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Reflections on the company's first anniversary: Interview with CEO Stefan Sommer, ASK Chemicals GmbH, Hilden



At the end of 2010, ASK Chemicals, the new global provider for the foundry industry, was created from a joint venture between the foundry divisions of Süd-Chemie AG and Ashland, Inc. ASK Chemicals GmbH, headquartered in Germany, is now represented in 24 countries – in the traditional markets of Europe and Eastern Europe, in the USA, and in the booming markets of Asia and South America. More than 1,800 people work at 29 locations. After one year of doing business on the market, CEO Stefan Sommer reflects on the company's accomplishments to date and the coming challenges for the years ahead.

ASK Chemicals recently celebrated its first anniversary. How would you summarize 2011?

The merger of the foundry activities of Süd-Chemie AG and Ashland, Inc. has created one of the foremost and largest suppliers of consumables such as chemicals and materials to the foundry industry. We have successfully positioned the new ASK Chemicals on the market. The ASK Chemicals Group increased its revenues by 18%, from around EUR 500 million in 2010 to nearly EUR 600 million in 2011. We owe this progress not only to the positive economic development in 2011 but also to our overall portfolio, which our customers value and which will continue to provide further growth potential in future. Also, the outstanding foundry expertise of our employees helps ensure that we can further reinforce our core competence around the globe: developing and implementing tailored solutions for our customers.

When creating a new company from a number of single companies, as in the case of ASK Chemicals, integrating these companies is a main priority. How would you assess the current status of this process?

Of course it's always a challenge to integrate many small and heterogeneous companies into a larger, global one. This ranges from different systems and overlapping products and product names to different levels of corporate identity development. We are working tirelessly to integrate our electronic systems as well, though we are some way from completion. We have made more progress with our portfolios. Positioning the new ASK Chemicals corporate brand has certainly been a success and our customers approve! We put our slogan "We advance your casting" into practice. We are judged by this standard. Within the company, we have actively established our own ASK Chemicals culture — certainly assisted by the major GIFA trade show in 2011 — that is marked by pride in our performance and our past achievements.

It's all part of a greater whole with excellent prospects for the future.

Which countries and markets will you focus on in the next three years?

We are globally active, with 29 subsidiaries in 24 countries and 15 production sites. Thanks to this global presence, we can now offer tailored products and premium service in all key markets.

Europe, North America and Northeast Asia are the markets for developing pioneering technologies, and they will remain such for the time being. As an innovative company, of course we feel right at home in these technologically sophisticated markets.

Thanks to the global focus of ASK Chemicals and close cooperation among our ASK experts, we have created a solid foundation for know-how transfer. Such sophisticated developments from leading technology markets can be customized as needed to meet local requirements in the emerging markets for our customers in China, Brazil, India and Russia. Therefore, ASK customers around the globe benefit from our high quality standards worldwide. In the next three years we will reinforce our commitment especially to those markets, where we currently have less representation. Products to enhance the profitability and productivity of the foundries in these countries are more and more in demand. At the same time, we recognize the need to offer environmentally friendly solutions for foundries in especially also the emerging markets, in order to counteract the growing pollution caused by the rapid increase in industrialization.

ASK Chemicals has professed its commitment to the concept of sustainability. What is ASK doing to improve sustainability in foundries?

Sustainability is a holistic, three-pronged concept consisting of ecological, financial and social sustainability.

Our INOTEC inorganic binder system is known for its ability to nearly entirely eliminate combustion products during casting, for instance. So there are hardly any emissions that need to be suctioned out and burned. The absence of emissions benefits our customers' employees in particular as the work environment in the foundry is much improved. We are working at full speed to develop additional systems for a broader application base.

However, our approach to develop sustainable products doesn't end with inorganic binder systems. Our low-emissions cold box systems – the standard and backbone of series production in foundries – are being continually upgraded and improved. Additionally, our water-based coatings, release agents and inorganic feeder technologies make a key contribution to greater sustainability for the foundry industry.

We are very dedicated to the sustainable development of the foundry industry. This is why ASK Chemicals provides special resources in order to advance the development of sustainable solutions at its research centers.

What are your expectations for the years ahead?

We have plenty of topics for the future. Firstly, securing and expanding our good position in many European, American and northern Asian markets is a priority. We are driven greatly by the rising expectations of our customers for innovative and environmentally friendly products and solutions. In addition, the expansion of our market positions in the other Asian and eastern European regions will certainly be a focal point. Growth and technological developments in countries such as China, India and Russia will provide great potential for our products and services for many years to come.

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ABSTRACT

MATERIALS SCIENCE

EFFECT OF Sb ON THE TEXTURE DEVELOPMENT OF HOT ROLLED SLAB IN Hi-B SILICON STEEL USING LOW SLAB REHEAT TEMPERATURE

Fan LIFENG, Wang HAIJUN, Xiang LI, Qiu SHENGTAO, Tang GUANGBO

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Key words: Sb, EBSD, Goss texture, Hi-B

Abstract: The texture of hot rolled slab of Hi-B grain silicon steel which was rolled by Thin Slab Casting and Rolling process (TSCR) in the laboratory with different Sb contents has been investigated by Electron Back-Scattered Diffraction (EBSD). In this study, Goss texture is the main texture style in both surface layer and subsurface layer. The intensity of the Goss texture firstly increases and then decreases as the Sb increased, the most suitable addition of Sb is 0.04% in this study. After high temperature annealing, the specimens complete secondary recrystallization. When Sb content is 0.04%, the magnetic property is the best in this research, B_8 is 1.891T.

A NEW METHOD TO IMPROVE THE DENSITY OF FAVORABLE TEXTURES IN NON-ORIENTED ELECTRICAL STEELS

Haijun WANG, Xi HUANG, Li XIANG, Shengtao QIU, Jianjun WANG

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Key words: Non-oriented electrical steel; Microstructure; Texture; Copper;

Abstract: Favorable texture can improve the magnetic properties of non-oriented electrical steels. In this paper, new alloy elements and different annealing process are used to improve the density of favorable texture in non-oriented electrical steel. The microstructure and microtexture evolution along the final annealed samples was investigated with EBSD. It is found that inhomogeneous microstructure is produced in samples because of copper and phosphorus segregation as well as temperature different. As a result of copper segregate at crystal face of $\{100\}$ and the different of diffusion coefficient between copper and phosphorus. The copper hinder desorption of phosphorus, so as to the copper and phosphorus segregate at the crystal face of $\{100\}$. It hindered the growth grains of $\{100\}$ $\langle 010 \rangle$ in edge. But in central, the content of elements segregation on grain boundaries is more than edge. It is delaying nucleation in the unfavorable regions, consequently increasing the density of favorable textures.

NATURAL FREQUENCIES OF A HYDRAULIC EXCAVATOR AND THEIR EFFECTS ON THE EXCAVATOR OPERATORS

Olga LAZAREVIĆ, Vojislav BATINIĆ, Aca RANDELOVIĆ

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Key words: Natural frequencies, hydraulic excavator, dynamics.

Abstract: This work describes the dynamic behavior of a hydraulic excavator with the analysis of its effects on excavator operators. The excavator system has been described by applying LaGrange's equations of the second kind within the model space of six degrees of freedom, i.e. six generalized coordinates. The analysis refers to the excavator that is put into operation by a mechanism with pneumatic wheels and a mechanism with outriggers built in the undercarriage section. The obtained mathematical model represents the system of six nonlinear equations, non-homogeneous, differential equations of the second kind resolved by applying MATLAB packet program. Resolving the system of equations describing the dynamic behavior of a hydraulic excavator makes it possible to determine its natural frequencies and the corresponding vectors. The focus was put on observing the oscillations in human body together with the analysis of the effects of natural frequencies on the excavator operators. Because of the possibility to anticipate its dynamic behavior, the dynamic model proposed here may be a good model for designers when constructing hydraulic excavators with better performances.

EFFECT OF ELECTROMAGNETIC STIRRING IN MOLD ON THE MACROSTRUCTURE OF TP347H HEAT-RESISTANT STEEL BILLETS

Shu-cai ZHOU

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Key words: Continuous casting; TP347 heat resistant steel; Electromagnetic Stirring; Center Equiaxial Grain; Center porosity

Abstract: To understand the solidification behavior of austenitic heat-resistant stainless steel (TP347) in rotary electromagnetic-field, the influence of electromagnetic stirring in mold (M-EMS) on solidification structure of TP347 heat resistant steel in a round billet continuous casting was investigated based on industrial experiments. The results indicate that the excellent billet solidification structure of TP347 heat resistant steel can be obtained with appropriate electromagnetic stirring parameters. The solidification structure of TP347 heat resistant steel can be remarkably refined, central porosity and shrinkage cavity can be remarkably decreased and equiaxed grains zone widens was enlarged. The industrial trials verify that the stirring intensity of TP347 heat resistant austenitic stainless steel should be higher comparing with plain carbon steel. Due to a higher viscosity, rotating speed of molten stainless steel was 20~30% lower than that of molten carbon steel in the same magnetic flux density.

NUMERICAL SIMULATION STUDY OF GAS-CAP RESERVOIR BARRIER WATER INJECTION FLUID INTERFACE MIGRATION LAWS

Jia LIU, Linsong CHENG, Shijun HUANG

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Key words: Gas-cap reservoir, barrier water injection, numerical simulation, reservoir engineering method, fluid interface, development mechanism

Abstract: Based on the reservoir property of Zhanazhol oil reservoir with gas cap in Kazakhstan, the numerical model of oil reservoir is built to explore the migration law for oil reservoir with gas cap barrier waterflooding: before the barrier formation, barrier water flows towards gas cap and oil ring according to the migration law of radial flow to supplement the formation energy of the oil area and gas area, respectively, effectively inhabit the expansion energy of gas cap, reduce the migration velocity of the oil-gas interface. After the barrier formation, the barrier cuts off the channel communicating the oil area with the gas area to separate the oil reservoir with gas cap into an oil reservoir with big gas cap and an oil reservoir with small gas cap, so as to realize the separate exploitation of gas cap and oil ring and effectively prevent the mutual channeling of oil and gas. In combination with the barrier water injection migration laws, the reservoir engineering methods of gas-cap reservoir barrier water injection exploitation before and after the formation of the barrier are set up and the fluid interface migration speeds at different development phases are calculated according to the material-balance principle. And in accordance with the calculation results, before the formation of the barrier, the oil-gas interface migration speed decreases with the increasing of the barrier injection-production ratio, and it slows down more seriously when the barrier well is nearer the outside oil-gas interface, however, there are risks of invasion of crude oil into gas cap. After the formation of the barrier, the oil gas interface is translated into oil-water interface and gas-water interface, the oil-water interface migration speed increases with the increasing of oil recovery rate, and the gas-water interface migration speed increases with the increasing of gas production rate. The fluid interface migration laws at different stages of gas-cap reservoir barrier water injection are further studied respectively by means of laboratory experiments and reservoir engineering methods and the study results have guiding significance for field personnel in the control of fluid interface migration direction and speed.

OPTIMIZATION OF T6 HEAT TREATMENT PROCESS OF AISi9Cu3(Fe) ALLOY IN ASPECT OF IMPROVEMENT OF ITS MECHANICAL PROPERTIES

Jacek PEZDA

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Key words: aluminum alloys, thermal analysis, heat treatment, mechanical properties

Abstract: The paper presents test results concerning an effect of the T6 heat treatment on mechanical properties of the EN AC- AlSi9Cu3(Fe) alloy (tensile strength - R_m , elongation - A_5 and hardness - HB10/1000/30), modified with the AlSr10 master alloy. Solution heat treatment and ageing treatment temperature ranges were selected on the base of heating (melting) curves recorded with use of the ATD method. Temperatures of the solution heat treatment amounted to 485 °C, 510 °C, and 545 °C $\pm$ 5 °C, while the solution time ranged from 0,5 to 3 h (0,5; 1,5 and 3 h). Temperature of the ageing heat treatment amounted to 175 °C, 240 °C and 320 °C, while the ageing time ranged from 2 to 8 h (2, 5 and 8 h). On the base of obtained test results one determined optimal temperatures and durations of the solutioning and ageing treatments, being condition of improved mechanical properties of the investigated alloy.

