaborates on the vision and attributes its purpose. It has no time frame, so there will be as long as there will be a business activity of enterprises.

3. Mission defines objectives determination, i.e. choice of the future status by the rational use of available resources. Setting and determining goals is one of the most important tasks since their quality determines success and achievements of all other tasks. There are two main types of goals:

a) Strategic (organizational) goals - arise from the mission and are created during the strategic planning process. These goals are perennial and define the expected results of the company as a whole. They represent a starting point for defining more specific and detailed goals of lower organizational units of enterprises.

b) Operational goals – are set based on organizational goals. They are narrow, short-term, specific, and determine the desired or expected results of each lower structural unit of the organization. They should be hierarchically structured in a way that achievement of operational goals of each organizational unit on a lower level helps to the achievement of operational goals of the unit on a higher level i.e. it helps to the Board to achieve its strategical goals.

4. Appoint a coordinator for the FMC

5. Appoint a working group for the FMC system

6. Establish internal audit

7. List of business processes will be composed for each organizational unit based on instructions and guidelines of the FMC leaders and coordinators. It will include a list of business processes and determine the activities in each process. Common business processes and a list /book of business process will be determined afterwards.

8. Description of business process (Production of audit trail) contains a flow diagram, activities description, a person responsible for the implementation of certain activities in business processes as well as the period within which or by when the activity should be implemented and other documents used in business processes. After determining the business processes at each level of the organizational unit every head-officer will determine the order of business processes based on their importance for goal accomplishment.

9. The process book provides complete description of the business processes with business objectives and determines correlation of single organizational units with possibilities for prospective business improvements in general.

10. Assessment and risk management will cover the business objectives determination and possible risks that affect the goals achievement. Executives of organizational units shall conduct risk assessment in relation to the probability of occurrence and the significance of consequences. They shall also establish appropriate measures for risk management within the organizational unit and individual business processes. Then they will develop risk management strategy of the business processes of the company as a whole as a result of a process of risk assessment

11. Analysis of the required and existing control - after compiling the views of established controls, needs for additional control activities will be discussed. Additional activities can be established as:

- The previous control (ex ante)
- Subsequent control (ex post)

12. Plan to eliminate weaknesses in control-plan of additional controls establishment will predict the actions to be taken in order to establish the necessary controls and remove controls that may have been unnecessary

13. Annual report on the FMC system - FMC manager is obliged to prepare an annual report on activities related to the establishment and development of FMC, and after approval by the leaders, to provide it to the Central Harmonization Unit

14. Training of persons involved in financial management and control - in order to develop FMC systems in the desired direction, all persons involved in the FMC will be continuously educated to acquire the skills needed for the establishment and development of this system.

For all activities related to the establishment and development of FMC system, exact indications of the time when and what will be done and who is responsible for necessary activities within the Plan should be prepared. It should be noted that once established the system of internal financial control is not final.

4. Tabular Review of Planed Activities

Table 1.Plan of the establishment and development of financial management and control

NECESSARY ACTIVITIES	RESPONSIBLE	DUE	STATUS
1. Appointment of the Head of Financial Management and Controls	Leader	By March 5, 2007.	Completed
2. Appointment of persons responsible for irregularities	Leader	By April 4, 2007.	Completed
3. Appointment of the Coordinator for the Financial management and control and establishment of departments for financial management and control	Leader	By August 31, 2007.	Completed
4. Establishment of working groups for financial management and control	Leader	By August 31, 2007.	Completed
5. Establishment of Internal Audit	Leader	By January 4, 2008.	Completed

Table 2. The establishment and development of financial management and control

NECESSARY ACTIVITIES	RESPONSIBLE	DUE	STATUS
1. The preparation of statements of vision, mission and key objectives of hospitals and administrative / organizational units-departments	Leader, Assistants, Departmental Managers	31.12.2007.	Completed
2. Initial estimate five components of internal control	FMC Managers	30.06.2008.	Completed
3. List / book of business processes and defining the activities in each process	Departmental Managers	30.06.2008.	Completed
4. Creating a description of the business processes (audit trail)	Departmental Managers	31.12.2008.	Completed
5. Production of process books (folders)	FMC Managers	30.06.2009.	Completed
6. Determining the most important risks to achieving the goals and decisions on control objectives in relation to the management of the most important risk-risk register - a strategy for making risk management	Departmental Managers Leader	30.06.2009.	Completed
7. Analysis of existing / established and the expected / required controls, defining the position and functions of the previous and subsequent control	FMC Managers, and Task Force	31.12.2009.	
8. Preparation of the Plan for internal control weaknesses removal	FMC Managers	30.06.2010.	

9. Progress monitor and review (of the Plan of the necessary controls establishment)	FMC Managers	Continuous (once a month)	
10. Annual report on the system of financial management and controls and reporting to SHJ	Leader, FMC Managers	31.01.for previous year	
11. Training of involved personnel	Leader, FMC Managers	Continuous	

5. Conclusion

The purpose of introducing and implementing financial management and control in the public sector is improvement of financial management and decision making in order to achieve following objectives set before every budget user:

- Conducting business in a proper, ethical, economical, efficient and effective manner,
- Compliance of operations with laws, regulations, policies, plans and procedures,
- Protection of assets and other resources from the losses caused by poor management, unjustified spending and the use of these irregularities and fraud,
- Strengthening the accountability for the successful achievement of tasks,
- Timely financial reporting and tracking of business results.

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The Role of Osijek – Baranja County in EU Accession

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Abstract

According to the amended Act on the Area of Counties, Towns and Municipalities in the Republic of Croatia (that came into force on 30 January 1997), 47 municipalities attained the town status, 63 settlements attained the municipality status, and 13 municipalities became settlements. Thus, there are currently 122 towns and 416 municipalities in Croatia.
The Osijek-Baranja County was established in 1993 by the act defining the new territorial organization in the Republic of Croatia,and the county seat is the city of Osijek.
The Osijek-Baranja County is connected to a number of regions, countries and associations by means of different forms of cooperation. Sometimes it is based on a formal relationship governed by a signed agreement or some other document, and sometimes it is a matter of daily interaction and complementary activities of international character.
With such cooperation and activities, the County has been establishing bilateral and multilateral relationships for years. Some of the most important associations that the County belongs to are as follows: Croatian Association of Counties, Euro-regional Cooperation Danube-Drava-Sava, Working Association of Danube-Basin Regions , European Campaign for Sustainable Cities and Communities, Conference of European Regions, Croatian Network of Healthy Cities.
In addition to being a member of these important associations, the County also boasts close and friendly relations with the County of Baranya in the Republic of Hungary, Autonomous Province of Friuli-Venezia Giulia in the Republic of Italy, as well as the Vincenza Province, also in Italy.
The paper will give an overview of different projects, their implementation, results and effects, which are primarily based on successful cooperation with the stated partners.

Keywords: project, EU, Osijek-Baranja County, cooperation

1. Introduction

According to the new Act on the Territories of Counties, Towns and Municipalities of the Republic of Croatia (of 30 January 1997), the town status was given to 47 municipalities, 63 settlements received the municipality status, and 13 municipalities became settlements. Thus there are currently 122 towns and 416 municipalities in Croatia. Based on the law regulating the new territorial organization of the Republic of Croatia, Osijek-Baranja County was established in 1993 with its seat in Osijek.

According to the last, i.e. 2001 census, Osijek-Baranja County had a total of 330,506 inhabitants, of various age, education level, ethnicity and religion. Thus Croats account for 83.39 % of inhabitants, there are 8.73 % of Serbs, 2.96 % of Hungarians, whereas other minorities account jointly for further 2.64 % of population. A small percentage, 1.78 % remained ethnically uncommitted. Such a variety within a relatively small geographic and political area indicates genuine multiethnic and multicultural features, which helps in promoting communication and overcoming possible obstacles to integration, development and accession to the European Union.

2. International and Interregional Cooperation of Osijek - Baranja County

Osijek-Baranja County is connected to a number of regions, countries and communities through different types of cooperation, be it a formally established legal relationship based on a signed agreement or some other document, or everyday interactive cooperation in the

form of complementary activities of international character.

These kinds of cooperation have enabled the County to establish and maintain bilateral and multilateral relations with other entities for many years. As part of these activities Osijek-Baranja County has become a member of different agreements and associations, the most important being the following: the Croatian County Association, the Danube-Drava-Sava Euroregional Cooperation, Working Community of the Danube Regions, the European Campaign for Sustainable Cities and Towns, the European Regions Assembly, and Croatian Network of Healthy Cities.

In addition to being a member of several important associations such as those mentioned above, Osijek-Baranja County has excellent relations with the County of Baranya from the Republic of Hungary, Autonomous Furlania-Julian Region of Italy, and Vicenza Province, also from the Republic of Italy.

Another important point is that the County has recently established a representative office of Slavonia and Baranja in Bruxelles, which ensures a permanent presence of the Osijek-Baranja County in the seat of the European Union.

3. European programmes, funds and projects with Osijek – Baranja county as a Participant

Opportunities are arising at a daily basis for Osijek-Baranja County to attract an increasing amount of funding through a range of projects financed either by the European Union, or through some other international sources. The County takes an active role in designing, submitting applications and implementing projects in different fields, and its status varies accordingly, from the sole applicant, co-applicant, to national partner, cross-border partner, etc.

The projects that Osijek-Baranja County has so far applied for are funded by various programmes and countries of the European Union: INTERREG, CARDS, PHARE, SAPARD, EU funds, EIB (European Investment Bank), IEE (Intelligent Energy Europe), IBRD (International Bank for Reconstruction and Development), Youth in Action, the Republic of France, and the Republic of Italy.

Osijek-Baranja County is frequently seeking partners in order to nominate projects funded by the European Union. The largest number of projects was nominated with these project partners: Austria, Bosnia and Herzegovina, Bulgaria, France, Italy, Hungary, Poland, Romania, Slovakia, Slovenia, Serbia (Autonomous Province of Vojvodina).

The current value of all the projects initiated from the area of Osijek-Baranja County amounts to over 22 million Euros. The participants are the County itself, other units of local self-government within Osijek-Baranja County, Regional Development Agency of Slavonia and Baranja, different non-governmental organizations and other legal and natural persons. The areas covered by the submitted projects are quite heterogeneous, ranging from administrative/institutional and political topics and sectors, to youth issues and entrepreneurial ones, which encompass tourism, culture, agriculture, ICT training, traffic infrastructure, environmental protection, nature conservation etc.

Some of the major project are entitled as follows: @ccess, Plant Network, CROST, Digital history, Energy-efficient house, Capacity building for NGOs and LSGUs (local self-government units), Cluster 'Apple', International Communal Network, Panonnian tourism, Platform for improving relations between Adriatic regions in Europe, Foundations for the ecological region of the river Drava basin, Cross-border cooperation in natural disaster management and protection, Sustainable development programme for family farms in Baranja, Local development advisory centre, multi-faceted cultural and tourism cooperation between Osijek-Baranja County, the County of Baranya (Hungary), the City of Osijek and the City of Pecs called '*Združimo se'* (Let's work together).

All these different titles indicate a wide range of interests exhibited by different entities within Osijek-Baranja County, and also believed to be among the domains that the EU would be willing to finance, or contribute to their funding. By initiating and implementing such projects the stakeholders can directly contribute to the economic growth of the County and the wider region. The basic postulate of attracting and using the resources from pre-accession, and later structural and cohesion funds, is to recognize what projects might be interesting for the EU to finance. They should simultaneously satisfy and promote local and regional needs.