STUDY OF GX7CrNiMoCuNb18-18 STEEL HARDNESS BY USING SOLUTION ANNEALING HEAT TREATMENT
Mohammad KUWAITI

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Key words: GX7CrNiMoCuNb18-18 steel, Hardening, Annealing Solution.

Abstract: Mechanical properties of steels are affected the performed heat treatment. In this study was investigated the hardness of GX7CrNiMoCuNb18-18 (1.4585) steel after solution annealing heat treatment at different times. The results showed that after increasing solution annealing time decreases the hardness of 1.4585 steel.

FOUNDRIES OF THE KOLUBARA DISTRICT (VALJEVO) IN SERBIA DURING THE TRANSITION PERIOD
Miodrag ŽIŽOVIĆ, Zoran PETROVIĆ, Kosana VIČENTIJEVIĆ, Mališa ŽIŽOVIĆ

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Key words: metallurgy, foundries, foundry sites, the process of ownership transformation foundries

Abstract: This paper gives an overview of the companies in the field of casting during the period of the sanctions and the transition when the need for businesses in the area had a very specific form in the Kolubara District of Serbia. We also pointed out some characteristics of today's work in this area. Methodology for assessing the sites of these companies is also given and it is concluded that this method of presentation is at the fundamental level.

THE IMPACT OF DIFFERENT MATERIALS ON RING DEFORMATION OF HOT-WATER PUMP
Yue LI, Weidong SHI, Xiulan WANG

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Key words: different materials, high-temperature, temperature distribution, thermal-solid coupling, ring gap,

Abstract: In order to study the different materials impact on ring deformation of high-temperature process pump, TEG200-400 type hot-water circulating pump was taken as an example, based on the software ANSYS Workbench analyzed with thermal-solid coupling. At the same temperature, the temperature distribution, stress and strain distribution of the hot-water pump of the different materials, and the deformations of the volute ring and the impeller ring had been obtained. Based on the MATLAB software to process data, and obtained the size of the ring gap of the hot-water pump of different materials. These results can provide a certain basis for the choice of materials for the design of high-temperature process pump.

STRENGTH ANALYSIS OF STAINLESS STEEL STAMPING MULTISTAGE PUMP BASED ON FLUID-STRUCTURE INTERACTION
Chuan WANG, Weidong SHI

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Key words: Stainless steel, stamping pump, strength analysis, fluid-structure interaction

Abstract: In this paper, in order to explore the reliability of the impeller structure for stainless steel stamping multistage pump, based on the ANSYS Workbench, the final-stage impeller strength of the multistage pump was calculated by using unidirectional fluid-solid interaction method. After calculating the stamping impellers with different blade thickness by using the finite element method, the influence of inertial force and flow field pressure loads on equivalent stress and deformation of the impeller were found out. Results indicate that the maximum stress and deformation caused by fluid pressure load are much larger than those caused by inertial force, while slightly smaller than their composite, which means that the pressure load caused by high-pressure fluid plays a dominating role

in distribution of stress and deformation of impeller. With the increase of flow rate, the maximum stress of the impeller gradually increased, while the maximum deformation of the impeller first decreased then increased, and achieving the minimum value at the rated flow point.

IMPROVEMENT OF CENTERLINE SEGREGATION IN CONTINUOUSLY CAST BILLETS OF HIGH CARBON STEEL BY COMBINATION OF INTENSE SECONDARY COOLING AND F-EMS

Sen LUO, Miao-yong ZHU, Wei-ling WANG, Dong-bin JIANG

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Key words: centerline segregation, intense secondary cooling, F-EMS, high carbon steel, continuously cast billet

Abstract: In order to comprehensively investigate the effects of intense secondary cooling and F-EMS on the improvement of centerline segregation in continuously cast billet of high carbon steel, the numerical simulations of temperature field, electromagnetic field and fluid flow field and plant trials were performed in present study. The numerical models were validated by the strand surface temperature measured by infrared camera ThermalCAMTM, shell thickness measured by nail-shooting method and the magnetic flux density measured with Teslameter CT-3, respectively. The liquid pool thickness of strand, the magnetic flux density and liquid flow in the liquid pool at the location of F-EMS were calculated by the numerical simulation model to theoretically determine the suitable casting parameters and stirring parameters. Moreover, plant trials were further carried out to optimize casting parameters and stirring parameters to improve the centerline segregation in continuously cast billets. The results show that the centerline segregation in continuously cast billets of 70# steel can be significantly improved by combination of intense secondary cooling and F-EMS, and the suggested specific secondary cooling water, casting speed, and current density and frequency of F-EMS stirrer located at 8.2m from the meniscus are 1.0L/kg, 1.80m/min, 360~380A, 6Hz, respectively.

STUDY OF GX7NiCrMoCuNb41-20 STEEL MORPHOLOGY AFTER TEEMING AND FORGING OPERATIONS
Mohammad KUWAITI

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Key words: GX7NiCrMoCuNb41-20 steel, Morphology, Forging, Teeming.

Abstract: The morphology of steels is usually changed after teeming and forging. In this study was discussed the microstructure of GX7NiCrMoCuNb41-20 (1.4559) steel after teeming and forging treatment. The results showed that after teeming in surface structure and center, continuous lattice of carbide in grain boundary is deposited carbides when the after forging, ingot center microstructure is completely different.

RESEARCH ON RECRUITING SIMULATIONS AND CAREER CENTER SERVICES IN VIRTUAL ENVIRONMENTS

Jelena STANKOVIC, Marina SAVKOVIC, Zona KOSTIC

.....55
Key words: recruiting, virtual environments, career counselling, employer branding, job interview, e-learning

Abstract: The paper is focused on technologies used for student online learning on recruiting process, within career advising services. The results of this research show positive effect of virtual environments in preparation for active job seeking, especially job interviews. Different games, simulations and other online services presented in the paper are developed to help potential and current job seekers to improve their employability. The mentioned tools improved overall quality of career counselling services, providing a realistic experience. The results of the paper show potential benefits of cooperation between career centres and companies that provide preparation modules for recruitment and selection, in the terms of candidate job prospects and employer branding. Disadvantages of the virtual environment conditions, in this sense, could be overcome by relevant additional services of career centers.

CORROSION BEHAVIOR OF NiFe_2O_4 -10NiO BASED CERMET INERT ANODE SURFACE FOR ALUMINUM ELECTROLYSIS

Han-bing HE, Zhao-hui CHEN

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Key words: dense layer; corrosion behavior; cermet inert anode; aluminum electrolysis

Abstract: The cup-shaped cermet inert anode for aluminum electrolysis, composed of 20Ni-Cu/(90NiFe₂O₄-10NiO), was prepared and the operation performances were investigated in a lab-scale electrolysis cell with the electrolyte CR2.3 and Al₂O₃ concentration of 7.43% (mass fraction). The results indicate that the NiO phase on the surface of the cermet anode after electrolysis for 10 h to 40 h was gradually dismembered and engulfed by the NiFe₂O₄ phase, and the NiO-NiFe₂O₄ phase reacted with the Al₂O₃ dissolving in flux. Moreover, aluminates such as NiAl₂O₄ and FeAl₂O₄ were formed on the surface of the cermet, and preferential corrosion of the Fe element was found. Thus, a dense layer containing a NiFe₂O₄-NiAl₂O₄-FeAl₂O₄ spinel phase was formed, originating from the reaction of Al₂O₃ dissolved in the electrolyte with NiO or FeO and the annexation of NiFe₂O₄ toward NiO.

STUDY OF ANNEALING AND AGING HEAT TREATMENT ON THE MECHANICAL PROPERTIES OF GX7NiCrMoCuNb25-20 STEEL
Mohammad KUWAITI

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Key words: GX7NiCrMoCuNb41-20 steel, Morphology, Forging, Teeming.

Abstract: Undoubtedly heat treatment is affected on the stainless steels morphology and mechanical properties. In this study was discussed the effect of annealing and aging heat treatment cycles on GX7NiCrMoCuNb25-20 (1.4500) steel microstructure and mechanical properties. The results showed that decreasing of annealing temperatures and keeping of cycle time in specific heat treatment can be led to complex carbides precipitate in the microstructure of the 1.4370 steel and severely influences on the mechanical properties of this steel.

HIGH TEMPERATURE MECHANICAL PROPERTIES OF 27CrMoTi STRUCTURAL STEEL

Xiuqin TAN, Mengjiao DENG, Wei CHEN, Lin BAI, Liangying WEN

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Key words: 27CrMoTi; structural steel; mechanical properties; high temperature.

Abstract: The mechanical properties have an important role in structural steel design due to the rapid reduction on mechanical properties under high temperature conditions, such as yield strength and elastic modulus. Therefore, as a newly designed structural steel-27CrMoTi, there is a need to understand its mechanical property to establish a proper reheating schedule. In this article, tensile samples were tested by Gleeble 1500D for temperature in the range of 600 - 1100 °C. The test results show that there is a phase transformation during 600-800 °C at where yield strength, tensile strength and plasticity have a drastic change.

CONTRACTOR CHOICE OPTIMIZATION IN COMPLEX PROJECTS

Jovo VULETA, Slobodan ANDZIĆ, Srećko NOVAKOVIĆ, Snežana KRSTIĆ, Jonel SUBIĆ

.....66

Key words: optimization, network model, optimal solution, algorithm, combinatorial optimization

Abstract: One of the most important problems that arise in the realization of any project and especially complex projects is contractor choice optimization of all its activities. The term choice optimization presumes the selection of such contractors that will perform their activities, and thus the whole project, on schedule and at minimum cost. This paper analyzes these problems in detail and shows how they can be presented using models of combinatorial parametric optimization. Since the majority of algorithms for resolving these models is inconvenient for practical application, this paper recommends a modified PERT-COST algorithm for cost minimization of project realization based on its lead time.

SELECTION OF THE BEST CONTRACTOR FOR REALIZATION OF EACH PROJECT ACTIVITY USING MULTI-CRITERIA ANALYSIS

Jovo VULETA, Rosa ANDZIĆ, Slobodan ANDZIĆ, Dragan VUKASOVIĆ, Aleksandar MILETIĆ

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Key words: optimization, network model, optimal solution, algorithm, transportation problem

Abstract: This paper presents a specific problem of transporter selection optimization in the transport issue. The main characteristic of this problem is that every route has a capacity limit constraint,

while the cost of transport per unit is partitioned and well known in advance. These costs are determined based on the potential transporters' offers. This transport problem is solved by an appropriate transport network and by application of a method for the minimization of costs related to non homogeneous flow realization in the network with known value. With this problem solved, the transporter selection is optimized, that is, identified are those transporters who will transport specified amount of given product from all producers-warehouses to all consumer centers with minimum total transport costs.

THE TRANSPORTER SELECTION OPTIMIZATION IN TRANSPORT ISSUE

Jovo VULETA, Slobodan ANDZIĆ, Gordana ĐORĐEVIĆ, Nemanja JEVTIĆ, Nada Vignjević ĐORĐEVIĆ

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Key words: multicriterial optimization, network model, optimal solution, algorithm

Abstract: This paper presents a specific problem of transporter selection optimization in the transport issue. The main characteristic of this problem is that every route has a capacity limit constraint, while the cost of transport per unit is partitioned and well known in advance. These costs are determined based on the potential transporters' offers. This transport problem is solved by an appropriate transport network and by application of a method for the minimization of costs related to non homogeneous flow realization in the network with known value. With this problem solved, the transporter selection is optimized, that is, identified are those transporters who will transport specified amount of given product from all producers-warehouses to all consumer centers with minimum total transport costs.