Table 1. Projects submitted to EU Pre-accession funds from the area of Osijek-Baranja County (OBC)

PROJECTS		TOTAL VALUE
OBC applicant or co-applicant in 4 projects	838,809.00 €	
OBC partner in 19 projects	5,757,311.00 €	
Total value of 23 projects that are completed, under way or being evaluated		6,596,120.00 €
Regional Development Agency is a partner or associate partner in 20 projects	2,027,233.00 €	
Out of which 5 projects are emphasized		488,557.00 €
Local self-government units, institutions, and companies owned by public authorities in OBC have developed, have been implementing or participating as partners in 26 projects		8,862,713.27 €
Non-governmental organizations in the area of OBC have developed, have been implementing or participating as partners in 29 projects		4,248,409.71 €
Private beneficiaries in the area of OBC have developed, have been implementing or participating as partners in 9 projects		1,983,849.53 €
Total value of 92 projects (32 completed, 55 under way, 5 being evaluated) with entities from the OBC area as participants		22,179,649.51 €

Table 2. Programme Frameworks of EU Pre-accession funds with entities from Osijek-Baranja County as Participants

PROGRAMME FRAMWORK	NUMBER OF PROJECTS
WB (World Bank)	42 projects
INTERREG	25 projects
PHARE	16 projects
CARDS	15 projects
IPA	10 projects
EIB (European Investment Bank)	4 projects
SAPARD	3 projects
EU funds	2 projects
HAMAG	2 projects
IEE (Intelligent Energy Europe)	2 projects
Youth in Action	2 projects
PROGRAMME FRAMWORK	NUMBER OF

	PROJECTS
CEI (Central European Initiative)	1 project
Europe for Citizens	1 project
IBRD (International Bank for Reconstruction and Development)	1 project
Kingdom of Belgium	1 project
Republic of France	1 project
Republic of Italy	1 project

Table 3. Partner Countries with which entities from Osijek-Baranja County participate in projects from EU Pre-accession funds

PARTNER COUNTRIES	NUMBER OF PROJECTS
Hungary	27 projects
Italy	18 projects
Serbia (AP Vojvodina)	7 projects
Bulgaria	4 projects
France	4 projects
Romania	4 projects
Slovakia	4 projects
Poland	3 projects
Bosnia and Herzegovina	2 projects
Belgium	1 project
Czech Republic	1 project
Greece	1 project
Slovenia	1 project
Austria	1 project

Table 4. Unaccepted projects – initiated by various entities from Osijek-Baranja County, but refused by the EU Assessment Committees

UNACCEPTED PROJECTS	NUMBER OF PROJECTS
Unaccepted projects	38 projects

It is important to note that for Osijek-Baranja County most of the work lays ahead, i.e. its institutions have yet to attract the European Union funding. The first step on this road is the IPA programme (the Instrument for Pre-Accession Assistance), which will soon be made available to the Republic of Croatia. In our country, the IPA programme will replace the programmes PHARE, ISPA and SAPARD. The IPA programme is divided into five components that indicate in which areas entities can submit projects that will be eligible for co-financing:

- Aid in transition and institutional linkage

- Cross-border and regional cooperation
- Regional development
- Transport
- Environmental protection
- Regional competitiveness
- Human resources development
- Rural development (IPARD)

Table 5. Total funds to be at Croatia`s disposal under the IPA Programme, broken down by components and years:

		2007	2008	2009	2010
1	Aid in transition and institutional linkage	47.6	45.4	45.6	39.5
2	Cross-border and regional cooperation	9.7	14.7	15.9	16.2
3	Regional development	44.6	47.6	49.7	56.8
	Transport				
	Environmental protection				
	Regional competitiveness				
4	Human resources development	11.1	12.7	14.2	15.7
5	Rural development (IPARD)	25.5	25.6	25.8	26.0
	TOTAL	138.5	146.0	151.2	154.2

There are some other programmes available to the Republic of Croatia, and thus also to Osijek-Baranja County, notably international networks INTERREG IVc, URBACT II, INTERACT II and ESPON II, then activities within the Seventh Framework Programme (FP7, research and development), KULTURA (cultural events), Marco Polo (sea and river transport), YOUTH (networking between young people), Gender equality, FISCALIS (tax system), CARINE (customs and tariffs policy), IDABC (pan-European e-government) and others. The EU programmes are targeted primarily towards member states; however, Croatia also has a chance to participate as a candidate country. There are special conditions that come together with this status. In certain programmes membership is gained after paying a membership fee, which is a requirement that the Republic of Croatia needs to meet in order to participate.

4. Conclusion

With the ever increasing number of competent professionals who are interested in collaboration in projects and who believe that this way of drawing funds into Osijek-Baranja County is a key to future prosperity and advancement for the entire population, we can fully optimistically accept the idea of accessing the European Union that will mean more resources, faster development and advancement for all. In the past there was a prevalent concept of passively obtaining the means for different purposes. However, this concept is gradually changing and evolving into another approach that is based on concrete measures, which means that concrete needs and requirements of ultimate beneficiaries are defined, as well as the needs of applicants, i.e. project partners. This whole approach is based on strategic priorities of the community, discussed and worked out in advance, and this can refer to both regional and local decision-making level. Thus, in the transition process we are evolving from the approach “sitting on one’s hands, waiting for the funds to come on their own” to a proactive approach of seeking funds from the European Union on the basis of concrete project submissions, action plans, expenditure plans with precise spending allocations, as well as with possible and likely benefits for the ultimate users. His is just the beginning of the whole story: throughout the project, applicants have to adhere to strict rules and control systems in order to meet all the rules. This is done by submitting very detailed and exact reports to the donor(s).

The approach to drawing and obtaining resources from the EU funds described above is a novelty for our community and society as a whole, but these are the rules set by the European Union, which we have to observe if we wish to become a part of the

European team and get our piece of the "European pie". The approach is actually quite simple – all the resources are there for the taking, but one needs to know the right way of taking them, which is to follow the rules and standards as defined by the European Union.

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Functions of Human Resource Management

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Abstract

The aim of this paper is to present the basic theoretical functions of human resources and explain their role and importance in modern enterprises. Croatian companies show experiences with activities related to human resources. The purpose is to explain how to find, develop and keep best employees who promoting business. Educated people are intellectual capital of every company. Main method of research is poll conducted in two different companies. Goal of research is to show the current state of implementation and human resources development within selected companies. This issue has great importance for the development of enterprises in transition countries like Croatia. Research implicates that Croatian transition market successfully accepts capitalistic features of human resource management.

Keywords: Employment, Development, Education, Performance, Management

1. Introduction

Nowdays, importance of human resource management is emphasized because, it helps managers to lead their business activities in the best possible way. Human resources are base for creating successful business strategy. An accent is on existence of competition for each work place. Human resource management is tissue of organizational strategy, managing, employee's satisfaction and development. It is process where each activity or function has an important role in creating successful business strategy. Specificity of human resources is that human capital cannot be owned by a company. They just can rent their services [1].

Development of human resources functions is an integral component of business strategy. An final aim is to achieve motivation and satisfaction of employees, productivity of company and end user's satisfaction.

2.Functions of human resource management

Assumptions of study:

A1: Croatian companies implement human resource functions in their business

A2: Companies increasingly encourage employee development

There are seventy-three human resource functions. We'll divide them in eighteen core functions. These basic functions are: Personnel Policy, Job Analysis, Planning, Winning, Selection, Introduction to work, Career Development, Education, Progress, Consultation, Motivation, Creative Techniques, Evaluating Performance, Rewarding, Detection of managerial potential, Administration, Information and Communication, Controlling execution [2].

2.1.Employment

Human resources manager should have idea how many new employees the firm needs to hire. Job analysis includes all information about job. It helps management to fill free positions with qualified employees. If current way of doing business successfully satisfies needs of employees and their customers, then it should continue with same applications in further operations. But if it's not effective it is necessary to change the goals and ways of achieving goals. Managers of human resource department warn about job vacancies. Executives establish conditions for jobs and necessary qualifications. Recruiting is a process of attracting the largest possible number of qualified employees. There are internal and external source for gaining applicants. Internal source includes selection among current employees. More expensive way of hiring is external source, when better qualified people come outside of the organization.

In a process of selection, when all information about applicants are collected, company has to decide which ones to hire. It includes application, interviewing, testing and reference checking. Application is first step when applicants fill out application form. The goal is to cut out those who are not qualified for the job. Interview helps management to obtain detailed information about applicants. Some companies do

testing to see IQ level, creativity, aptitudes and so on.
Reference checking
Mostly involves educational background and previous work experience references. In a process of selection company can implement all four steps or can combine some of them [3].
When applicant is selected company has to organize a systematic introduction to a new job. The purpose of introducing new employers to job is adaptation in new situations and working environment. Job introduction has importance for the further professional development, career development of employees, their motivation and identification with the company.

2.2. Professional development and education

New employees must learn how to do specific job task. Professional development needs to determine the position within strategic plans of company and direction of development. It helps to prepare employees for increased responsibility and job promotions. Training is connected with development. It allows workers to performing tasks of job.
Professional development is determined by: career development, education, progress, and consultation.
Under the career it is always thinking of the time active service. Career development includes permanent care and monitoring of employees in the selection of profession. Career development requires at least the following assumptions: cumulative school system, better employment opportunities, professional introduction into the business, system improvement, professional orientation, consulting in company.
Today, managers and all employees must take care of obsolescence of knowledge. Knowledge we get through formal education systems may satisfy the needs in one period. Over time such knowledge is no longer sufficient to keep up with development of new technologies and trends in the business. For these reasons, permanent, lifelong education has main importance [4].
In example of Croatia and EU, percent of high educated people in Croatia is 8%. In EU is about 30%, plus Croatia has 20% of illiterate population.
Progress is interaction between people and businesses that have common goals. Individuals have influence on company and reverse. Both effects on career development. Progress of employees includes: communication, role playing, advance in salary, prestige and so on. Company wants higher profits, investment, expansion, and decisions about progress through their managers [5].
Company consultations are services of psychological counseling in situations where employees need assistance due to stress, protests, some job problems, informing about salaries, working rights, free days, etc.

2.3. Performance encouraging

For most companies humans are most valuable resource. Employees must be motivates, have abilities and tools to achieve organizational objectives. Managers who can recognize need of employees can reach higher levels of productivity.
Motivation goals establishing and implement plans for stimulation of employees. Motivators can be external and internal. External motivating factors can be wages, executives, working conditions, company image and so on. Internal are the possibility of training, promotion, colleagues acceptation, verification capabilities and so on. Classical theory of motivation says that money is main motivator for workers. It is believed that well paid workers would produce more. According to modern theories money is not the main motivator. Motivators for some people are opportunity for advancement, working conditions, working environment, image of business, job security, job satisfaction, business travel ability.
In order to encourage creativity improvement, company must strive to transform ideas into action. Creative individual brings changes in established trends. This change makes company more creative. For creative development there must be a social environment that encourages creativity. Company must follow creative features if it wants to become a framework for creative thinking. Managers have to support creativity and not to sabotage it.
In our region success assessment was neglected due to political equality. In the Western world it is practice that company evaluates the performance of employees. They evaluate characteristics and behavior of staff, measure and analyze their work. The goal is promotion of good workers, indicates on poor and marginal workers, detecting groups that have a need for additional education and rewarding rather than punishing. Company must distinguish efficient from inefficient workers.
Reward system includes material and immaterial rewards to employees. Material reward system makes the payment. The salary may be agreed secretly between the employee and employer, that other has not been informed about it. In addition to the salary, material reward may be different cash bonuses for

well done job, percentage of profits, monetary compensation, simulations, etc.
Immaterial rewards can be greater motivation and greater reward than any material reward. It can be: attendance to various courses, further education, team-building, benefits like kindergartens within the company, which can be more important to parents than monetary compensation.

2.4. Detection of managing resources

Type of leadership is changed. Market does not need directors and executives of old caliber. New type of manager is hard to create or find on Croatian market. Training process for them is long and difficult. Managers are the most important capital resource of any organization. Creating a good manager team require large investments and many time.
For personality assessment is important ability to control people, development of positive qualities, delegation of tasks, communication skills, knowledge, evaluation of personal characteristics of associates, etc. Techniques for discovering new potential managers are: psychological tests, questionnaires, biographies, ratings colleagues, interviews, recommendations and other techniques.
Administration Department is present in every company. Administrative action is required by law. It includes personnel data base, appointments, contracts, payroll, health, social and pension insurance, protection at work, collective agreements, coordination with the trade union, etc.
Successfully development of human resources is not possible without information systems in the field of action. The main goal of human resource information system is to inform all employees about their essential activity and relations.
An information system helps to perform affairs of recording development of human resources, salaries, education and training. It helps to facility the work of the department of human resources.
Controlling execution includes carefully monitoring, analyzing development organizations, labor costs in the company and the efficiency of the complete human resources function.