THE IMPACT OF BALANCE SHEET STRUCTURE ON THE PERFORMANCE OF INDUSTRIAL ECONOMIC ENTITIES IN THE REPUBLIC OF SERBIA

Milovan STANISIC, Nemanja STANISIC, Vule MIZDRAKOVIC, Zeljko RACIC, Tijana RADOJEVIC

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Key words: asset structure, financial leverage, default risk

Abstract: The goal of this paper is to examine whether the percentage level of certain balance sheet items at the end of 2008 had an impact on the profitability of industrial economic entities of Serbia in the period from 2009 to 2011 and to what extent. The research included a sample of 3,866 industrial economic entities from the Republic of Serbia, which were grouped on the basis of a local size classification into medium-sized and large legal entities. Results indicate that economic entities where the percentages of property, plant and equipment were at higher levels recorded worse results in the period of three years from the beginning of the crisis. On the other hand, economic entities which had high percentages of liquid items recorded outstanding results. We show that economic entities which had higher percentages of long-term loans recorded better results than economic entities which mostly had short-term loans.

IS THERE SKILL BIASED TECHNOLOGICAL CHANGE? EVIDENCE FROM AGGREGATE PRODUCTION FUNCTION OF CHINA

Min YAN

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Key Words: Skill-Biased Technological Change; Aggregate Production; Nonlinear panel model

Abstract : The paper makes an empirical study on the presence of the skill biased technological change with China's panel data from 2002-2010 based on aggregate production and nonlinear panel data estimate. It points out that there is skill biased technological change in China. China's technology can conduct skill demand growth. So the skill premium is increasing. While the fact that it is difficult to be employed remind us to enhance the quality of university students on the basis of the Quantitative expansion.

EXCEL FILE FINANCIAL FRAUD FORENSIC ANALYSIS – CASE STUDY

Gojko GRUBOR, Kosana VIĆENTIJEVIĆ, Zoran PETROVIĆ, Nataša SIMEUNOVIĆ

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Key words: fraud, financial accounting, financial fraud, forensic accounting, forensic investigation

Abstract: As current business practices are changing, leaving more room for fraudulent activity, the new field of forensic accounting emerged. Fraud is growing and can be a huge problem for a business or a government entity. Most frauds involve financial matters, so accountants are the most useful people to investigate them. Forensic accountants are specially trained to investigate and report fraud in courtroom. For this reason, forensic accountants are often called fraud investigators or fraud examiners. Despite the fraud takes many forms, usually it is theft of funds or information or misuse of someone's assets. In this paper, we detailed a case of Excel file financial fraud forensic analysis. We outline some of the difficulties involved in tracing a fraudster by using some different approach than those well described in classic forensic examination such as postmortem, data mining and other techniques [5, 8, 20, 4]. In forensic examination step we used open sourced Deft 7.1 Digital Evidence & Forensic Toolkit [22] and verified results by another forensic tool, Meld - a visual diff and merge tool for compare files and directories. We refer to our process as combined digital forensic and accountant investigation. We conclude by discussing some future work that needs to be done before this approach can be properly evaluated.

MODEL SYSTEM FOR REMOTE CONTROL AND MONITORING IN PUBLIC LIGHTING

Lazar MOSUROVIĆ¹, Dragan SOLEŠA², Marijan RAJSMAN

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Key words: Remote control and monitoring, public lighting, model, PLC, communication

Abstract: By using the system for remote monitoring and control of public lighting is achieved by rational and economical exploitation of street lighting and lighting of roads and intersections, efficient system maintenance and energy savings of 30-50%. Since the world of lighting consumes about 20% of the total electricity produced, telemanagement imposes a serious concept of energy saving. Also, by increasing the energy efficiency of public lighting, reduced CO2 emissions, which is in line with the EU Directive on Environmental Protection (EN-2002/93/76 EEC). The paper will present the effects of energy savings, as a model system for remote monitoring and control of public lighting, which is expected economical and rational exploitation of public lighting.

DEVELOPMENT OF ECONOMIC THOUGHT THROUGH THE GLOBAL ECONOMIC CRISIS

Slobodan ANDŽIĆ, Snežana KRSTIĆ, Dragan VUKASOVIĆ, Aleksandar MILETIĆ, Srećko NOVAKOVIĆ

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Key words: neoliberalism, finance, global economic crisis

Abstract: The pursuit of sustainable economic development of society is seriously called into question with origin and development of the global economic crisis. The entire society is geared towards the development of economic thinking to solve a problem caused and the economic development and prosperity. The free market, it had pursued the ideal of economic thought for more than a century, lost its importance and it is necessary to resort to various mechanisms of its regulation, primarily by the state, whose role is again gaining in importance. The previous limit the role of government and its suppression at the expense of other (private) actors led to a more pronounced difference between all classes of people. On the one hand we have the poorest people, who do not have even the minimum for survival, indebted middle class and new (old) class over-rich who use any means to make a profit. The aim of this paper is that through the prism of neoliberal ideas review the roots of the global economic crisis and the effect that has on the world. The development of economic thought has to answer the challenges of growing and successful through the global crisis.

PERSONALIZED eLEARNING SYSTEM ARCHITECTURE SOLUTION BASED ON LEARNING OBJECTS

Dragica JOVANOVIĆ

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Key words: eLearning, personalized sequencing, student profile, metadata, pedagogical methods, learning styles.

Abstract: This paper presents the architecture of personalized eLearning system base on learning objects. Developed architecture provides derivation of student's profile, sequencing of personalized eLearning sessions and supports scenario for designing lessons content tailored to the individual student's needs. The example of

personalization process is shown. Further, here is described how the personalization system INDeLER includes teacher's influence to the eLearning experience by composing different pedagogical aspects and corresponding didactics' and methodic' processes to the unique way of teaching tailored to the particular student's needs

ANALOG CIRCUITS FAULT DIAGNOSIS BASED ON MULTI-UNIVERSE QUANTUM NEURON NETWORK

Fangxia HU, Gaofu DENG

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Key words: Fault diagnosis; Multi-universe quantum neuron; Analogous circuit

Abstract: According to the uncertainty question of analogous circuit's fault diagnosis in control system, the multi-universe viewpoint which is produced based on the quantum state the superimposition phenomenon is applied to the structural design of the neural network, and a multi-universe quantum neural network model is produced. The structure system of this model include classical networks and quantum neural networks. So multi-universe quantum neural network model can use the special collapsing method to get a good diagnosis result, and also can quantify the sample structure distribution at input space. The example simulation and analysis proved that this model can more effectively solve the uncertainty problem in the fault diagnosis process compared with BP network. The model improves the fault diagnosis recognition precision greatly, and the rate of diagnosis accuracy could achieve over 95%.

COMPARISON OF METHODS, USING FOR EVALUATION OF MINING FIRMS IN CONDITIONS OF SLOVAK REPUBLIC

Erik WEISS, Katarína ČULKOVÁ, Ladislav MIXTAJ

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Key words: evaluation of the firm, discounted cash flow, mining firms.

Abstract: The paper contributes to the empirical evidence on the techniques and methods used by mining industry in Slovak Republic to estimate a company's value of particular mining companies. Present business environment is not stable, full of problems that have considerable influence to the value of the company. Successful can be only such companies that consider management of the value as main principle of their business and firm's strategy.

SERBIA'S PROSPECTS IN THE IT BUSINESS - KNOWLEDGE OF CULTURAL DIFFERENCES

Ana LANGOVIC MILICEVIC, Tatjana CVETKOVSKI, Zlatko LANGOVIC, Brankica PAZUN, Violeta CVETKOVSKA OCOKOLJIC

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Key words: globalization, intercultural knowledge, IT business

Abstract: The establishment of modern business means continuous improvement. This is being accomplished through the exchange of experiences with a numerous business people who originate from different parts of the world. In order to compete globally and collaborate with other nations, it is needed to the communications be adopted, to obtain the information about the characteristics of business communication of the country whom we entreat to co-operate with. The main purpose of any business correlation is the achievement of the profit to the mutual satisfaction, which is the result of the successful cooperation. Therefore it is important to explain the link between cultural heritage and corporate culture and communication. This research will be related to the culture of the Serbia and United States of America, likewise for making a parallel between them in purpose of better cooperation later. To understand the different cultures, it is necessary to resort to the dimensions of individual cultures. A matrix, through which the features of cultures of different nations may be broken, is created by comparison of the dimensions previously mentioned, as well as finding similarities and differences among them. This can be done by studying the components and dimensions of culture.

BUSINESS OFFER ANALYSIS OF CONSULTING ORGANIZATIONS IN SERBIA

Branko MIHAILOVIC, Drago CVIJANOVIC, Vesna PARAUSIC, Aleksandra TESIC

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Key words: consulting organizations, management, networking, consulting techniques.

Abstract: *This paper's aim is to find out quality and quantity of the consulting services in Serbia at this stage of its accession to Europe in this field. According to an objective state of the consulting in Serbia in the observed moment, there logically imposes a fact that the best offer is of those consulting services which refer to strategy and management, so this question has formed into a hypothesis: The biggest offer of the consulting services in Serbia is in the field of a corporative strategy and an operational management. That is to say, affirmation of market business in Serbia has imposed new rules in society and economy. Such changes are excellent precondition for the consulting sector development. Enterprises try to improve competitiveness through adoption of new products, technologies and services. A need for getting to know some business processes has initiated better consulting engagement. However, lack of information in enterprises on useful effects of the consulting services represents a significant obstacle for the consulting market development. Consequentially, this paper has pretensions to point out to many questions related to this problem, to start their solving, to inform those who should be interested in a role and a significance of the consulting, methods of their use – everything which could contribute to some interest and economy development, including also solutions proposals, resulted from the exact researches by logical conclusions, through the scientific methods application.*

ENERGY CONSUMPTION AND ECONOMIC GROWTH IN CHINA: EMPIRICAL EVIDENCE FROM PANEL DATA OF 30 PROVINCES

Qier AN, Haizhong AN, Wei LIU, Hai QI

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Key words: energy consumption, economic growth, panel data, exergy, cluster analysis

Abstract: *This paper tries to investigate the relationship between energy consumption and economic growth in China using panel data of 30 provinces. Firstly we analyze the status of each province in energy consumption and then classified those provinces into 5 classes by the method of cluster analysis. After that, panel data model are built to investigate the relationship between energy consumption and the economic growth in each class. With industrial GDP as dependent variable, three non-energy variables (inflation, labor, capital stock) and eight energy variables are employed in our models. To consider both the quality and quantity of energy, exergy is utilized instead of energy indicators. Estimate result within each class shows the energy which exerts a significant impact on economic growth differs from place to place, indicating that different energy policies should be taken in different provinces.*

ARGUMENTS IN FAVOR OF INVESTMENTS IN ENERGY CULTURES VERSUS INVESTMENTS IN MICRO HYDRO POWER PLANTS. CASE STUDY: ROMANIA

Maricica STOICA

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Key words: Investments, biomass, environmental protection

Abstract: *The results of the research in this paper aim to present the main arguments in view of Romania's supporting investments in biomass energy cultures. Their high advantages are presented from an ecological, economic perspective, due to the possibilities of multiple energy recovery possibilities, possibilities of long term storage compared to the energy obtained in micro hydropower plants which cannot be stored. The latter is dependent upon the level of rain, which aggressively modifies ecosystems in the long run, being a profitable resource just for investors.*