3. Results and achievements of research

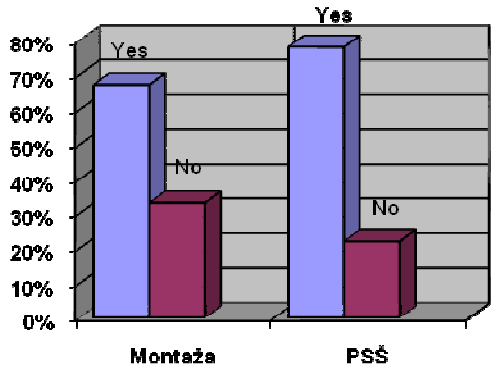
In the first part of the paper we have presented a theoretical point of view of human resource functions. For the research part we test two by their nature different companies. Chosen companies are company „Montaža“ that is a member of group Đuro Đakovic Holding d.d. Slavonski Brod and the „Prva stambena štedionica“-PSŠ member of Zagreb Bank Group. Montaža deals with industrial and power plants and steel works. [6] PSŠ is banking sector of savings. Both companies operate for many years and have some experience in the management of change, both joint stock companies. They perform different activities and are at different geographic localities. Also they have different personnel structure of business, customers, users of their services, etc. Testing instrument was a poll survey. Survey had 73 statements on human resources functions, which we grouped in four sections based their similarity.

3.1. Employees structure

According to research in October, 2007 company Montaža had totally 1035 employees. 760 of them work in production, and rest in offices. Qualification structure show that there are 74 high qualified, 725 qualified and 236 of low qualified employees. In 2007, PSŠ had 179 employees and all work in offices. 127 of them are high qualified and 52 have high school education.
Statistics show Montaža has 7% of high qualified and in PSŠ 71%.

3.2. Survey results

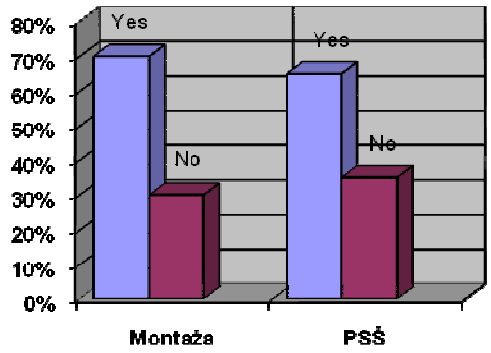
As a survey results there are four charts. They represent level of implemented functions of human resources of the companies.



Picture 1. Extraction, selection and introduction into job

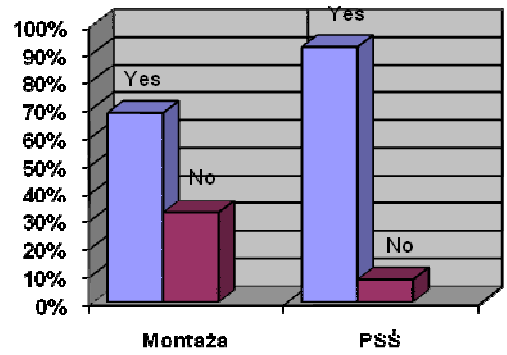
In this part of the research we obtained similar results for both the percentage of firms that match. Obtained result tells us that Montaža successfully implements 67% of offered human resources functions of

extraction, selection and introduction into job. PSŠ implements and support 78% of human resource functions. 22% of answers were negative. These identical results lead us to the fact that both companies probably have almost the same system of obtaining employees.



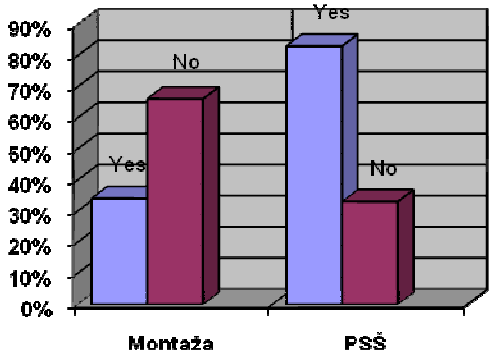
Picture 2. Education and Career Development

70% of answers are positive response to the claims related to education and career, which confirms that they develop education and careers of its employees. From these results, we can conclude that the company has a plan and program of education, training to work, to scholarships, etc. They follow the new trends of the modern economy that is based on intellectual capital. PSŠ diagram shows that 65% of positive responses to the claims of the whole education and career development.



Picture 3. The functions of monitoring performance and rewarding

Results are in huge measure positive. Montaža 68% positive answers, and PSŠ 92%. Conclusion is that both companies have good system of rewarding their employees. We can make conclusion that employees are satisfied. If results were different it would mean that employees are not satisfied and that company doesn't work well.



Picture 4. Management development

Montaža implements 34% of claims with positive responses, while 66% of negative responses related to management development. PSŠ has 83% refers of acceptable answers which shows that the company accepts and implements the functions of human resources

4. Conclusion

This paper gives a theoretical view of the role and importance of human resources in enterprises. According to research on the Croatian economy in transition with an emphasis on human resource, development is very positive. In Croatia, the most successful companies are mature and it can be concluded that they work on the development of human resources. Researched sample shows that there is a connection with desire for development of human potential and actual real development.

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[3] O. C.Farrell; G. Hirt; L. Ferrell, Business A Changing World. Fifth Edition, McGraw-Hill-Irwin, (2006), page 312-315.
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[6] Đuro Đaković Montaža, Slavonski Brod, http://www.durodakovic.com/proizvodni_program_grupacije/industrijska_i_energetska_postrojenja_celicne_konstrukcije/default.aspx, 28/11/2009

Cost management in projects using Earned Value Analyses method

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Abstract

Due to increasing market relations and to society conscience change, especially in the time of recession or economic crisis, in business environment the terms "saving" is dominant. In such conditions companies which uses the project management principals have the great advantage due ther ability to decrease the costs and react in a best possible way on trends and market challenge in their business environment.
Implementation of project management include nesessity for monitoring and project control. One of the method which has been shown in this article is Earned Value Analysis as a part of MS Project 2007 tool for project management.

Keywords: project management, earned value analyses

1. Introduction

During the recent years, in Croatian business enviroment, more and more attention has been given to project management. Numerous authors in this field assume that the project management is one of the keys for companies success and it's competetive advantages.[18] The importance of projects lies in fact that with their implementation companies makes new better products and services, new organization structures, new or improved working processes, cost decreasing and better company financial results.

In this article it has been described the procedure for implementation EVA method in projects. EVA is a powerfull tool which enables simultanious financial and manual performance control. EVA gives informations about time, progress and costs related with scope, quality and risks. EVA method enables to managers cost managing with "open eyes" since the project managers have posibility to see what was planned, what was accomplished and what are the current costs. Insight in real costs enables to the managers required informations for timely decision making and keeping the project in planned time and budget frame.

2. Term and definition of project

Project is defined as "temporary enterprise taken with attention to make uniqe product or service"[19]. Many organizations today show more and more interest for project management.[20] Until the 80's of the last century project management was primary focused on ensuring the data of activities, costs and resources for the top management. Tracking and control of these key parameters represent one of the most important element of management process even today but the project management today is much more complex. Business enviroment become more and more complex, new technologies become one of the key factors in business. These changes intrude need for the advanced business organizations and better project management.

Business organizations perceive that accomplishment means not only to know but to implement the modern project management techniques. These techniques using bring some advantages like:

[1] Darko Barišić: Povezanost projektnog menadžmenta i uspješnosti poslovanja poduzeća, magistarski rad, Ekonomski fakultet, Zagreb, 2007 str.3.

[19] DuncanR.W.: A guide to the Project Management Body Of Knowledge", Project Management Institute, Sylva, 2000, str. 4

[20] Dean Dech:Model projektnog upravljanja primjenom suvremene informacijske tehnologije – magistarski rad, Ekonomski fakultet,Zagreb, 2004, str.8.

- improved financial, material and human resources;
- improvement customer relationship;
- delivery time shortening;
- lower costs;
- better quality and reliability;
- bigger profit;
- better productivity;
- better internal comunication;
- bigger working motivation.

3. Project management

Project management imply time, material, human resources and cost management with attention of execution the project in anticipated time, cost frame and with anticipated product or service quality.

We can say, for every project, that it is limited with time, cost and scope. These basic elements of the project in project management terminology are called "triple constraint". They are connected in such way that every change on each of these constraint causes change at least one of the rest two.[21] With these three constraint we must add quality together with the customer satisfaction, which play a significant role. Figure 1. illustrates three dimensions of triple constraint .

Project manager must consider cost, time, human reosources and materials and manage them in an optimal way to acchive the predefine goal.

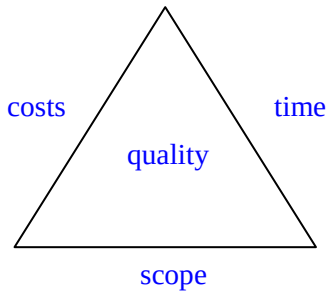

Fig. 1. Triple constraint on project

4. Cost management and budgetting

Every delay of time for realization of the project causes extra expenses. Because of that fact, mutual time and cost coherence is very important for a project efficiency. Let's remember the B. Franklin proverb from year 1748: "time is money". With that analogy, we can have direct connection between delay of activities and total project budget.[22] If we increase time for certain activity, we must spend more resources that lead to cost increasing. Also, if we want to contract some activities on a critical path, we change the cost of the activities, causing the activity cost change. This is due to increasing of resources on that activity which lead again to whole project cost increasing. Considering well known project constraints time-cost-scope-quality, we can see that due the time shortening we must increase costs or decrease quality. Besides that, we must calculate the opportunity cost because the project product is not in use and it doesn't gives any profit which was planned.

Because of all these reasons, project manager must pay close attention to cost management. Effective cost management on a project can be shown threw the several phases:

- resource planning – this is the resources assortment defining process (equipement, material, workers) and quantities needed for realization of each project activity,
- cost estimation – imply cost estimation of the needed resources for project completion
- cost budgetting– budget construction and making base plan of costs which will be used for evaluation of real costs on project
- cost control – where the base cost plan will be compared with the real costs

It is necesary to emphasise that project budgetting apropos project cost audit is not completely equable with the accounting and finance policies. Project cost is made in the moment when the work or service is recognized, but accounting cost is recognized after the invoice is accepted. Financial cost is made when the invoice is paid apropos when the cash flow is made. Due to these differencies, the problems are beeing caused very often in project manager reports about project costs.

4.1. Cost estimation

If we want to finish the project within budget frame, project manager must make cost estimation very

[21] Dean Dech:Model projektnog upravljanja primjenom suvremene informacijske tehnologije – magistarski rad, Ekonomski fakultet,Zagreb, 2004, str.9.

[22] M.A. Omazić, S. Baljkas: Projektni menadžment, Sinergija nakladništvo, 2005, str.218.

seriously. Cost estimation is made during several phases in project:

- ROM estimation – this is an estimation which gives rough picture about the costs of particular project. This estimation is beeing made in early phase of the project apropos in initiation phase. Top management use this estimation during the project evaluation and selection.
- Budget estimation – is beeing used for alocation finance assets inside of budget of whole organization. Budget estimation is beeing made one or two year before the project execution.
- Final estimation – this estimation gives accurate project cost estimation. It's been made in project planning phase and it's been used in decision making process during purchase and equipement supply needed for project execution. This is the most accurate estimation mostly used for final project cost estimation.

When we talk about tools and techniques of budget estimation or about estimating budget strategies, we must mention three basic categories:

- down – top strategy– this strategy is based on work breakdown structure apropos basic assignments, to their schedule and individual budgets. The lowest lewels on hierarchy scale are consulted apropos people who works as operative personnel on project. Initialy, the calculations are resources based (material, human capital, equipement, services) which later are beeing converted in money units. The diversities in opinions between lower and upper levels of management are beeing solved with mutual discussion in order to achieve compromise. After opinion adjustment, individual budgets are being added together and the total project budget is being made. People who are closer to operative actions on a project have better picture and idea about nedeed resources on a project. If they are included in decisions making process, top management gets their attention for project tasks execution because those people find that job as theirs and are not enforced from another persons.
- top – down strategy – this strategy is based on top and middle management expirience, knowledge bases which refers on past, similar experiences. Those managers estimate total project costs and cost of every individual activity on a project. These estimations are being transfered on a lower management and they expect from them to continue with cost brake down on every specific tasks and jobs. At the end, the budget is being broken down until the smallest details. This kind of a procedure results dissapointment of lower levels of management who are going to demand bigger funds. This strategy advantage is that not one task from the project is not going to be supressed and the overdetails are going to be avoided.

- zero point strategy – this is a special way of estimation when higher management gives acceptable internal profitability rate, at which project office makes cost/benefit analasys for every potentional projects.For those who fulfil the conditions, project production is being recommended.

4.2. Budgeting

Budgeting include total project cost allocation. Costs are being allocated on every indiviual working packages and because of that it is necesary to have work breakdown structure (WBS). Furthermore, for time costs alocation, it is necesary to have a cost life cycle apropos activity time schedule. Purpose of budgeting is to alocate costs on a project and organization resources or in one of its part making the cost baseline. This cost baseline represent the basis for control and measurement of all performancies in project apropos deviation from baseline plan.

Most of business organizations have developed budgeting processes. Usually, it constain already prepared bases and tables where all important data about budget must be written. These data are basic data about project on which the budget refers, its duration, various informations about cost alocation inside organizational structure all the individual accounts and total project cost. Besides direct costs on individual activity, there must be planned all indirect costs. These costs are various costs for consulting services, equipement supply, business trip expences, depreciation costs , interests, varanty period costs, lease costs etc.

Furthermore, every delay of cost execution makes opportunity costs which can be calculated.

4.3. Costs control

According to Mr. V. Srića, control is like planning, organisation and leading are one of the basic manager functions.[23] Control contain of dana gathering, measure and analasys.[24] Dana are being collected via all kind of reports (project status, financial reports etc.) According to PMBOOK in cost control there are some processes:[25]

- whole process control;
- process fraim control;
- time limit control;
- costs control;
- quality control;
- risk control.

There are all line of missjudgement about project progress control in praxis.[26] In cases when it's been spent more, or even less, there's always a question is the project progress in advance or is it hang behind the schedule. In any case, plann changes significantly changes the cash flow.

5. Earned value analasys (EVA)

EVA (Earned Value Analasys) is a earned value analasys of project and it compares values of project progress with real costs on the project in that moment. As name EVA represent project tracking method, we often call it just EV method. This method enables firsth signal for problems on a project, with fastest way of getting informations how the project will end. It enables recognition of budget overrun, risks and mistakes which can have influence on successfull project execution. This method is based on tracking the individual activity execution and it is declared financialy. That means that work, material, tool, investment, services, machines and all others participants on project are evaluated financialy. Foundation for project tracking is financial management baseline (FMB) and it is based on work breakdown structure.

EV method is the most used method for project tracking. It is based on three basic variables, Fig. 2:

- project planned value in time P (BCWS – Budget Cost of Work Scheduled). Cost estimation is made in planning phase. Based on a whole project costs we can estimate total project costs B (BAC – Budget at Complete). In fact, estimated costs are the total project budget.
- actual project costs T (ACWP – Actual Cost of Work Performed), costs of performed work in time, wheather direct or indirect costs. This value depends on account policy but in this way costs tracking demands are more extensive.
- budget cost of work performed O (BCWP – Budget Cost of Work Performed), shows how much work has been done on project in time. Achieved value is obtained by summing achieved values in times.

For a long period of time, projects progress has been tracked with costs control. Real and planned costs were being taken in ratio and it was presumed that the costs are a synonym for achieved value on project. In case where the project has been tracked with costs method, situation in which the real costs T are bigger than planned costs P, could make us think that project have a good progress, but it can be totaly wrong. Therefore, it is clear that it is spent more as it was planned, but also there's been missing some essential informations such as:

- does project late or progressing faster than planned;
- does project really exceed the budget or planned values;
- do we spend money in a proper way.

[23] Srića V.: Upravljanje kreativnošću, Školska knjiga Zagreb, 1992, str. 70.

[24] Kerzner. H.: In search of excellence in Projekt Management – Successful Parctices in High Performance Organizations, John Wiley & Sons Inc., New York, 1997. str. 6.

[25] PMBOOK Guide: cit. pod 16, str. 36.

[26] M.A. Omazić, S. Baljkas: Projektni menadžment, Sinergija nakladništvo, 2005, str.263.

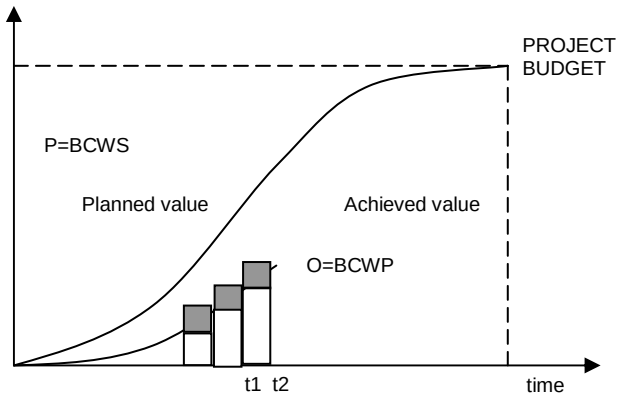

Fig. 2. Achieved and planned value ratio

Based on this consideration we conclude that the only possible way for realistic project progress tracking is to track work performed on a project taking in consideration all three values: planned, spent and achieved.

EV method has a couple of advantages:

- it is integral tool for project control which include work performed, time schedule and costs
- the results of EV method can be key information in "what if" analasys
- it gives very early alert sign in case of overbudgeting
- it gives real budget estimations at the and of the project
- EV coefficients can be unique indicator for project portfolio and programme management
- It increases very big amount of informations during project tracking in only two numbers apropos to coefficient achieved value of the project and project time schedule coefficient

EV method gives informations about the project status to all participants on the project: project manager, financial manager, client, project sponsor and all others participants in a project team.

Besides advantages, EV method has some dissadvantage which manifests in project costs increasing. These costs are caused by detailed budget planning threw work breakdown structure, analasys making and adition documentation tracking. This cost increasing around 0,5-4% of a project budget. Despite on project cost increasing, EV method is unavoidable tool of every project manager.

6. EVA in Microsoft MS Project 2007

The MS Project is the most common programm tool for project management. This tool supports EV method in this way: it ensure comparation of accepted project plan in planning phase and plan in execution phase with informations if the costs are accomplished through the accepted project plan[27].

MS Project support Earned Value Analysis for tasks and resources, and EVA for tasks which are supported through 3 tables in table Gannt chart diagram:

- The “Earned Value” table - overview of the work, cost, schedules, and estimates for tasks;
- The “Earned Value Cost Indicators” table - focus is on cost budgets, variances, and estimates;
- The “Earned Value Schedule Indicators” table - focus is on schedule budgets and variances.

The following image shows an example of a basic “Earned Value” table.

[27] Carl Chatfield, Timothy Johnson: Microsoft Office Project 2007 Step by step; Microsoft Press, 2007., str. 73

	Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	SV	CV	EAC	BAC	VAC
1	Obtain Land	$1,300.00	$1,083.33	$1,300.00	($216.67)	($216.67)	$1,560.00	$1,300.00	($260.00)
2	Excavate Land	$4,500.00	$4,500.00	$4,650.00	$0.00	($150.00)	$4,650.00	$4,500.00	($150.00)
3	Install basic utilities	$1,584.00	$1,584.00	$1,848.00	$0.00	($264.00)	$1,848.00	$1,584.00	($264.00)

Fig. 3. Earned Value table

Meaning and description of column in table 1:

Table 1. Column description in Earned Value table

Abbreviation	What it stands for	What it shows	Formula
BCWS	Budgeted Cost of Work Scheduled	This is what should be spent (baseline) on a task up to the status date.	N/A
BCWP	Budgeted Cost of Work Performed	The cost of work corresponding to % completed on the task, according to the original budget (baseline).	N/A
ACWP	Actual Cost of Work Performed	The sum of all costs for work performed on a task to date.	N/A
CV	Cost Variance	The difference between how much was budgeted for the task's performed work (BCWP), and how much the task actually costs (ACWP).	BCWP – ACWP
SV	Schedule Variance	The difference between how much was budgeted for the task's performed work (BCWP), and how much the task should cost according to budget (BCWS).	BCWP – BCWS
EAC	Estimate at Completion (also known as Forecast at Completion)	Project's estimate of how much the task will cost when it is done.	ACWP+(BAC-BCWP) CPI
BAC	Budgeted at Completion	The budgeted amount that the task will cost when it is done.	Derived from Baseline Cost field
VAC	Variance at completion	Difference between actual and baseline costs at completion (BAC-EAC).	BAC – EAC

EVA method in MS Project is shown on task 'Install Plumbing' in Tracking Gant View which is in figure 4, 50% finished.

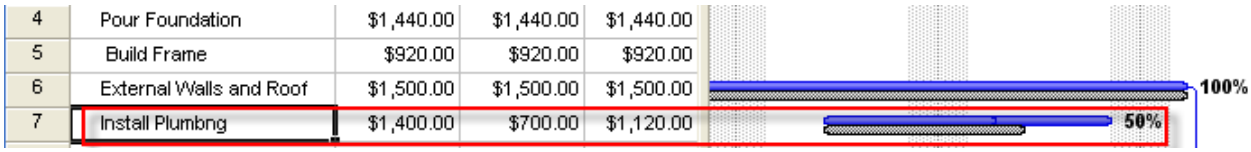

Fig. 4. Task 'Install Plumbing'

Also, we can see that the baseline duration (grey bar) is significantly shorter than the actual duration (blue bar). The information we have seen so far tells us that the task duration has exceeded the original baseline estimates, and still the task has not been completed.

EVA table for observed project is shown in figure 5.

	Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	SV	CV	EAC	BAC	VAC
1	Obtain Land	$1,300.00	$1,083.33	$1,300.00	($216.67)	($216.67)	$1,560.00	$1,300.00	($260.00)
2	Excavate Land	$4,500.00	$4,500.00	$4,650.00	$0.00	($150.00)	$4,650.00	$4,500.00	($150.00)
3	Install basic utilities	$1,584.00	$1,584.00	$1,848.00	$0.00	($264.00)	$1,848.00	$1,584.00	($264.00)
4	Pour Foundation	$1,440.00	$1,440.00	$1,440.00	$0.00	$0.00	$1,440.00	$1,440.00	$0.00
5	Build Frame	$920.00	$920.00	$920.00	$0.00	$0.00	$920.00	$920.00	$0.00
6	External Walls and Roof	$1,500.00	$1,500.00	$1,500.00	$0.00	$0.00	$1,500.00	$1,500.00	$0.00
7	Install Plumbng	$1,400.00	$700.00	$1,120.00	($700.00)	($420.00)	$2,240.00	$1,400.00	($840.00)
8	Install Electrical	$1,400.00	$404.43	$3,640.00	($995.58)	($3,235.58)	$12,600.61	$1,400.00	($11,200.61)

Fig. 5. EVA table with task 'Install Plumbing'

The first column contains BCWS values. From the table, we can see that the BCWS value for task 7 is $1400. This means that the planned cost for this task according to the baseline is $1400.

In the next column we can see the BCWP values. For task number 7 the value in the second column is $700. This means that the task, budgeted for $1400, has only been completed to the $700 dollar mark, based on the original budget. (This is because the task is only about 50% complete.)

In the ACWP column, we can see that the value is $1120. This means that actual cost of the work performed (about 50% complete) is $1120. This is because the task has run overdue, that is, it has taken longer to reach the 50% complete mark than it should have. Because it has taken longer, more work related costs have accumulated. Therefore, the actual cost of work performed is higher than the budgeted cost of work performed (BCWP).

In the CV field, we can see the difference (variance) between how much was budgeted for the current level of completion of the task and how much it actually has cost to get to the current level of completion for the task. Negative values are shown in parentheses, so the CV field value for task number 7, which is ($420), is a negative value. This means that the actual cost of the work done to the current completion level is higher than the budgeted cost of the work done to the current completion level. If the CV value was positive, it means that the actual cost of the work done is less than what was budgeted.

Additional indicators EVA method from table 1. can be einserted as new columns in Earned Value table in standard way of column adding in MS Project (Insert/new column).

7. Conclusion

Business organizations today are faced with increasing competition therefore should increase their competitiveness through better financial control, material and human resources, customer relations, delivery time shortening, better quality and simultaniously lower total business costs. It is considered that successfull management is one of most important factors for sucessfull business. Project management is one of the tools which has significant influence on duly business task execution. In this way, it improves competitiveness and success of the business organization. Every extend in time for project execution causes additional expences for a business organization and decreases it's competitiveness. Business organizations must have (in every moment) informations about project progress and costs related with work performed, quality and project risks. These informations are provided with EVA method for project costs tracking. Continuous access in real and current costs enables managers corrective actions in every moment so they can always bring the project back on tracks. However, there are no guaranties, but with project management use and with EVA costs tracking method business organizations have better chance to achieve their goals and market success.