A TEMPORAL FRAMEWORK EMBEDDED IN DECISION MAKING SYSTEMS, SPECIFIC CASE OF IRON AND STEEL INDUSTRY

Vasile MAZILESCU

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Key words: Temporal framework, Extended Fuzzy Logic System, Decision Making Systems, Economic Intelligent Systems, Materials Engineering

Abstract. *In today knowledge-based economy the value of goods, services and companies is created mostly by assets based on effective usage of knowledge and therefore knowledge management. The technical performance of modern Information and Communication Technologies (ICTs) has significantly changed not only the organisational structure of work but also individual work profiles. In this transformation process, the new wave of technologies is oriented to Semantic Technologies. From*

this perspective, the development of Distributed Knowledge Management Systems (DKMSs) that incorporate the human imprecision is a very important effort, especially from a dynamical view. This paper shows that the influence of knowledge on new forms of work organisation can be described as mutual relationships. Different changes in work organisation also have a strong influence on the increasing importance of knowledge of different individual and collective actors in working situations. After that, we characterize a piece of basic formal system, an Extended Fuzzy Logic System (EFLS) with temporal attributes, to conceptualize future DKMSs based on human imprecise for distributed just in time decisions. The approximate reasoning is perceived as a derivation of new formulas with the corresponding temporal attributes, within a fuzzy theory defined by the fuzzy set of special axioms. In a management application like the prototype REFK2, the reasoning is evolutionary because of unexpected events which may change the state of the DKMS. In this kind of situations it is necessary to elaborate certain mechanisms in order to maintain the coherence of the obtained conclusions, to figure out their degree of reliability and the time domain for which these are true. These last aspects stand as possible further directions of development at a basic logic level for future technologies that must automate knowledge organizational processes. Materials technologies development has to be considered, too.

INTEGRATING INFORMATION AND KNOWLEDGE IN INTELLIGENT ECONOMIC SYSTEMS. SPECIFIC SITUATION OF METALLURGICAL INDUSTRY

Vasile MAZILESCU

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Key words: Knowledge Distribution, Intelligent Economic Systems, Competency Management, Knowledge Management Systems, Materials Engineering.

Abstract. *Knowledge is based on the accumulation of facts, procedural rules or heuristics. Knowledge is supported by both formal and informal processes and structures in their acquisition, sharing and applications. Workers and employees communicate and assimilate values, procedures, rules and data from the beginning of their activity in an organization, and hypothetically should begin to be increasingly willing to share what they know as their length of service increases. This paper presents a deep analysis of knowledge, as the basic pillar of the intelligent enterprise and of many other Intelligent Economic Systems. In this respect we emphasize that it is essential to realize that Knowledge Management is both a cultural and a technological provocation. Our work demonstrates the main aspects and strategic advantages of knowledge representation, processing based mobilisation and distribution in the long process from integrating information and applications to automate knowledge worker functions. Developing systems that incorporate knowledge within organizations differs significantly from other systems, because it is absolutely necessary to associate operational interpretations with the information, in order to transform them into knowledge useful in various acts of decision. Understanding, defining and using knowledge can be based on a number of many approaches, such as the synthesis of Knowledge Management Systems, Knowledge Agents, Knowledge Discovery and Data Mining, Organizational Semantic Webs. In this respect the contribution of materials engineering is very important.*

THE ECOLONOMIC BEHAVIOUR – THE BASE OF HEALTHY PROFIT. HOW THE METALLIC MATERIALS INDUSTRY CONTRIBUTES

Constantin POPOESCU, Miltiade STANCIU, Anca POPOESCU

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Key words: ecolonomic behaviour, the trezviu, "win-win" principle, the healthy profit, metallic materials.

Abstract: *The ecolonomic way of thinking and life is also determined organically by the **man culture**, by that spiritual traditional depth that helps him get close to the sense and significance of the goods it consumes, the choices that it makes, the surrenders that it is able to, in order to be who he is etc. Therefore, our view is that a human behaviour is only perceived as durability when the human being **integrated it in cultural and moral terms**, when this has become some kind of "to be", of the diversity of the world that it lives in, as uniqueness and individuality. Nothing that's not culturally and traditionally perceived by the human being, could not become the source of a sustainable healthy behaviour! The international known experience proves that any way of life that was commanded from outside, by force, didn't resisted, because it wasn't*

perceived in cultural, moral and traditional terms by the human communities that "were wanted for transformation"!"

THE ECOLONOMY OF HUMAN BUSINESSES, A NEW PARADIGM, THE CONTRIBUTION OF METALLIC MATEROALS INDUSTRY

Constantin POPESCU, Miltiade STANCIU, Anca POPESCU

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Key words: integrated living integer, living integer health, ecolonomy, healthy profit, education re-disembodiment, metallic materials.

Abstract: The researches of the fields of quantum physics, holistic medicine, trans-personal psychology, systemic biology, anthropology etc. highlight the need to rethink the concept about life from the perspective of interpretation of the Planet Earth, as „a living and conscious entity“. The supreme value of life as „integrated-integers“ is conceived by the new vision under the name of harmony, defined by the attributes: adjustment, coherence and resonance. No matter if we refer to the natural environment or to the environment created by the human being, the life in harmony appears under the form of the „existence in relationship“ of the integrated integers. For this purpose, the human's life is „an integrated living integer“ that is connected to himself, to the divinity – on the life vertical, as well as to the fellow humans, to the living integer – on the life horizontal. In this context, we consider that the ecolonomy represents a new manner of interpreting the world of human businesses from the perspective of the paradigm that we have titled "the health of the common living integer". The world of human businesses includes the life as the first business of the human being, as well as the other forms of life known as economic, social, cultural, religious, political life, etc. According to such vision, the economy is a living entity created by the human being, as a skill-answer to the nature's „graspingness“, in conditions of uncertainty, that the defining attributes may be, healthy or ill. The ecolonomy is conceived by us as the science about the health of the economic life, as an organic part of the social life and together, of the living world ecology. Contribution of metallic materials for creation of healthy environment.

TRANSITION TO THE ECOLONOMIC SOCIETY, THE EVOLUTION OF METALLIC MATERIALS INDUSTRY

Constantin POPESCU, Miltiade STANCIU, Anca POPESCU

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Key words: ecolonomic responsibility, ecolonomic behaviour, systemic wisdom, ecolonomic society, metallic materials.

Abstract: The transition to the wisdom era, as base of ecolonomic society is a complex process wich begin with the human and institutional behavior respiritualization . The substance of this process has its source in rethinking education, from the perspective of transition to education in love and fully understanding of life.the contribution of metallic materials is important in this respect.

OPERATIONAL MANAGEMENT TECHNIQUES TO PREVENT AND COMBAT THE UNDERGROUND ECONOMY IN ROMANIA, SPECIFIC SITUATION OF METALLIC MATERIALS INDUSTRY

Alexandru Roland SAVULESCU

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Key words: black labor market, underground economy, unemployment, metallic materials industry.

Abstract. The underground economy in Romania is very high comparative with other EU countries. The economic crisis has brought a growing of shadow economy in a context where there were increases of taxes, in particular VAT and excise duties. A recent EUROSTAT report estimated the underground economy of tends to be 18% out of Romanian GDP. The present essay emphasizes the importance of political regulatory actions that must be put in practice in order to turn the grey economy into taxes paid to the budget. The author also explains the disadvantages of shadow economy in case of undeclared employment. The situation in the metallic materials industry is also studied.

PRIVACY-RELATED ASPECTS OF THE MARKETING COMMUNICATION WITH THE CONSUMERS: AN EXPLORATORY ASSESSMENT, SPECIFIC SITUATION OF METALLIC MATERIALS INDUSTRY

Călin VEGHEȘ, Mihai ORZAN, Carmen ACATRINEI, Diana DUGULAN

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Key words: privacy, marketing communication, Romanian consumers, metallic materials.

Abstract: The performances of the marketing communication with consumers depend on the appropriate selection of "traditional" (press, radio, television, outdoor) and/or direct media (mail, telephony, mobile telephony, and the internet), capable to draw the attention of the consumer, generate his/her interest, stimulate the desire for, and determine the buying of the promoted products, services, and brands. In the process of selecting these media, several privacy-related aspects should also be taken into consideration. The paper explores some of these aspects – preferences for searching or receiving information, preferences for receiving marketing messages in terms of the media employed as sources of information, attitudes towards disclosing, capturing, processing and employment of the personal data, assessment of the aggressiveness of the media employed in the direct communication, and the attitudes toward buying products and/or services after being directly approached – and presents the results obtained at the level of a sample including Romanian consumers.the importance of metallic materials industry has to be analyzed in this respect.

MARKETING COMMUNICATIONS OF SMALL AND MEDIUM ENTERPRISES - A RESEARCH FROM THE CUSTOMERS PERSPECTIVE

Ioana Cecilia POPESCU, Călin Petrică VEGHEȘ, Camelia KAILANI

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Key words: marketing communications, promotional tools, SMEs, Romania.

Abstract: This paper aims to highlight some of the aspects regarding the marketing communications of SMEs in Romania, from the perspective of their clients. The research conducted on this purpose was intended to reflect the perceived utility of the communication techniques and tools for the companies that have relationships with SMEs on the Romanian market. The research results have revealed that the marketing communication tools used by SMEs are adapted to the characteristics of the client-companies (number of employees, annual turnover, type of capital, structure of marketing activity), but the most used tools are not always perceived as most useful from the customers point of view.The main conclusion of the research is that SMEs have to choose the most appropriate modalities of marketing communications, in order to be able to enhance their position on market, develop the relationships with their clients and gain a competitive advantage.

RESEARCH ON EMPLOYERS' NEEDS REGARDING ECONOMIC GRADUATES' COMPETENCIES - PILOT STUDY FOR METHODOLOGY ADJUSTMENT

Ioana Cecilia POPESCU, Loredana DINULESCU

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Key words: educational marketing, graduates' competencies, employers needs

Abstract: The higher education institutions, which are more and more characterized by a stronger competition, must learn to apply scientific management and marketing principles, in order to enhance their competitiveness. Students, on the one hand, and employers, on the other hand, have increasing expectations in terms of learning outcomes. This paper aims to present a pilot-study, conducted to assess the willingness of employers to engage in a long term relationship with the universities in order to express their views on the competencies provided to graduates by study programs in economics. In addition, this pilot-study seeks to adjust the methodology of a complex research that universities in the economic field must conduct to identify the employers' needs and expectations on the issues that define the learning outcomes.

EFFECT OF Sb ON THE TEXTURE DEVELOPMENT OF HOT ROLLED SLAB IN Hi-B SILICON STEEL USING LOW SLAB REHEAT TEMPERATURE

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Key words: Sb, EBSD, Goss texture, Hi-B

Abstract: The texture of hot rolled slab of Hi-B grain silicon steel which was rolled by Thin Slab Casting and Rolling process (TSCR) in the laboratory with different Sb contents has been investigated by Electron Back-Scattered Diffraction (EBSD). In this study, Goss texture is the main texture style in both surface layer and subsurface layer. The intensity of the Goss texture firstly increases and then decreases as the Sb increased, the most suitable addition of Sb is 0.04% in this study. After high temperature annealing, the specimens complete secondary recrystallization. When Sb content is 0.04%, the magnetic property is the best in this research, B_8 is 1.891T.