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The EU's funding policy for culture: an opportunity or a constraint

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Abstract

The article's main aim is to introduce the reader with the dual system of the European Union's cultural policy from the aspect of the EU funding projects. The community cultural policy exists in the EU since the declaration of the Maastricht Treaty with the inauguration of Article 151. In some cases the EU runs cultural projects, with the idea of creating the so called European identity. However in most cases the national cultural policies have the right to form their own national identity and run national cultural financing systems. To demonstrate these examples we are going to analyse the EU's cultural policy from institutional aspect. The author assumes that the slow development of the EU cultural policy and the strategy of financing community cultural projects on the EU level help the communitarisation of the member sates in the field of culture.

Keywords: European Union, EU funding, Cultural Policy, Communitarisation.

1. Introduction

The establishment of the European Union was driven by economic reasons. The creation of the free market and its institutions are efficient bases for this purpose. At the birth of the united Europe the role of the national cultures was not determined and treated as an important factor in the Europeanization. The situation changed as the Union grew bigger and bigger, extended its boarders. Nowadays one of the main aims of the European Union is to create the so called European identity. What is European identity, which are the origins of it? To answer these questions we should look back into the history of Europe.

The Greeks and the Romans used the term Europe for the rest of the continent, not including them. Bar Barossa was one of the first historic persons who used the terminus technicus: "We are Europe.", emphasising that all the nations on the continent belong to the European identity. In the middle ages the networks of the various convents founded a new type of unity based on Christianity, which tradition nowadays still lives on. After the world wars Europe was divided into two by two contradictory ideologies on the economic and political level as well. 64 years after this big trauma there is the chance for Europe to get the most of the advantage which was in the past treated as a hold back. *Democracy, Christianity* and *Tolerance* are the common key points in creating the European identity [1]. Contrary to these historic backgrounds and the aim of the European Commission, The Lisbon Agenda still doesn't give a dominant role for culture, and cultural diversity. The European Cultural Parliament [2] put this problem into the focus of its case study (*Culture, the Heart of a Knowledge-based Economy*) on the role of culture in the Lisbon Agenda. Later we will explain why the European Union chooses the slow development of its cultural policy. We assume that although this strategy seems to be too slow and careful, in fact it gives the opportunity for the Member States to create the so called European identity with the help of an endogenous institutional change. As later we will show, the resource allocation (*funding*) is one of the fastest tools to back the communitarisation process.

As we can see the duality, which is characterizing the role of culture on the social, economic and political level of the European Union exists and appears in the cultural policy of the EU as well. We argue that this duality is an opportunity and not a constraint in the development of the Member States' cultural policy and the creation of European identity.

In the first section we are introducing the reader with the development of the European Union's cultural policy. The second chapter is focusing on the changes of the institutional levels on the informal and formal levels too. In the third part the European

Cultural projects will be introduced, which programs demonstrate the institutional change on the resource allocation level in the Williamsonian (2000) institutional model. In the final chapter we are going to prove the hypothesis that the step-by-step method of creating cultural projects financed by the EU is efficiently help the communitarisation process of the Member States with using the institutional economical method.

2. The role of institutions in the dual system of the European Union's cultural policy

In this section we are introducing the reader with the Williamsonian theory of the institutional levels and their transition. In the introduction of the article we already referred to the importance of the institutional system in the communitarisation process. In the article we base our concept on North's definition [3:97]: *"Institutions are the humanly devised constraints that structure political, economic and social interaction. They consist of both informal institutions (sanctions, taboos, customs, traditions and codes of conduct) and formal rules (constitutions, laws, property rights)"*. Institutions are important as they create order and reduce the uncertainty in exchange. The different kinds of institutions can be categorized as the following [4:597]:

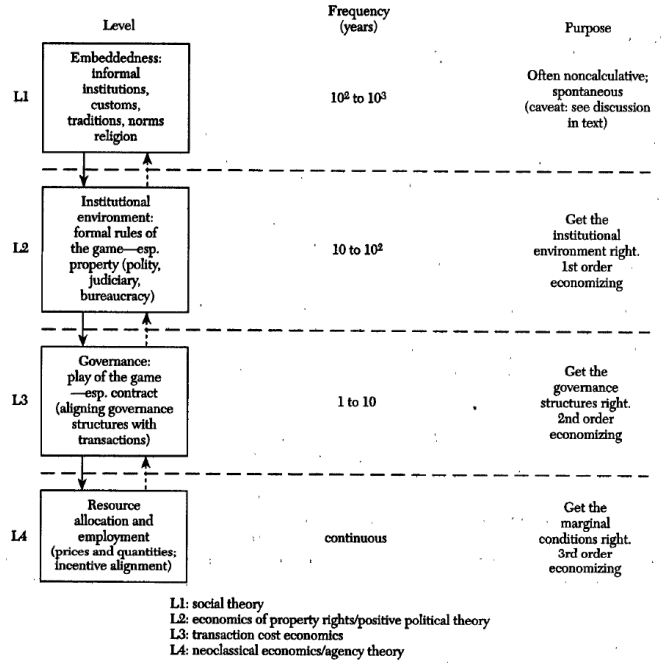

Fig. 1: Economics of Institutions

As we can see in *Figure 1.*, there are 4 levels of the institutions. To show the differences of these levels we give examples from the cultural sphere. On the first level the informal institutions form the core of the whole system. On this level the customs, beliefs and norms form the agents' actions. These institutions are embedded in the peoples' beliefs and action. In the cultural sphere all the customs, the national culture itself forms this level. As these beliefs and norms are highly embedded they change very slowly. These informal institutions and their slow institutional change have a determining role why the European Union chose the slow implementation of the common cultural policy and its main aim, the creation of the European identity.

The second level contains all the formal rules and statutes, which are the rules and laws of the European Union to create a cultural policy on the supranational level. The best example of this type of institution is Article 151, which will be introduced in the next chapter.

On the third level we can find all the rules and laws made by the national governments to make their own cultural policy on the national level.

Finally we speak about those rules, which control the resource allocation for cultural projects. This allocation can be found on the national and supranational level as well in the EU. In this article we focus on the latter. The fourth chapter of the article will show these EU funded projects and their role in the transformation of the Member States' cultural policies and the creation of European identity.

In this chapter our aim was to introduce the reader with the institutions, which have a determining role in the communitarisation of the EU Member States in the field of culture. First we defined the institutions then the different kinds of institutions were demonstrated with concrete examples taken from the cultural sector.

3. The communitarisation process in the European Union's cultural policy

In the previous chapter we already referred to those formal institutions, which form and help the communitarisation of the EU Member States. The laws and rules of the supranational level establish the framework, in which the national cultural policies could develop in an endogenous way. In this chapter we introduce the reader with Article 151 and its role in the communitarisation process.

The European Union pined down itself to establish the liberalisation of the economy in the Treaty of Maastricht. The Article 151 of the Treaty of Amsterdam contains some regulations accepted by the Member States and the community on culture. One of the main aims of the European Union that the cooperation among the Member States should be managed with using the common EU law under the institutional system of the EU in the communitarisation process. As I have already mentioned in the introductory chapter that the core policy of the EU was ratified in the Treaty of Rome. There are still some cases, such as the cultural policy, in which the communitarisation process is slower than in other areas, but the process exists and its slow movement is a motivating factor for the Member States. Article 151 sets the basic principals of the common EU cultural policy:

1. The Community shall contribute to the flowering of the cultures of the Member States, while respecting their national and regional diversity and at the same time bringing the common cultural heritage to the fore.
2. Action by the Community shall be aimed at encouraging cooperation between Member States and, if necessary, supporting and supplementing their action in the following areas:
   - improvement of the knowledge and dissemination of the culture and history of the European peoples;
   - conservation and safeguarding of cultural heritage of European significance;
   - non-commercial cultural exchanges;
   - artistic and literary creation, including in the audiovisual sector.

3. The Community and the Member States shall foster cooperation with third countries and the competent international organisations in the sphere of culture, in particular the Council of Europe.
4. The Community shall take cultural aspects into account in its action under other provisions of this Treaty, in particular in order to respect and to promote the diversity of its cultures.
5. In order to contribute to the achievement of the objectives referred to in this Article, the Council:
   - acting in accordance with the procedure referred to in Article 251 and after consulting the Committee of the Regions, shall adopt incentive measures, excluding any harmonisation of the laws and regulations of the Member States. The Council shall act unanimously throughout the procedure referred to in Article 251;
   - Acting unanimously on a proposal from the Commission, shall adopt recommendations.

The first regulations, which were inaugurated on the supranational level, cover the audio-visual sector, the book sector and the field of copyright. In the communitarisation process of these sectors two countries took the major role, the United Kingdom and France. Both of the countries tried to put its legal system based controlling system onto a supranational level. The United Kingdom emphasised the positive effects of the liberalisation and the “rule of law”, while the French focused on the protectionist way of controlling originated from the “civil law”. Both sides were supported from other Member States. These supporters are the same, who use either the liberal or the state-controlled model. This group decided to use the proactive strategy during the negotiations as they build their strategy on the cultural pessimist view or the so called aesthetic approach. They thought if they can win against the liberal way of controlling, their national culture will be safe for the future and they will have the possibility of getting into new markets [5]. Germany, as using the fiscal federal model with market-oriented aspect, supported the United Kingdom and its liberal way of harmonization in the fields of the audio-visual sector and the copyright, but had another opinion on the book sector, so in this question voted beside France. We can see that the communitarisation process in these three questions was not easy but the result is successful and long lasting for the future. Finally the European Commission, the Directorate General and the European Court of Justice accepted the liberal way of harmonization represented by the United Kingdom and other market-oiented countries.

This previously mentioned communitarisation process opened the possibility of creating a cultural program for 2007-2013 in much bigger consensus. The Programme is aimed at three specific objectives:

- promotion of the trans-national mobility of people working in the cultural sector;
- support for the trans-national circulation of cultural and artistic works and products;
- promotion of inter-cultural dialogue.

The agreement is emphasizing the importance of the harmonization on regional, national and supranational level. "*The Programme has been established to enhance the cultural area shared by Europeans, which is based on a common cultural heritage, through the development of cooperation activities among cultural operators from eligible countries, with a view to encouraging the emergence of European citizenship"*. The EU believe that the Commission has to intervene only when the Member States are not able to cope with the EU regulations and they need community help in the successful achievement. The advantage of this approach is that the Member States don't regard the European Union's aims as being compulsory, so they feel free in the method of implementing the common cultural policy in praise of the Treaty of Maastricht.

These facts raise the question whether this market oriented attitude is the best way to help communitarisation. Our answer is yes.

In the second chapter we showed that there is big difference among the speed of the institutional change of the 4 levels. The slowest change can be expected on the informal level. The culturally embedded norms, beliefs and customs are changing during 100-1000 years. This fact strengthens our assumption that the duality of the cultural policy is an opportunity and not a constraint. In 1957 when the establishment of the EU became reality, the founders didn't force the immediate creation of the common cultural policy. They did it as they realised that the fastest way of the communitarisation can be managed to do on the economic level and the slowest can be on the cultural level. They also believed that the top-down rule making doesn't support economic development as efficiently as bottom-up institutional change does (Shleifer et al. 2009), so the strategy to create a unified Europe not only economically but culturally too can be successful only with not interrupting the process of the endogenous institutional change.

Although the development of the common cultural policy is very slow, the fact that it exists is the most important fact and with the help of the well planned strategies on the formal institutional levels they shore up the change of the informal level too, which will result in the creation of the European identity in the peoples' beliefs.

In this chapter our aim was to demonstrate why the EU chose the slow development of the common cultural policy. We analysed the Article 151 from an institutional aspect and showed how the communitarisation process was carried out in the filed of the audio-visual, book sectors and copyright.

We argue that the resource allocation and the funding of common cultural projects are the fastest and most visible ways to help the communitarisation in the field of culture.

4. The European Union financed cultural programmes

In this chapter we briefly introduce those EU funded cultural projects which have important role in the formation of European identity.

The first community projects appeared in the middle of the 90s. These were the basics for the Cultural Programme 2000 and the recently running Cultural Programme 2007–2013. The Treaty of Maastricht established some other new programs like the Kaleidoscope, Ariane and Rafael, which programmes now integrated into Cultural Programme 2007–2013.