1. INTRODUCTION

Grain-oriented silicon steel is an important magnetic material that is widely used as core material in transformers¹. It is clear that the magnetic properties are related to the sharpness of $\{110\}\langle 001\rangle$, i.e., Goss texture, which is evolved by secondary recrystallization^{2,3}. The sharp Goss texture of grain-oriented silicon steel is the results of microstructural and textural inheritance chain. In general, the original of the evolution of the final Goss orientation occurs in the hot rolling stage where the Goss texture develops⁴. Therefore, the intensity and component of hot slab texture of grain-oriented silicon steel is crucial to the final Goss orientation.

MnS, CuS and AlN are well known as inhibitors, and the segregating element Sb was added in the oriented silicon steel as the supplemental inhibitor through grain boundary segregation⁵. The past research has shown that it is beneficial to the Goss texture development by adding Sb⁶. The purpose of this paper is to clarify the texture development of hot rolled slab of grain-oriented silicon steel with different Sb content.

2. EXPERIMENTAL METHODS

The hot rolled grain oriented silicon steel was normally rolled by Thin Slab Casting and Rolling process (TSCR) in laboratory. The steel was melt by vacuum induction furnace, and poured into water-cooled copper mould with dimension of 50mm×100mm×400mm, ensuring that the temperature was at least 950°C before removal from the mould. In the subsequent process, the slab was kept at 1180°C for 0.5h in a holding furnace, and then hot rolled to 2.3mm-thick strip. This was then rolled to 0.3mm by single-stage cold rolling after two-step normalizing. Subsequently, the specimens were then subjected to decarburization annealing in wet hydrogen at 875°C and high temperature annealing at 1200°C.

The Chemical composition of the specimens are as indicated in Table 1. The texture of the samples was determined by Electron Back-Scattered Diffraction (EBSD). The EBSD investigations render possible a detailed analysis of the microtexture of the hot rolled slab. As texture inhomogeneity of hot slab is considered to play a pivotal role in the production of intense Goss texture in the final material, the specimens were divided into three sections: S=0, the surface layer; S=1/4 the subsurface layer; S=1/2, the central region.

Table1 Chemical composition of specimens wt %

No.	C	Si	Mn	Cu	S	Als	N	Sb
1#	0.04	3.00	0.1	0.15	0.0045	0.028	0.011	/
2#	0.04	3.00	0.1	0.15	0.0045	0.028	0.011	0.04
3#	0.04	3.00	0.1	0.15	0.0045	0.028	0.011	0.06

3. RESULTS AND DISCUSSION

3.1 Hot rolling texture of 1# Specimen

Figure1 shows the ODFs for the $\phi_2=45^\circ$ section at different depths in the hot rolled slab, which illustrates the main texture components present and their intensity. In surface layer, (S=0), the hot rolled slab has a significant intensity in the general vicinity of Goss texture with a maximum intensity at the exact Goss orientation of ~ 2.63 . Furthermore, there is (554)[225], (332)[113] and some α -fibre texture in the layer. In subsurface layer, (S=1/4), Goss texture was transformed into γ -fibre texture as the slab thickness climbs. And

the intensity of α -fibre texture is higher than surface layer, and the orientation intensity increases to 8.062. In the half thickness layer, (S=1/2), a strong (001)[110], i.e., rotated cube texture is observed, and the maximum intensity of texture is highest. Through analyzing orientation densities along α , γ and η fibers at different thickness in hot rolled slab, it is clear that the principal texture component of surface layer is Goss. However, Goss intensity of subsurface layer and central region are weaker than surface.. Therefore Goss texture is mainly distributed in the surface of hot rolled slab, which agrees with the observations made about the ODF maps.

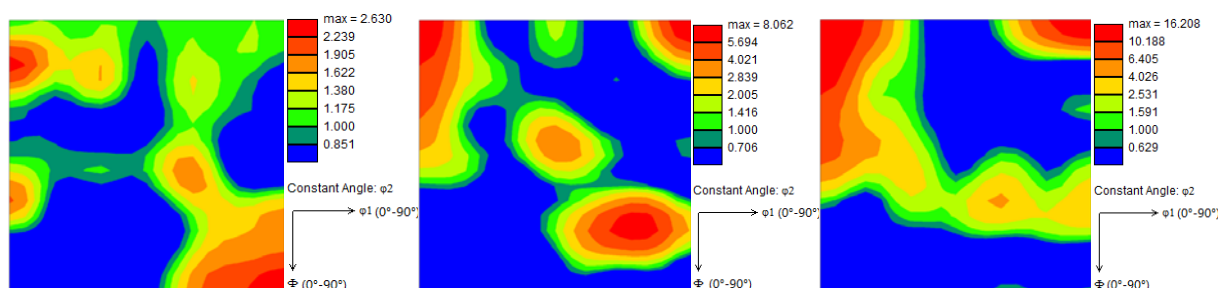


Fig.1 ODFs section of $\phi_2=45^\circ$ at the different thickness in hot rolled slab

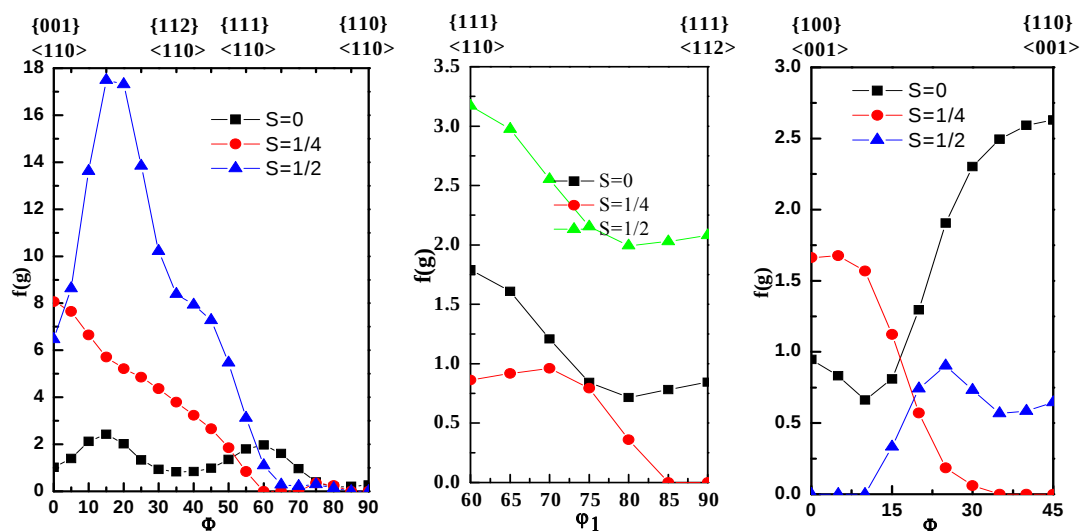


Fig.2 Orientation densities along α , γ and η fibers at different thickness in hot rolled slab

3.2 Hot rolling texture of 2# Specimen

Figure3 shows the ODFs for the $\phi_2=45^\circ$ section at different depths in 2# hot rolled slab, which illustrates the main texture components present and their intensity.

In surface layer, the hot rolled slab has significant intensity in the general vicinity of Goss texture, and the maximum intensity at the exact Goss orientation is 4.151. Furthermore, there is some brass and copper texture components present in the layer, but of weaker intensity. In subsurface layer, γ -fiber texture instead of Goss texture as the slab thickness climbs, which is mainly $\{111\}\langle 112 \rangle$, whose

orientation intensity increases to 5.327. In the half thickness layer, the texture is strong $\{001\}[110]$, i.e., cubic texture, and the orientation intensity gets close to 1# the half thickness layer orientation intensity. Through analyzing orientation densities along α , γ and η fibers at different thickness in hot rolled slab as shown in Fig.4, it is clear that the grain orientation is mainly concentrated in $\{001\}\langle 110 \rangle$ orientation in half thickness layer, and the principal texture component of surface layer is Goss texture, and the intensity of $\{111\}\langle 112 \rangle$ is the highest in subsurface layer.

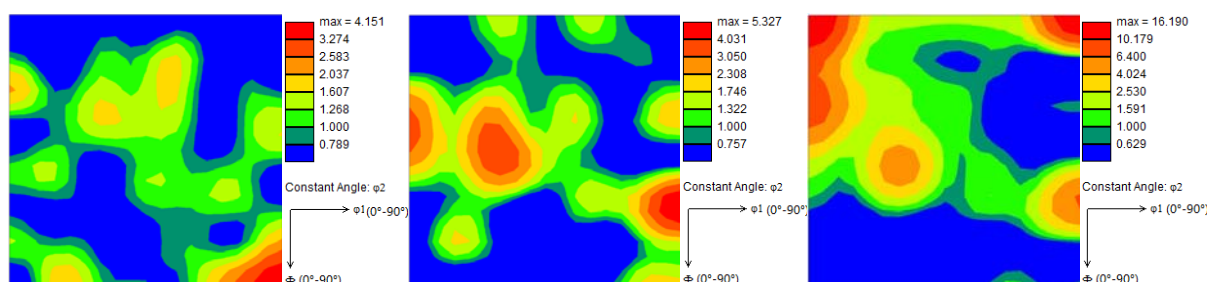


Fig.3 ODFs section of $\phi_2 = 45^\circ$ at the different thickness of 0.04% Sb in hot rolled slab

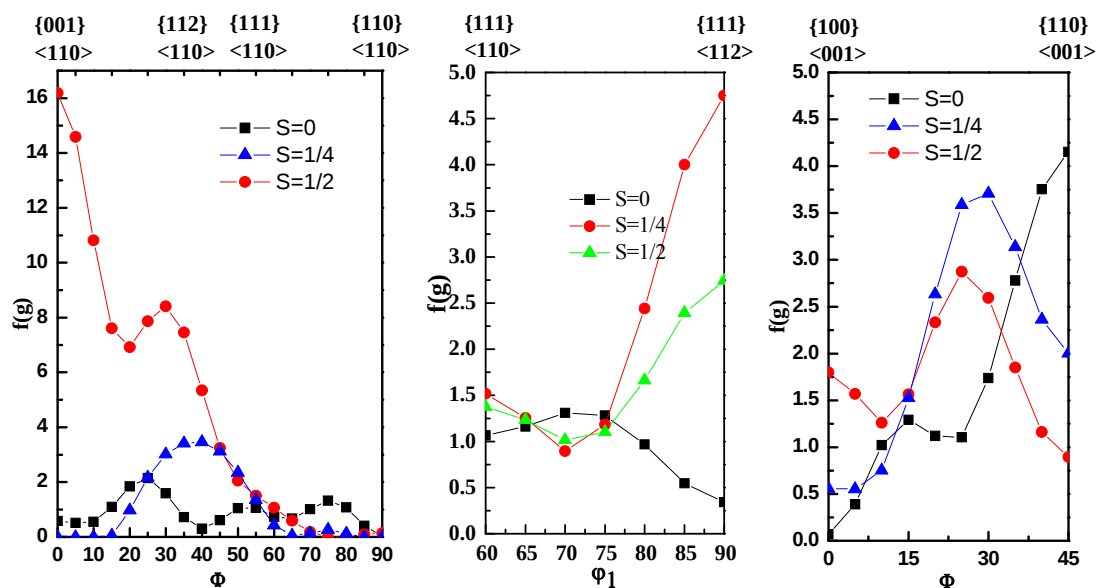


Fig.4 Orientation densities along α , η fibers at different thickness of 0.04% Sb in hot rolled slab

3.3 Hot rolling texture of 3# Specimen

Figure 5 shows the ODFs for the $\phi_2=45^\circ$ section at different depths in 3# hot rolled slab, which illustrates the main texture components present and their intensity. In surface layer, the texture of hot rolled slab is random, for instance, there are $\{221\}\langle 4910\rangle$, $\{331\}\langle 589\rangle$, weak copper and brass texture. The maximum intensity is 2.378. In subsurface layer and the half thickness layer the hot rolled slab's texture concentrated in sharp

cubic texture and weak α -fiber texture. The orientation intensity increases as the slab thickness increasing. Through analyzing orientation densities along α , γ and η fibers at different thickness in hot rolled slab as shown in Fig. 6. It is clear that the hot slab have strong cubic texture in subsurface layer and intermediate layer. According to η orientation analysis, Goss texture is weakest in different depths in 3# hot rolled slab compared with 1# and 2#.

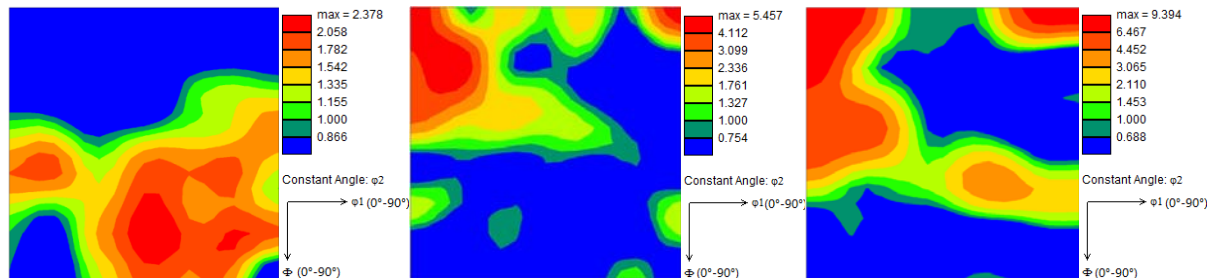


Fig.5 ODFs section of $\phi_2=45^\circ$ at the different thickness of 0.06% Sb in hot rolled slab

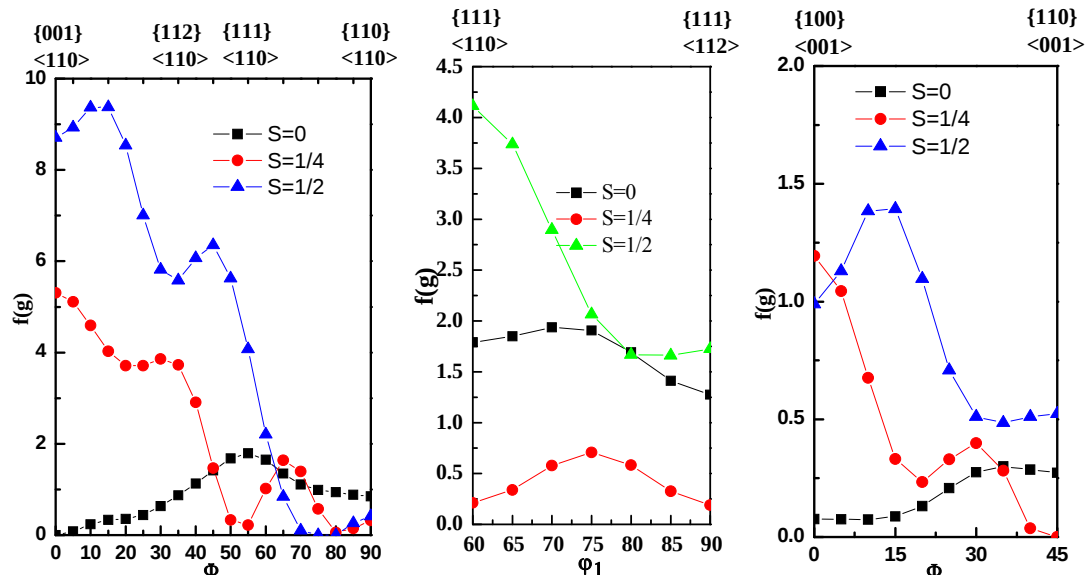


Fig.6 Orientation densities along α , η fibers at different thickness of 0.06% Sb in hot rolled slab

3.4 Discussion

There is a consequence that the Goss orientation grains in primary recrystallization are derived from the Goss orientation grains of the hot rolled surface layer, which is so called "texture genetic effects". Hence, inhomogeneity of recrystallization in hot rolling, especially Goss texture intensity of surface layer and subsurface layer is crucial to the perfect development of secondary recrystallization.

The texture of surface layer for 1# specimen is mainly Goss texture which is the type of desired texture, and its intensity is 2.530. However, Goss intensity is almost 0 in subsurface and intermediate layer. The main texture for 2# specimen surface layer is Goss texture and the orientation intensity has a substantial increase compared to sample 1 #, and its intensity increases to 4.15. In subsurface layer, the main texture is $\{111\}\langle 112\rangle$. As $\{111\}\langle 112\rangle$ and Goss constitute 35° orientation relationship, $\{111\}\langle 112\rangle$ can be swallowed by Goss texture. So $\{111\}\langle 112\rangle$ is a favorable texture. In addition, there is also some weaker Goss texture exists in subsurface layer. From the analysis above, it can be seen that Goss texture distributes in surface layer and subsurface layer, and thus has potentially more Goss nucleation sites. The surface layer of 3# specimen has a random texture, and no Goss has been found. Besides, the specimen having a strong cubic texture in subsurface layer and intermediate layer, which is bad for the development of secondary recrystallization.

From above analysis, it is manifest that, after adding 0.04% Sb, Goss texture can be found in surface layer and subsurface layer in hot rolled slab and increasing Goss nucleation sites that is beneficial to the development of secondary recrystallization. And the orientation density of the Goss texture also has a correspondingly increasing. In addition, we had done statistical analysis of Goss

component proportion in surface layer and subsurface layer of hot rolled slab. As Fig. 7 shown. According to the chart, we can increase the Goss proportion by adding Sb, however, excess Sb will impede the development of Goss texture. So the Sb addition has a suitable range. In this study, the suitable Sb addition is 0.04%. B_8 of 1#, 2# and 3# specimens are 1.863T, 1.891T, 1.83T, respectively. It has been clarified the magnetic property can be improved with a suitable Sb addition.

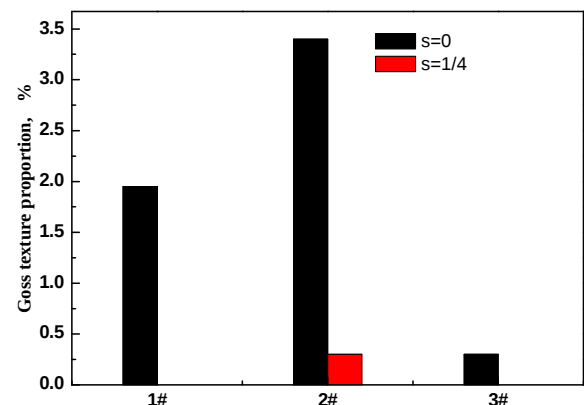


Fig.7 Proportion of Goss texture in hot rolled slab with different Sb

4. CONCLUSIONS

(1) In this study, Goss texture is the main texture in surface layer of hot rolled slab for grain-oriented silicon steel with different Sb content. While it is mainly γ -fibre texture in subsurface layer and cubic texture in intermediate layer. Because of different chemical components, the components of texture and orientation density are different.

(2) It can increase Goss proportion by adding Sb, if the Sb component is within a suitable range. In this study, the suitable Sb addition is 0.04%, and the surface layer of hot rolled slab has a sharp Goss texture and the highest orientation intensity.

(3) After high temperature annealing, all the specimens complete secondary recrystallization. When Sb content is 0.04%, the magnetic property is the best, B_8 is 1.891T.

Acknowledgements:

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REFERENCES:

[1] Xia Zhaosuo, K. Y., Wang Quanli, Developments in the production of grain-oriented electrical steel[J]. Journal of Magnetism and Magnetic Materials, 2008, 320 (23), pp 3229-3233.

[2] Dörner, D., Zaefferer, S., Lahn, L., etc., Overview of Microstructure and Microtexture Development in Grain-oriented Silicon Steel[J]. Journal of Magnetism and Magnetic Materials, 2006, 304 (2), pp 183-186.

[3] Dörner, D., Zaefferer, S., Raabe, D., Retention of the Goss orientation between microbands during cold rolling of an Fe3%Si single crystal[J]. Acta Materialia, 2007, 55 (7), pp 2519-2530.

[4] Takamiya, T., Komatubara, M., Hayakawa, Y., etc., Influence of heat treatment before secondary recrystallization on magnetic properties of 3% Si grain-oriented steel containing Sb[J]. Journal of Magnetism and Magnetic Materials, 1996, 160 (0), pp 131-132.

[5] Rodrigues, M. F., da Cunha, M. A., da Costa Paolinelli, S., etc., Texture and magnetic properties improvement of a 3% Si non-oriented electrical steel by Sb addition[J]. Journal of Magnetism and Magnetic Materials, 2013, 331 (0), pp 24-27.

[6] Matsuo, M., Sakai, T., Suga, Y., Origin and development of through-the-thickness variations of texture in the processing of grain-oriented silicon steel[J]. Metallurgical Transactions A, 1986/08/01, 1986, 17 (8), pp 1313-1322.

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A NEW METHOD TO IMPROVE THE DENSITY OF FAVORABLE TEXTURES IN NON-ORIENTED ELECTRICAL STEELS

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Key words: Non-oriented electrical steel; Microstructure; Texture; Copper;

Abstract: Favorable texture can improve the magnetic properties of non-oriented electrical steels. In this paper, new alloy elements and different annealing process are used to improve the density of favorable texture in non-oriented electrical steel. The microstructure and microtexture evolution along the final annealed samples was investigated with EBSD. It is found that inhomogeneous microstructure is produced in samples because of copper and phosphorus segregation as well as temperature different. As a result of copper segregate at crystal face of {100} and the different of diffusion coefficient between copper and phosphorus. The copper hinder desorption of phosphorus, so as to the copper and phosphorus segregate at the crystal face of {100}. It hindered the growth grains of {100} <0v0> in edge. But in central, the content of elements segregation on grain boundaries is more than edge. It is delaying nucleation in the unfavorable regions, consequently increasing the density of favorable textures.

1. INTRODUCTION

Non-oriented electrical steels have been used as core materials of motors, generators and small transformers, it is a kind of indispensable soft magnetic materials in national economy and production. The magnetic properties of non-oriented electrical steels is affected by many factors, such as the basic elements, but also affect by the impurities, the parameters of heat processing, final heat temperature, the rise rate of temperature and textures [1-6]. Textures are mainly divided into two parts, one is favorable textures with orientations such as α -fiber, Goss texture; the other is unfavorable textures with orientations such as γ -fiber. It has been found that favorable textures with the orientations such as {100} <0v0>, Goss texture can improve the magnetic properties of non-oriented electrical steels, however, unfavorable textures can significantly reduce magnetic properties [7-9]. It has been found that phosphorus and copper can segregate on grain boundaries, but the effect on the magnetic properties of non-oriented electrical steels are still in heated disput [1,10,11,12,13]. J.T. Park et al [1] had reported that the phosphorus can increase the {222} texture and reduce the {110} texture component during the phosphorus content is increases. Also, the other scientists had replicated his result [13]. In contrast, I. Tanaka [11,12] found that the density {111} <112> in steel with large phosphorus is lower than that with a small amount of phosphorus in recrystallization textures. The effect of copper on the grain boundaries is similar with the phosphorus during annealing process [14]. D. S. Petrovic et al [15] had studied the surface segregation of copper in the non-oriented electrical steel, they pointed out that the copper segregation rate was estimated based on the surface concentration of copper after annealing at a temperature. However, we can not find any related literatures about textures of non-oriented electrical steel containing copper, also, the effect on textures of phosphorus and copper are not completely clear.