4.1 Kasleidoscope Programme (1996–1999)

The European Parliament and the Council of Ministers adopted the Kaléidoscope programme on 29 March 1996 for a period of 3 years (1996–1998), with a global budget of 26.5 million euro. It was extended in 1999 with a budget of 10.2 million euro. 518 projects were funded over these four years. The European City of Culture and the European Cultural Month were also supported, as well as the activities of the European Union Baroque Orchestra and the European Union Youth Orchestra. The programme, prepared for by way of pilot activities between 1990 and 1995, was intended to encourage artistic and cultural creation in Europe through cooperation. Its aim was to support projects with a European dimension, i.e. implemented in partnership with bodies in various Member States, in order to promote knowledge and the dissemination of the culture and cultural life of the European peoples, to contribute to professional training for artists and other cultural operators and to facilitate access to culture for all. The sectors covered by the programme were: the performing arts (*dance, theatre, music, opera, etc.*),

the plastic and visual arts (*painting, sculpture, architecture, carving*), the applied arts (*photography, design*) as well as projects involving multimedia as a form of artistic expression.[28]

4.2 Ariane Programme (1997–1999)

Ariane was a programme to support the books and reading sector, including translation. Adopted for two years (1997–1998) and allocated a budget of 7 million euro, it was extended for one year in 1999, with a budget of 4.1 million euro. Altogether, Ariane supported 767 translations of literature, plays and reference works, cooperation and professional training projects. The European Literary Prize and the European Translation Prize, known as the "Aristeion Prize", were also supported. The programme's aims were as follows:

- to encourage cooperation between the Member States in the field of books and reading and to complement their activities in this area, by contributing to the development of their cultures while respecting national and regional diversity;
- to increase the knowledge and dissemination of the literature and history of the European peoples, notably through support for the translation of literary works, plays and reference works, support for cooperation projects carried out in partnership and improvement of the skills of professionals in this field.[29]

We can see that not only general cultural projects, but specific ones were supported and ran by the European Union in the second half of the 90s.

4.3 Rafael Programme (1997–1999)

Raphael was a Community action programme in the field of heritage. Adopted for four years (1997–2000) with a budget of 30 million euro, it ended in 1999. Its aim was to encourage cooperation for the protection, conservation and enhancement of Europe's cultural heritage, raising citizens' awareness of cultural heritage and facilitating their access to it. The main sectors covered by the programme were movable and immovable heritage (*museums, collections, libraries and archives, including photographic, film and audio archives*), archaeological and undersea heritage, architectural heritage and cultural landscapes (*natural and cultural objects*).

It supported a total of almost 360 projects relating to the conservation and enhancement of heritage, involving more than 1 500 operators from all over Europe. The European heritage laboratories were also supported.[30]

4.4 Culture Programme (2007–2013)

The first main field of support of this project is for cultural actions. The first strand of the Culture programme encourages cultural organisations and operators to work together on cultural and artistic projects.

The first sub-category seeks to lay down *multi-annual, trans-national cultural links* by encouraging a minimum of six cultural operators from at least six eligible countries to cooperate and work across sectors to develop joint cultural activities over a period of three to five years. EU support for the actions is limited to half of the total eligible cost and is set at a maximum of Euro 500 000 a year. The funding is intended to help set up or extend the geographical reach of a project and make it sustainable beyond the funding period.

The second sub-category concerns *actions shared by at least three cultural operators*, working across sectors, from at least three eligible countries over a maximum period of two years. Actions that seek to develop long-term co-operation are especially targeted. EU support for the actions is limited to half of the total eligible cost and is set between Euro 50 000 and Euro 200 000. Literary translation projects are also supported under this sub-strand.

The third sub-category refers to high-profile actions of substantial scale and scope. They should make an impact on European citizens and help *to promote a sense of European identity*. These actions are supposed *to raise awareness and appreciation among citizens of the richness of Europe's cultural diversity and to contribute to intercultural dialogue.*

The European Capitals of Culture are also supported within this sub-strand. This has grown, over

[28] Source: http://ec.europa.eu/culture/archive/culture2000/historique/kaleidoscope_en.html [6]

[29] Source: http://ec.europa.eu/culture/archive/culture2000/historique/ariane_en.html [6]

[30] Source: http://ec.europa.eu/culture/archive/culture2000/historique/raphael_en.html [6]

two decades, into one of Europe's major cultural events.

A further aspect of this sub-strand is the award of prizes to celebrate artistic talent among young Europeans. Finally, this strand also supports our joint actions in the field of culture with the Council of Europe. The selection procedures as well as the potential beneficiaries of the EU support depend on the action in question.[31]

The Cultural Programme 2007–2013 focus not only the support of action but cultural bodies too. Cultural organisations, associations and institutions play a crucial role in promoting culture and advancing its interests. However, cultural bodies operating at a European level are still few and far between. This strand of the Culture programme supports cultural bodies which operate or seek to operate at a European level. Support is available for organisations engaged in providing representation at EU level, collecting or disseminating information to encourage trans-European cultural co-operation, networking at European level for cultural bodies, participating in cultural co-operation projects or acting as ambassadors for European culture. Festivals can also be funded. Festivals are an established feature of European cultural life and, increasingly, they offer opportunities for artists to perform outside their national borders offering European audiences the chance to experience the full range of Europe's cultural potential. One of the advantages of supporting activities of this type is that the work of these bodies can become a permanent feature of European cultural life. They produce publications, recordings, and other products, which give the possibility that their work can continue to circulate even after a specific event, tour or conference is over.[32]

In this framework there is a budget for dissemination and analysis activities and projects too. To maximise the benefits from the projects which receive EU funding, the results need to be communicated as widely as possible. It is also important to regularly assess whether the objectives are being met.

This is precisely the purpose of strand three (about 5% of the programme's budget). It supports analysis and dissemination activities in three ways.

Firstly, this strand supports studies to help improve understanding of European cultural co-operation and the conditions which help it to flourish. Subjects such as the mobility of cultural workers, the circulation of works of art and artistic and cultural products, and intercultural dialogue are of particular interest.

Secondly, the programme supports cultural contact points in each participating country. Their function is to promote the Culture programme locally and raise awareness of its activities and the opportunities it offers among potential participants and citizens at large in each participating countries. These culture points also exchange information with national cultural institutions and organisations, maintain contact with the participants in EU programmes and liaise with other sources of information.

Lastly, the collection and dissemination of information on the various EU-funded cultural activities and projects is intended to raise public awareness across the EU of this important field and to ensure that projects have a maximum impact. An internet tool will be developed aiming to facilitate the exchange of experience and good practice about cultural projects as well as projects under the other programmes in the field of DG Education and Culture.[33]

We can see that although the EU funding for cultural projects are not focusing on the interruption of the Member States cultural policies, they are able to form the common European Identity with their supranational aspect. This duality is positive and reaches its goals so the EU is efficiently help the communitarisation process of the Member States with using this institutional-based dual method.

5. Conclusions

In this article our aim was to show the dual system and its efficiency through the European Union's funding system in the field of culture. After the introductory first chapter in which we defined the puzzle and the main questions of the article, we introduced the role of institutions and analysed how they affect the communitarisation process in the European Union in the second chapter. In the third chapter the communitarisation process and its result the Article 151 were described. In the fourth chapter we collected and briefly introduced those cultural projects, which have a major role in the creation of the European identity.

We argue that the European Union implemented the best possible variation to help the

[31] Source: http://ec.europa.eu/culture/our-programmes-and-actions/doc421_en.htm [6]

[32] Source: http://ec.europa.eu/culture/our-programmes-and-actions/doc423_en.htm [6]

[33] Source: http://ec.europa.eu/culture/our-programmes-and-actions/doc505_en.htm [6]

communitarisation process and the creation of the European identity when chose a dual system in the field of culture. The slow development of the common cultural policy help the embedded national cultures and the people to make the feeling being European in an endogenous way without forcing them to reach the common aim with supranational constraints.

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Estimation of perspectives for organic food production in BiH, based on SWOT analysis

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Abstract

Organic production as part of environmental healthy, sustainable development includes manufacturing food products, but also some of plant and animal origin. According to the basic standards, organic production is based on the use of agroecology. It is legally regulated, it involves the production, storage and sale of products with their certification. International (EU, FAO / WHO) and national legislation were formed on the principles of basic standards of IFOAM. Today, organic production is developed in all countries of the world as part of sustainable development. From the moment when the EU regulation came into force in 1992, tens of thousands of farms turned into organic farms and that trend continues. At the same time there has been increasing interest in organic products by consumers. In BiH organic agricultural production is in its infancy, especially in livestock breeding.

The paper analyzes the prospects for increasing production of organic food in Bosnia and Herzegovina by using SWOT analysis methods, and identifying the internal and external factors that represent the strengths, weaknesses, opportunities and threats for organic agriculture. The conclusion is that in Bosnia and Herzegovina, the production of organic food has a good perspective, and in the future its production, domestic consumption and export could be increased, if the system devoted more attention on this issue by a long-term policy and took synchronized measures which would exploit the identified strengths and opportunities, and reduce or eliminate internal weaknesses and threats from the environment.

Keywords: Organic Food, Organic Agriculture, SWOT Analysis

1. Introduction

In the seventies of last century, organic agriculture has come to the forefront thanks to increasing awareness of environmental conservation. Numerous associations were created, which include manufacturers and others interested in environmental protection and ways of life in harmony with nature. Today, the methods of organic agriculture are being improved with the development of ecological types of machines and the development of control system for diseases, pests and weeds. This facilitates the production and increase economic efficiency [4]. The largest market of organic products are Europe (Germany, Italy, France and Great Britain), North America and Asia.

According to the definition given by FAO [7], organic agriculture means „comprehensive production management system that avoids use of synthetic fertilizers, pesticides and genetically modified organisms, reduces air, soil and water pollution, and optimizes health and productivity of mutually dependent communities of plants, animals and people."

Organic agriculture is more important from aspects of rural area development, which are reflected in the following:

- Economic role is represented by higher employment, as a way of preventing depopulation of the rural areas, and creating greater added value by combination of production resources in a new way,
- Ecological roles that is reflected in saving environment and biodiversity
- Socio-cultural role which is reflected in revitalization and preservation of traditional methods of production and habits of a given community.

Contrary to conventional production, based on monoculture plantations, a large number of animals in a small space, limited engagement of the workforce and application of synthetic products, organic production is based on the use of semi-intensive and extensive system of animal rearing, principles of culture shifting, natural and biodegradable plant protection chemicals and alternative medicine for animals, maximum use of grazing and respecting principles of animal welfare. This production is harmonized with the environment, and therefore can be called agroecological.

Organic agriculture involves restriction of use of artificial fertilizers, pesticides and veterinary drugs in order to reduce their concentration in agricultural products. Types and breeds of plants and animals that successfully submit this mode of production generally belong to the transitional and primitive races, whose performances were less than noble breeds used in conventional breeding systems. This results in reduction of yield, which reflects the profit.

Production in accordance with the standards of organic agriculture leads to a decrease in the level of environmental pollution, which is a benefit to society, provide greater employment of rural population, but also increases the cost of production. In order to achieve satisfactory economic profits despite increased costs and lower yields, however, it is necessary to produce in such a way to recognize the higher cost price and selling price. Reorientation from conventional to organic production is justified if the cost-benefit analysis shows that it is economically profitable for producers, taking into account the level of subsidies, which is usually higher for organic production, due to the efforts of society to achieve social objectives of sustainable use of natural resources.

Data from 2003 [3] indicate that the largest area in the system of organic agriculture are located in Australia (10.6 million ha), Europe (5.1 million ha) Latin America (4.7 million ha), North America (1.5 million ha), while these areas in Asia and Africa are significantly smaller (0.6 and 0.2 million ha). Viewed in relation to the total area, the largest share of land under organic production is in Europe, where the consumer interest is highest. That is confirmed by the fact [5] that 46% of world income from the sale of organic products is achieved in Europe.

Given the growing trend of interest in organic products, the relatively more prices in the market (eg. 16 % for milk, eggs even 166%)[6], as well as the lack of restrictions on exports, organic agriculture in the future could be a new alternative to the break through of Bosnia and Herzegovina agriculture in European and world market. Also, this production, from the previously ignored matter, can be turned into important factor of rural, regional and national development. Changing over to organic production increases the economic viability of producers through the production of higher value and environmental sustainability of natural resources through their rational use and gives manufacturers new oportunities in financial entrepreneurship.

2. Methods and materials used for research

Researchers took the task to determine the prospects that a part of agricultural production (plant and animal) in Bosnia and Herzegovina could be transformed from conventional to organic production method. As a research method, they choose SWOT analysis – process of identifying strenghts, weaknesses, opportunities and threats for production of organic food production in BiH. In fact, as sources for identifying internal and external factors were sorted into one of four common categories of the SWOT matrix, they used various sources of bibliographic, statistical and other data and own observations on the basis of personal knowledge of the situation in agriculture and rural areas of BiH, including activities which is implemented by Association of producers of organic products.

In the context of this analysis, all factors that apply to BiH as a country were treated as internal factors, ie. as the strengths and weaknesses of BiH in raising prospects for organic food production in the future, and factors in the domain of opportunities and threats coming from the environment, ie. outside BiH are treated as external factors.

3. Results and achievements

Organic agriculture involves food production of special quality, as a result of specific production in which the quality assurance system is the basis of all activities.

The project of organic production in RS, FBiH and Brcko District involves manufacturers whose production includes the area of plant production (growing corn, vegetables, herbs, collecting wild herbs and forest fruits), livestock and beekeeping.

A producer of honey (100 hives), a manufacturer of animal production (breeding turkeys), a production operator for collecting production (medicine herbs and forest fruits) and three manufacturers in plant production (growing corn, vegetables, flowers) passed the entire process of certification in the area of Brcko District [2][1] in 2007. During 2008, 24 manufacturers were introduced in the organic certification process. They were classified in following groups: plant production - 12, cattle – four, beekeeping – seven, collecting production - one manufacturer. Results of monitoring of their production showed if they could respond to the level of compliance with organic standards, especially in segments that require passing the conversion period in future.

Results of research using SWOT analysis are summarized in the following table.

Strenghts	**Weaknesses**.
– natural potentials (unpolluted land, water, air); – existence of indigenous breeds; – existence of relatively cheap workforce in rural areas; – legislation that covers this area is adopted (Law on organic food production and other acts); – subsidizing the presence of organic production; – increase of domestic consumption of organic food; – increase of awareness of the need to preserve traditional ways of production, genetic resources and typical regional products; – support to the participation of local producers of organic food in international trade fairs; – a limited number of local licensed houses for organic production certification.	– the absence of systematic monitoring of status of land, water and air; – inadequate system controls the presence of residues of harmful substances in food; – depopulation of rural space; – traditional organization of agricultural production; – insufficient level of knowledge about the demands of manufacturers of organic production; – Insufficient financial compensation for organic agricultural production; – lack habits of domestic consumers to buy organic food; – low living standard of the population; – unsafe placement of organic food – low bids (quantity) of organic products of the project; – high costs of certification
Oportunities	**Threats**
– increased interest of consumers in Europe and the world for organic products; – media climate that promotes greater food consumption of organic origin; – availability of dedicated funds from the grants for this type of production; – interest in organic food import originating from Bosnia and Herzegovina; – transfer of foreign experiences in organic production to BiH; – side investment in organic agriculture; – participation in international projects in this field; – participation in international fairs, organic food; – EU accession and equal status of the domestic producers of organic food.	– lagging for organic production in Europe and the world; – high prices of organic products originating in comparison to conventional; – higher production costs, – lower yields, – unclear and unequal marking standards of organic products, which can mislead the buyer; – importing cheaper products from neighboring countries (organic, and others); – negative natural and climatic influences (global warming, drought, etc.) – genetically modified organisms and increase of their use; – increase in environmental pollution; – neglecting certificates from BiH.

Analysis shows that BiH has a certain power and chances to increase food production and consumption of organic origin, but the realization of this objective at the same time are limited and endangered by certain identified internal weaknesses and external threats. How could the strength and opportunities be used in the future, and the weaknesses and threats neutralized?

In the future, we need to improve and strengthen the monitoring of natural resources, based on process of organic agricultural production certification. To make consumers know the composition and quality of food that they buy at the market, we should improve the system of marking agricultural and food products and their quality control. The difference between food produced in conventional and organic conditions should be clearly pointed out. A high percentage of rural population and high unemployment should be used for recruitment of manpower that is needed to increase the area in function of organic production.

It won't be possible to stop the trend of migration from village and town, but it can be slowed down if rural population is motivated and stimulated to deal with organic farming. Improvement of inspection, advisory and other services can ensure implementation of existing legislation for organic agriculture (the Republic of Srpska has Law of organic production since 2004, but Federation of BaH still doesn't have), which should be constantly monitored and updated as needed, following the examples from Europe. Lack of information and ignorance of the farmers about organic production can be eliminated by organizing specialized training and monitoring and helping the manufacturer through the advisory service, whose staff also needs to pass the appropriate training.

Existing subsidies for engaging in organic agricultural production should be increased to compensate higher costs and lower yields of production. Higher prices of organic products will remain a reality in the future, which in part limits the consumption of these products, but only increased incentives can artificially reduce and make them more accessible to consumers. Promotional campaigns are necessary to inform consumers about the benefits of domestic consumption of organic food origin and appeal to them to consume health secure food. Organizing and financing performance of domestic producers in international trade fairs can help in finding an importer of organic food produced in BiH and contribute to „merging" of interested partners for joint ventures, which would increase exports and thus overall sales. Institutional and financial support for the accreditation of domestic certificational house is a prerequisite for the facilitation of obtaining certificates of origin and quality of organic food.

By subsidizing the cost of these houses food vendors would be relieved of these, so high costs. In the future, increase of the living standard of the population is expected, which will increase the market segment of consumers of organic food.

All of the identified external opportunities related to the characteristic tendencies in the world market are in favor of increasing the food consumption of organic origin and Bosnia and Herzegovina should use them to the greater extent in the future. We do not eliminate some of the threats to organic food production in BiH, such as climate change, generally lower yields and production costs of BiH. However, the impact of some threats which appear in BH environment in domestic production of organic food can reduced by licensing (international recognition) of domestic certificational house, taking a clear attitude towards the production and consumption of GMOs, settlement of foreign trade regime in exchange basis, harmonization of standards related to food production and consumption of organic origin and the like.

4. Conclusions

Production and consumption of organic food in the world is increasing, while in BiH it is still poorly represented, yet also recorded an increasing trend. Food production of organic origin is characterised by lower yields, higher costs and sales prices, and requires a special group of customers with more money and existance of consumers who are aware of its advantages. In BiH, number of such consumers is still low, so that the increase in organic food production in BiH in the short to medium term is mainly associated with the possibility of export.

Based on the SWOT analysis, the conclusion is that, the production of organic food in Bosnia and Herzegovina has a good perspective that could be enhanced in the future by stimulating its production, domestic consumption and export if a long-term policy on this issue devotes more attention and a number of synchronized measures is taken in order to use the identified strengths and opportunities, and reduce or eliminate internal weaknesses and threats from the environment.

If many manufacturers practice organic agriculture, they would be able to success with smaller productive capacities, because they could manufacture products of greater value, which would ensure greater profits, provided that issues of specific production technology,

certification the project and its quality and organized access to domestic and foreign markets are solved.

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Lisabon Strategy Strategic framework for development of Croatia

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Abstract

The Lisbon Strategy was brought to reduce the gap between European Union on one side and United States of America and rapidly growing Asian countries on the other side. The Dutch Prime Minister Wim Kok created a report in 2004 in which he presented the implementation of the Strategy and it was called Koks report. The results of Koks report showed that the progress is uneven because of the glutted plan, bad coordination and contradictory priorities. Therefore, the conclusion was to get the focus on 5 main priorities: knowledge based society, unique market, mending the entrepreneurial climate, building flexible labor market, encouraging social cohesion and ecologically sustainable future. In the Lisbon Strategy mainframe, Croatia got close to reaching its goals, but it will have to carry out many reforms in order to achieve its own competitive advantage and find a place in the fast-growing global world.

Keywords: The Lisbon strategy, Koks report, globalization, competitive advantage

1. Introduction

Lisbon strategy was brought as a reaction of European Union to recognized lagging of the Union behind the United States and developing Asian countries. It was brought by European Council in Lisbon in 2000 and the main goal was to make the European Union the most dynamic and the most competitive economy in the world, based on knowledge, capable to maintain sustainable growth, offer more and better job positions and be the place with safe environment and social cohesion.

In order to reduce the gap between EU and its competitors, in 2002 in Barcelona, the European Council has decided to encourage research and innovative ideas by increasing the funds for Research and Development. The goal was that those funds reach the 3% of GDP by 2010, of which, the 2/3 of investment should come from private sector.

In March 2004, the European Council has established a group at high level that was supposed to analyze the implementation of Lisbon strategy. In November 2004, with Dutch ex Prime Minister Wim Kok in the chair, the group has presented its report on implementation of the strategy (so called Koks report). The report consists of Strategy analysis that almost everybody agrees with and a proposal on how to carry out the goals, but the opinions are divided on this issue. Based on Koks report as well as the opinion of member countries and the report on Strategy of sustained development, the Commission was supposed to make a medium-term analysis by January 2005 on Strategy implementation with some advice which would be reviewed by the European Council at the spring meeting in March 2005.

2. Development of Lisbon strategy

2.1 Koks report

Koks report gives a gloomy picture of progress in the past four years. Disappointing results came as a consequence of overfilled plan, weak coordination and priorities that are contradictory due to the lack of political guidance in member countries. The Strategy also includes territories that are not in EU authority. Therefore, the voluntary cooperation and so called "open coordination method", which implies the

application of other member countries' experience and their adjustment to specific conditions in every member county, is necessary for success.

The improvement in Lisbon Strategy implementation is based on 14 indicators:

1. employee work productivity
2. rate of employment
3. rate of women employment
4. rate of employment (for senior employees)
5. involvement in education of age group 20-24 years
6. part of GDP set aside for Research and Development
7. business investment
8. parallel price growth
9. risk of poverty
10. rate of long-term unemployment
11. regional rate dispersion
12. greenhouse gas emission
13. energetic intensity
14. transportation volume

The indicators present uneven progress. Therefore, Koks report says that concrete and large reforms should be carried out in order to prevent Lisbon from becoming a synonym for missed goals and unfulfilled promises. However, positive examples are also mentioned, especially in employment: rate of employment has increased from 62,5% in 1999 to 64,3% in 2003, employing women has also risen, in some member countries employing senior citizens has reached a target number of 41,7%, etc. Despite of that, creating new working places has stopped in 2001 so it is going to be difficult to reach the employment of 70% by year 2010.

Although, sharp departure from planned implementation has been identified, Koks report is dedicated to keep already established ambitious goals and deadlines.

Postponing the Strategy implementation could bring Europe further behind the USA and Asian economies, where the growth in economy is much faster than in EU. Therefore propositions are being constantly made to achieve well coordinated, focused and fast action in all member countries (including the new ones) as well as in the whole Community. Regarding the Koks report, attention should be focused on five priorities which are often recommended.

2.2 Society of knowledge

The Lisbon strategy predicts establishment of information society, larger investment in research (3% of GDP) and development of human capital via education. To achieve those goals, some actions should be taken, and they are:

- Pulling in and keeping the best researchers. This should have been accomplished by carrying out the action plan and by removing the obstacles for scientists and their families to move freely inside the Union borders (the deadline was Spring 2006)
- Research and Development should become number one priority
- Carrying out Europe's 2005 action plan and increasing accessibility of cutting-edge Information Technology
- Promoting innovation. Community Patent should have been discussed before European Council's spring meeting in 2005.