J. K. Sung et al [16] has been discovered a novel method to control the crystallographic orientation of body-centred cubic crystals of iron using the γ to α phase transformation. The magnetic properties significantly increase with increasing of the textures of

crystallographic orientation. Also, there are many researchers has pointed out that phase transformations can lead to the required <100> texture [17-19]. But non-oriented electrical steels do not undergo α to γ phase deformation during hot rolling according to silicon content. So, many researchers have started to work towards achieving the <001> columnar grains in hot plates but it is lost after heavy rolling and recrystallization. So many researcher works are focusing on it [20-22]. But it is very hard to use in industrial production.

In this study, a new method was discovered to control increasing the density of favorable textures and reducing the density of unfavorable textures. This method is different with the γ to α phase transformation and the <001> columnar grains, however, this method can improve the magnetic properties in non-oriented electrical steel. We also study the effect on textures with phosphorus and copper in non-oriented electrical steels. Furthermore, the different microstructure effect on textures in non-oriented electrical steels also studied.

2. MATERIAL AND METHODS

The materials used were copper-containing laboratory manufactured Fe-Si-Al alloys of non-oriented electrical steels. The vacuum melted alloys were cast into ingots and then hot rolled to a thickness of 2.5mm. After the hot rolling, the plate was coiled at about 690°C, then it was out into muffle furnace at 690°C and cooled with the furnace, later, the hot band was annealing before to cold rolling at temperature 975°C×4min. The chemical composition of the non-oriented electrical steel is given in Table 1. Subsequently, the samples have been cold rolled to a thickness of 0.5mm. The cold-rolled steel sheets were cut into 0.5mm × 300mm × 30mm coupons in both longitudinal and transverse directions with respect to the rolling direction. Finally, annealing was realized in a laboratory furnace, which simulates the industrially used continuous annealing process, 925°C×5min annealing under nitrogen: hydrogen =3:1 atmosphere, but different with the industrially continuous annealing process which atmosphere was added to it. Later, air cooling. While Fig.1 show the sketch map of the annealing process.

Table 1 Chemical compositions of non-oriented electrical steels (wt%)

No.	C	Si	Mn	P	S	Al	N	Cu
1	<0.005	0.83	0.3	<0.1	<0.003	0.3	<0.003	0.15

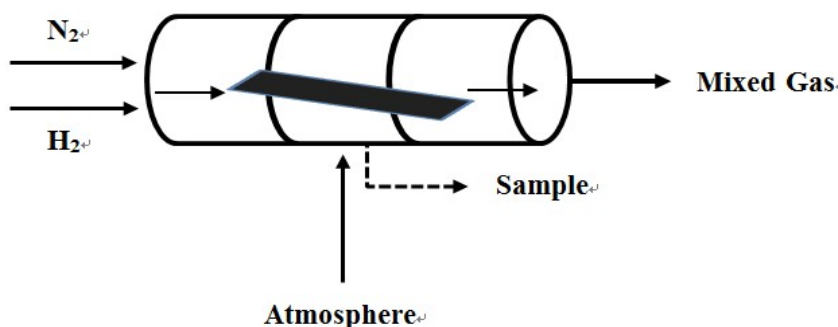


Fig.1 The sketch map of the annealing process

To analyse the morphology and texture of the samples, the cross-sections of the sample were prepared, which sample A and D were on the side while B and C were on the central. Select samples of A, B, C, D were shown in Figure 2.

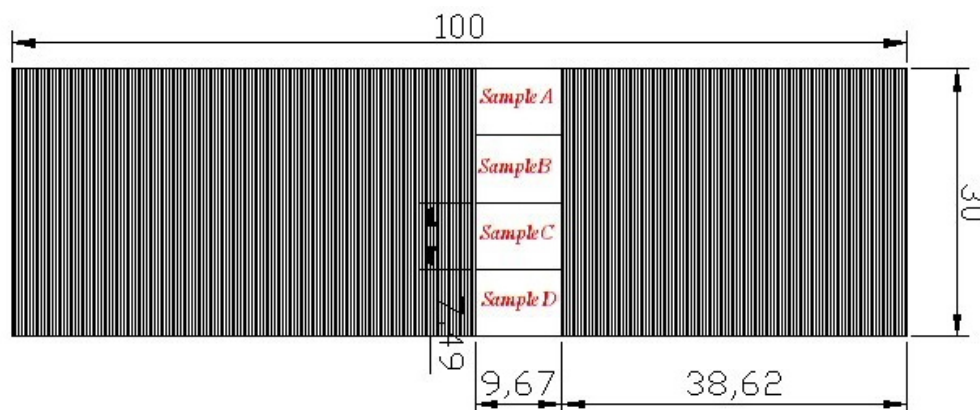


Fig.2 Select samples of A, B, C, D

They were metallographically ground and polished with 1 μ m grade diamond paste. The absorbed impurities on the surface of the cross-sections were removed by anhydrous ethanol. Microtexture determination was carried out by electron backscatter diffraction (EBSD) in a Philips XL30 SEM operated at 20KV accelerating voltage. The orientation distribution function (ODF) was calculated from the three pole figures using TSL OIM Analysis 6, a texture analysis software package from OIM. The magnetic properties were measured in the rolling direction at 1.5T and 50Hz. Twenty samples, which 30cm wide and 300cm long, were used for measured.

3. RESULTS

3.1 Microstructure and Grain size

The microstructure of the non-oriented electrical steel after annealing is shown in Figure 3. It should be noted in Fig. 3 that the grain sizes have strong inhomogeneity throughout the thickness of the specimen during the annealing process. Also, the samples have different grain sizes at different position. Samples B, C have smaller final annealed grains than A, D. Figure 4~7 illustrates optical micrographs for annealed specimen A~D with small and large grain sizes. Compared with A, B, C, D microstructure with small and large grain sizes, it can be found that of these four samples, sample A and D have the larger grain size than B, C. Table 2 lists grain sizes of materials after annealing. The average grain diameter is different in these samples. The average grain diameter of A is bigger than any other samples, while B is the smallest one. The average grain sizes of A can reach 42.1 μ m, but it is only 27.0 μ m in B.