2.3 Unique market

The main goal of the Strategy is to efficiently apply EU regulations to national level, to remove obstacles which prevent market of services (including financial services) to spread around EU, to establish unique market in "network" industries (liberalization of electric energy market, gas market, postal services market, railroad and air transport) and to insure unambiguous application of government assistance regulations. In order to succeed in this, recommended measures are the following:

- For faster application of legislation: the Commission should create complete list of regulations that are jet to be included in national legislation (the list should make sure that the weakest country is the first on the list)
- Accepting regulations on the level of the Community which remove the obstacles for free movement of service market by the end of 2005
- Accepting all the other regulations needed for carrying out the Action plan for financial services

2.4 Mending entrepreneurial climate

Lisbon predicts creating environment that encourages investment, innovation and entrepreneurship with easier approach to financial institutions, clearer bankruptcy rules and easier

company founding as well as cutting operating costs. The measurements should include:

- Better legislation, which is accomplished by continuously carrying out studies of influence on future regulations (for competitiveness and sustain growth)
- Member countries should be able to drastically reduce the time, effort and expenses needed to found a company

2.5 Building flexible labor market and enforcing social cohesion

The necessary actions for achieving Lisbon goals of increasing rate of employment, labor market flexibility, fighting against poverty and accepting European social model, are:

- carrying out European working group's recommendations for employment
- proposing national long-life learning strategies by the end of 2005
- working out a comprehensive strategy of actively growing old (which should include radical political and cultural change from early retirement)

2.6 Ecologically sustainable future

In order to achieve sustainable growth together with preserved environment, the Lisbon strategy suggests ratification and implementation of Kyoto Protocol on how to lay taxes on energy and introduce responsibility of environmental damage. For implementation it is necessary to:

- encourage development of ecological innovation and national plans on how to carry out EU's Environmental Technology Action Plan (ETAP) so the goal for preserving the environment wouldn't be opposite of competitiveness increase goal
- develop national action plans on "green" public supplying

2.7 Reactions on Koks report

Reactions on Koks report show that the Strategy is not implemented properly and that the smaller number of goals should be set. Opinions are divided on the issue whether the growth, employment and productivity are precondition for social cohesion and sustained development or to be more exact whether the recommended measures assure balance of economic, social and environmental goals of the Strategy. According to the Euro chambers and UEAPME, economic growth should be the most important because it is considered to be the precondition for keeping and improving social and ecological standards. However, on the other side, the EU unions think that the Report is too much focused on the two problems of the Strategy – growth and employment, and that social cohesion and sustained development should be the most important.

It looks like the conclusion of Koks report – in order for Lisbon Strategy to take effect, strong political will in all levels is necessary – means that the Strategy will not be able to be implemented successfully and the same conclusion was made by European Parliament's different political groups. According to the socialists, proposed measures are not clear enough for the goals to be exceeded and the European national party members think that the Report is "declaration of bankruptcy".

3. Croatian position in comparison to Lisbon goals

3.1 Lisbon strategy and the Copenhagen criteria

Candidate member country should fulfill all the political, economic, legal and administrative criteria in order to become a member. Lisbon strategy is focused on economic and social questions while the political aspects are less important. In the sense of economic conditions, Croatia can be considered a market economy. The date Croatia has officially set to be the date of the integration – the year 2009, matched the time frame in which the Lisbon goals could be reached. That means that in order for Croatia to fulfill Copenhagen economic criteria, it should be able to confront the competitive pressure and the forces of market in the worlds most competitive economy and this would make Croatia's adjustments even harder than they are now.

When we talk about the ability to take over the membership obligations, the European Commission report form 2005 says that Croatia will have to put a substantial effort in order to reach EU requirements. Talking about EU legal acquirement, in the preliminary period Croatia will have to adjust more regulations than the other member countries had to do. The 2007 Report on progress says that the preliminary talks with Croatia are going well and that the final phase is getting close.

Experience from the last expansion has showed that the regulation adjustment is much stricter with the candidate countries than member countries. For the

candidate member countries the pressure of negotiations is much stronger reform implementation instrument than the supervision of other member countries is. Furthermore, it should be mentioned that in member countries there is no gradual carrying out of the reforms in order to adopt the new legal acquirements. They are adopted in order they come. From the candidate countries perspective the important thing is gradualness, especially when the time frame for the membership is unknown and it can depend on internal EU development much more than on process of coordination.

Coordination of the politics means that the request for taking over the membership obligations considers accepting the goals of EU policy. In negotiations, it is said explicitly that Croatia will have to, among other things, accept the content, principles and political goals of the founding agreements which the Union is based upon. It will also have to accept the legal acts that are not legally obligatory such as guidelines, for example. The Lisbon goals are defined with the Founding agreements: one of these goals is promoting sustainable development, high level of employment and social protection and high level of competitiveness economic development convergence. The contract also defines what should be done on the EU level and which decisions should be made on national levels. Regarding employment, the contracts define advisory role of the Board of employment and responsibility for actions on national levels of member countries. Lisbon goals don't imply new criteria for EU membership, but they imply EU policy towards candidate members which will hold onto Lisbon activities as a priority inside European preliminary partnership. The Lisbon goals will take effect on EU region policies and the countries are also encouraged to put those goals into their reforms or action plans.

The Strategy should not be observed apart from general EU policies. It is firstly referred to as politic coordination in order to establish balanced sustainable development. This means that candidate countries should be gradually taking in the goals of Lisbon Strategy and developing policy combination which would enable keeping up with the Union trying to catch the step of USA.

3.2 Croatia's starting position

According to available statistics, it seems that Croatia can be compared to new member countries. GDP per citizen in Croatia is comparable to the one in Lithuania, Latvia and Poland, and it is bigger than the one in Bulgaria and Romania. Energetic intensity (comparable to Polish and Hungarian intensity) and greenhouse gas emission (which is closer to Kyoto goals than it is in new member countries). This is connected to industry reconstruction and it could also be connected to social transfers and future increase of public debt as well as to influence on employment.

3.3 Lisbon goals

Croatia doesn't have a whole action program for implementing Lisbon strategic goals, which could be compared with the documents prepared by other countries during their integration process, figured out yet. However, some goals and activities connected to Strategy implementation are included in some other documents made after year 2000. For example, the government has made around 20 strategic documents under the name "Croatia in 21st century", and some of them are pretty much in collision with the Lisbon goals. This refers especially to science and research strategy, which deals with questions of society based on knowledge, innovation, and new technologies. In wider aspect, the Lisbon goals are a part of 55 recommendations of National Council for competitiveness in Croatia, including education, innovation and technological development, building small and medium businesses, entrepreneurship etc.

In 2006 Strategic frame for development was presented in Croatia as a government key document for the next period. In that document, the biggest attention is given to knowledge based society and it is a guideline for total development in the next seven years. Main goals are increasing the level of competitiveness together with social cohesion and care. The growth of human resources is identified as the main source of Croatian competitiveness. This shows that the document follows the key Lisbon goals although it doesn't cover all of the redefined Lisbon Strategy areas. Furthermore, due to the fact that this is a strategic and not implemental document, it is going to be necessary to develop action plans and other implemental instruments with clear obligations, deadlines, tracking and reporting system in order to get Croatia closer to Lisbon goals during its integration process. Entering the preliminary negotiations, Croatia has agreed to accept EU's legal acquirements and synchronize policies respecting the principles and strategic documents of the Union. The focus is on synchronizing with so called soft legislature which implies the need to horizontally accept the instruments of Lisbon Strategy in order to implement its measurements functionally.

By accepting the legal acquirements, Croatia needs to declare that it accepts the Lisbon goals in many announcements and Commission's action plans. Above all, it is necessary to develop national action plan for putting the 3% of GDP aside on the account of research and development, together with coordinated measures and precisely defined goals, actions and supporting mechanisms. The goal of that kind of document is defining Croatia's priorities in that area by having in mind that there are some specific situations, individual needs and possibilities in the country. The plan should be based on a model of European action plan on setting aside the 3% of GDP for research and development by the end of 2010, out of which three quarters should come from private sector, but that doesn't mean that Croatia must follow the same goals. The target of 3% is not very real for Croatia – at the moment investment in R&D is 1,14% of GDP, while the average percentage in EU is 1,9%. It should be mentioned that Croatia has a program for innovative technological development called HITRA, which is a government program for establishing efficient national system of innovation by joining science and industry, refreshing industrial R&D and encouraging commercial research results.

Open method of coordination as an instrument for Europe's soft legislature implementation should be introduced into consulting procedures during policy development in Croatia. System for measures and indicators is important for Croatia because it allows comparison with member countries and other candidate countries and it also allows analyzing our own position in different areas. Because of that it is necessary to constantly develop the system for finding and tracking quality and quantity indicators on the as bigger areas as possible. That system in perspective should be connected with the EU tracking system (EUROSTAT) and should allow comparison of Croatia and other member and candidate countries on the equal grounds.

In 2006 Croatia was listed in the World's competitiveness yearbook for the first time, and since 2003 it was a part of Global competitiveness report. According to IMD report, main competitive challenges that also await on Croatia in 2006 are the new government role, promoting innovation and technological growth, stronger connection between institutions for R&D and businesses, increasing public and private investment in R&D and education, and speeding up the process of privatization and public companies reconstruction. The challenges match the Lisbon goals and also the priorities emphasized in government document The Strategic frame for development 2007-2013.

Another example is the field of education and improvement. European Commission's report on progress in implementation of the Lisbon goals in education shows that in some areas Croatia is better than the older member countries, in the sense of finishing high school in time. One of the Lisbon goals is to get 80% of population to finish high school, and Croatia already has 90%.

3.4 World 2008 Economy Forum's report

National Council for competitiveness has on 27th October 2008 published a report of World Economy Forum (WEF) on Lisbon Strategy implementation, which says that Croatia has among 16 other non-member countries taken the first place and according to total rank it lies side to side with Greece and Italy and before Romania, Poland and Bulgaria.

Among EU members, the first three places went to Scandinavian countries – Sweden, Denmark and Finland. Sweden, which was in the third place according to the last year's biennial report, now it is the first one on the list as the most competitive county with 5,71 points. Right behind it there are Denmark in the second place with 5,64 points and Finland with the same number of points. Netherlands is forth, on the same place it had in 2006, with 5,44 points.

It is obvious that Croatia, among 16 other countries, showed the best results in the fields of built information society (1st), network industry (1st), financial services (2nd), sustainable development (2nd) and promotion of innovation and research (3rd). The good position among non-members is also a relatively good position among the EU27 because Croatia is in the same group with Romania, Bulgaria, Poland and Italy.

The areas in which Croatia is not so highly ranked compared to other non-members are social involvement (7th) and community encouraging entrepreneurship development (11th). However these areas measure the biggest progress compared to 2006 results.

The analysis shows that in most areas of Strategy implementation Croatia is better than some current members of EU. In the last two years Croatia has made significant efforts in education and rising social involvement as well as encouraging entrepreneurship via removing administrative obstacles. These are, among others, still the areas where bigger changes can be made and along with that progress can be made in Lisbon Strategy implementation.

World Economy Forum publishes one report on Strategy application every two years since 2002. Lisbon Strategy starts with measures necessary for

structural changes so the EU can become the world's most competitive economy based on knowledge by the end of 2010. The revised Strategy from 2005 put an accent on growth stimulation and employment. Basic priorities were reaching the investment in amount of 3% of GDP in R&D and opening six million working places by 2010. By accomplishing that, the goal of having 70% employed people in EU would be assured (average value for EU in 2007 is 65,4)

4. Conclusion

Lisbon Strategy starts with measures necessary for structural changes so the EU can become the world's most competitive economy based on knowledge by the end of 2010. The revised Strategy from 2005 put an accent on growth stimulation and employment. Basic priorities were reaching the investment in amount of 3% of GDP in R&D and opening six million working places by 2010. By accomplishing that, the goal of having 70% employed people in EU would be assured (average value for EU in 2007 is 65,4). World Economy Forum publishes one report on Strategy application every two years since 2002.

Observing Croatian position, it is obvious that it is getting close to achieving the Lisbon goals, but the application does not cover all the areas. The most important thing is to understand the instruments of the implementation and then define priorities in coordination with specific needs and possibilities. Croatia needs to recognize and realize the necessary changes and by doing that establish two levels of accomplishment. First one is reducing current deficit, or in other words, facing present trends with accomplishments in EU environment and recognizing the divergence of today's economic policy compared to Lisbon agenda's focus of attention. Second one is, reaching the goals of Lisbon agenda as an easier way of satisfying Copenhagen criteria, which represent the formal and core demand of European Union for becoming its member. In that way, Croatia takes advice from other countries' process of transition. On one side, there are extremely successful Czech Republic, Slovenia and Estonia with Hungary and Slovakia right behind them, while on the other side there are Bulgaria and Romania where integration process is still active.

The date of entering EU is still not clearly defined. Croatia has a lot of chapters which need closure. It stands before a lot of changes and adjustments. Current crisis has disturbed the plans so the expected earmarking of 3% GDP is going to be hard to achieve by the end of 2010. But implementing complete reforms is absolutely unavoidable, not only because of joining EU, but because of raising countries' own competitive capabilities and finding the place in rapidly growing global world.

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