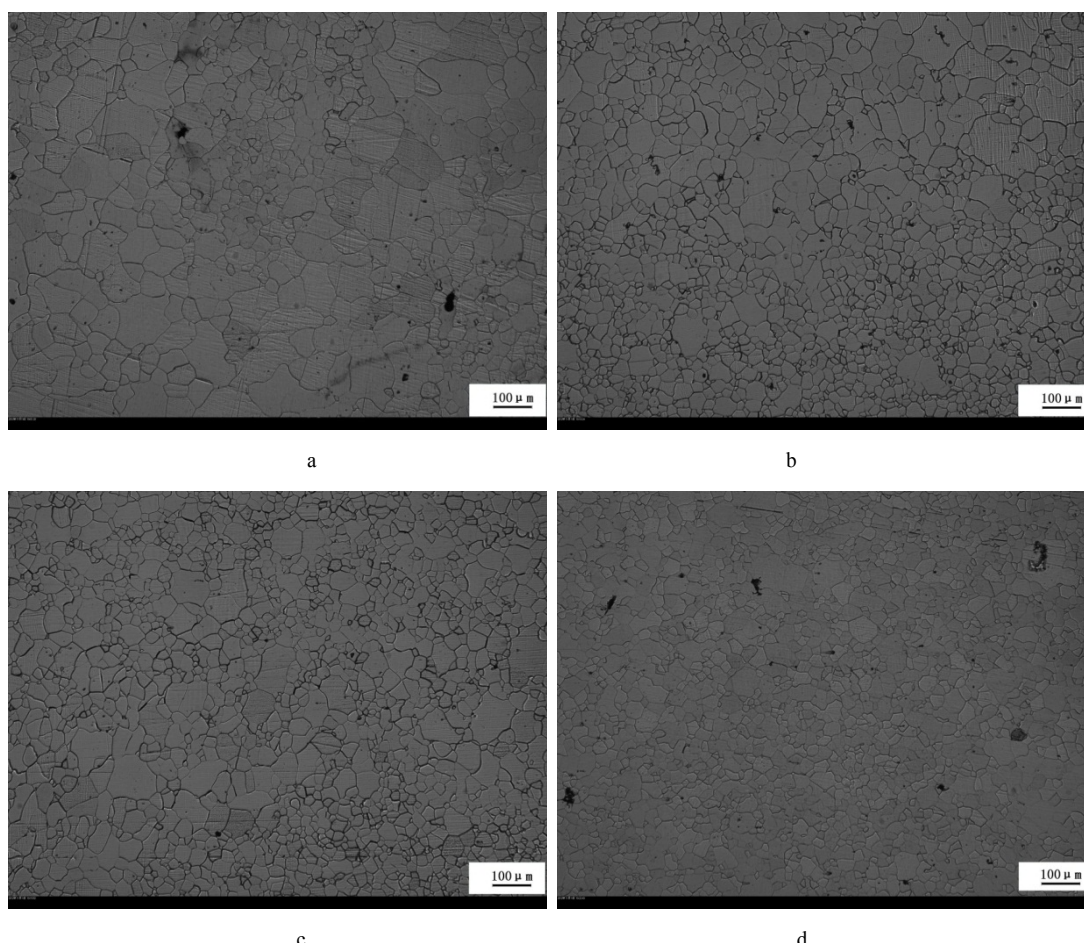


Fig. 3 Microstructure of sample A (a), B (b), C (c), D (d) after annealing

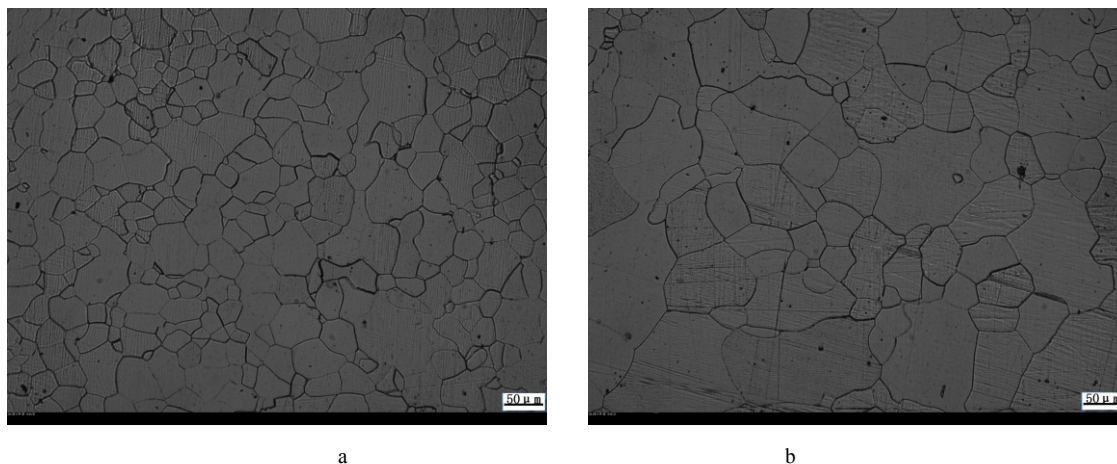


Fig. 4 Microstructure of sample A with small (a) and large (b) grain sizes

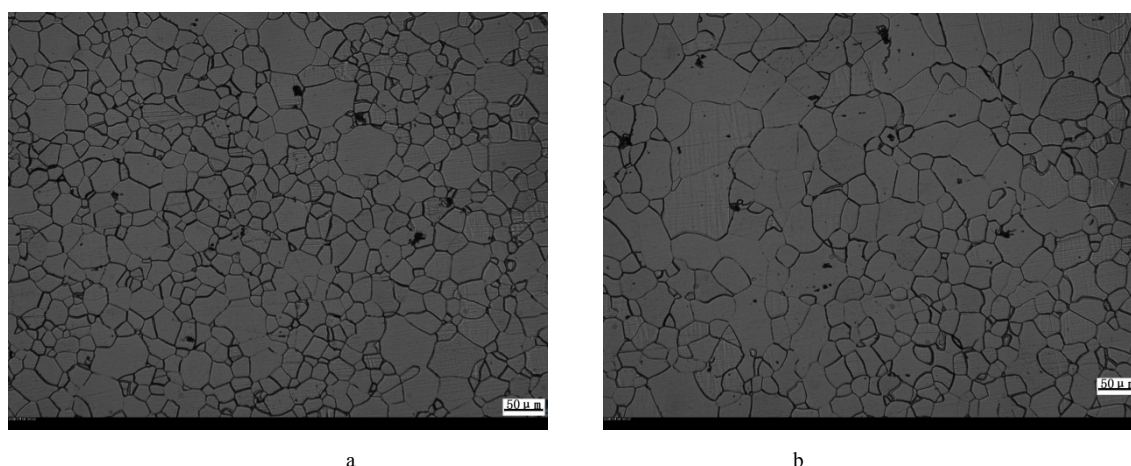


Fig. 5 Microstructure of sample B with small (a) and large (b) grain sizes

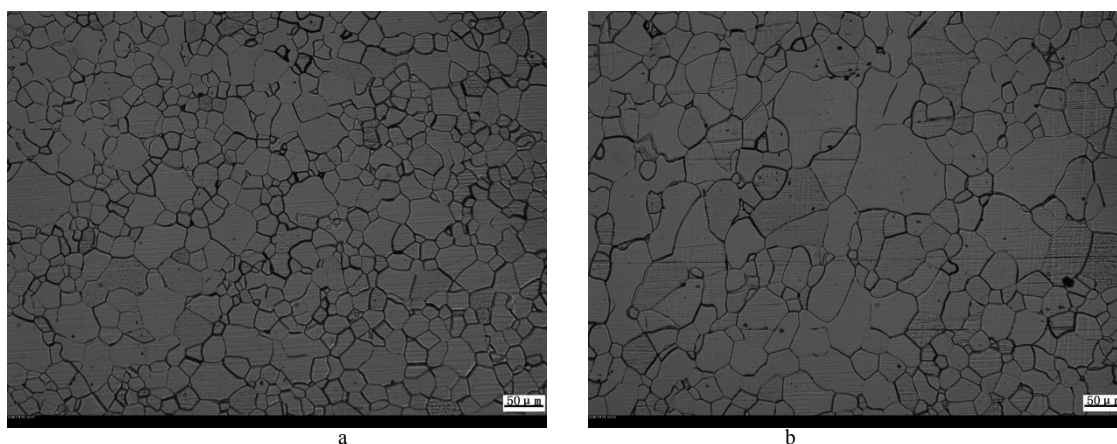


Fig. 6 Microstructure of sample C with small (a) and large (b) grain sizes

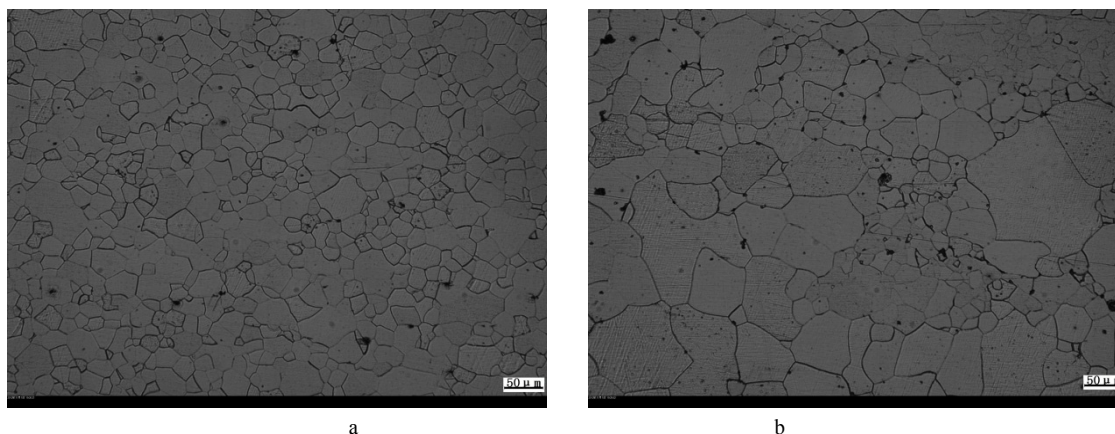


Fig. 7 Microstructure of sample D with small (a) and large (b) grain sizes

Table 2 Grain size after annealing

Samples	Grain sizes/ μm		
	Small	Large	Average
A	32.8	51.4	42.1
B	20.5	33.5	27.0
C	27.8	36.3	32.1
D	24.9	48.1	36.5

3.2 Texture

In order to observe texture inhomogeneity throughout the samples, EBSD was measured at different position. The crystal orientation distribution was analyzed with a tolerance degree 15° for each texture and fiber, as illustrated in Figure. Figure 8 shows the textures presented in the $\phi_2=45^\circ$ section of ODF at the grain sizes distribution of small and large in sample A. Although their dominant textures are γ -fiber textures which consist of $\{111\} \langle 110 \rangle$ and $\{111\} \langle 112 \rangle$ texture throughout the grain sizes distribution, their maximum

densities are quite different. The maximum density of small grain sizes is 12.817, but it is only 7.587 in large. These are much more Cube texture ($\{100\} \langle 001 \rangle$) in small grain size than large. It can be found that the density of Cube texture in small grain size is 2.5 but in large is only 1.1. It is also can be found that the small grain sizes have higher density of $\{111\} \langle 112 \rangle$ than large grain sizes, but it is completely opposite in $\{111\} \langle 110 \rangle$. The maximum density of $\{111\} \langle 112 \rangle$ and $\{111\} \langle 110 \rangle$ is 12.3 and 5.6 in small grain sizes, however, it is only 5.8 and 7.4 respectively in large grain sizes.

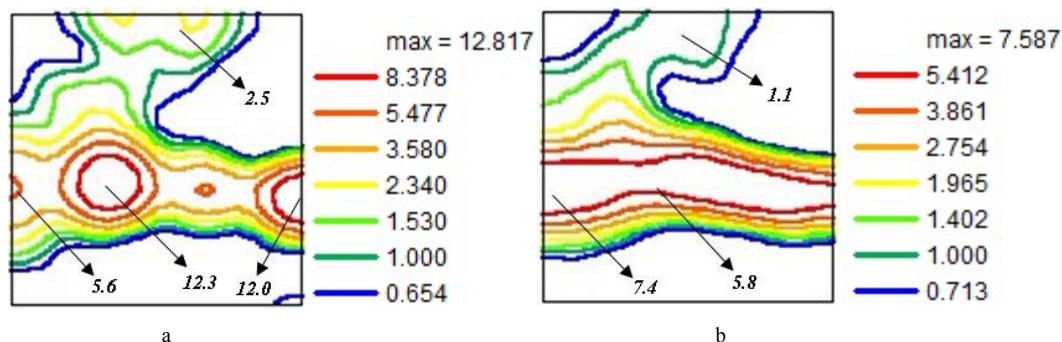


Fig.8 $\phi_2=45^\circ$ sections of ODFs at different grain sizes (a) small, (b) large in sample A

Fig. 9 shows the final annealing texture of the sample B with small and large grain sizes in $\phi_2=45^\circ$ section. It is apparent that there is a great difference between small and large grain sizes in textures. A very strong Goss texture ($\{110\} \langle 001 \rangle$) and weak γ -fiber texture are developed at large grain sizes while strong α -fiber with orientations such as $\{112\} \langle 110 \rangle$, $\{113\} \langle 110 \rangle$, $\{111\} \langle 110 \rangle$ and $\{111\} \langle 112 \rangle$, $\{100\} \langle 490 \rangle$ textures are found in small grain sizes. The intensities,

however, are different between the small and large grain sizes. The maximum density of large grain sizes is 25.445, but it is only 6.921 in small grain sizes. It can be found that the maximum intensity of $\{111\} \langle 112 \rangle$ is 3.7 in small grain sizes but it is 4.4 in larger. These are maximum density of Goss texture in large grain sizes, however, it is none in small grain sizes.

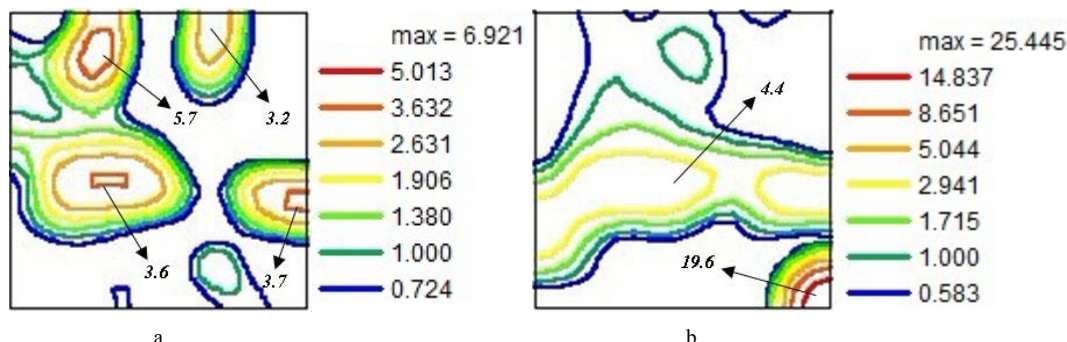


Fig.9 $\phi_2=45^\circ$ sections of ODFs at different grain sizes (a) small, (b) large in sample B

Fig.10 displays $\phi_2=45^\circ$ sections of ODFs at different grain sizes (a) small, (b) large in sample C. It is clear that the density of cube textures in small grain sizes is much more than large grain sizes. The density of Cube texture in small grain sizes is 5.2 but it has only 1.9 in large grain sizes. Also it has a great difference in texture types. A

very strong γ -fiber textures with orientation such as $\{111\} \langle 110 \rangle$, $\{111\} \langle 112 \rangle$ are found in small grain sizes, the maximum density of $\{111\} \langle 110 \rangle$ is 2.8. However, the textures of large grain sizes are $\{111\} \langle 110 \rangle$, $\{554\} \langle 143 \rangle$, $\{111\} \langle 123 \rangle$ and $\{110\} \langle 552 \rangle$, the density of these textures are 2.9, 4.7, 4.2 and 7.2 respectively.

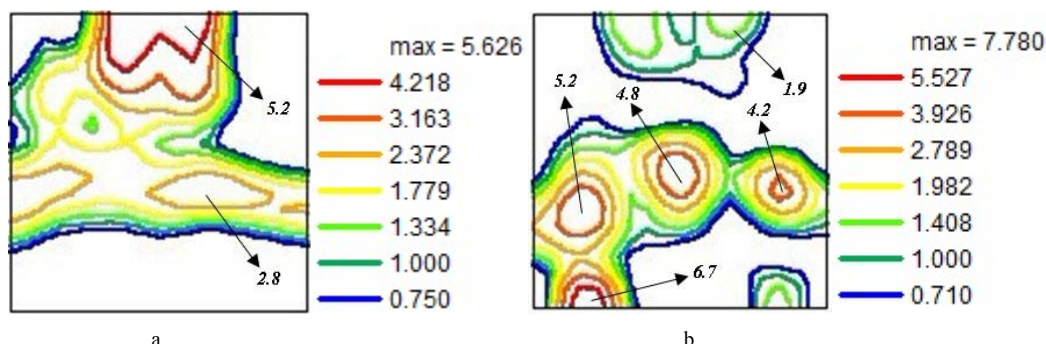


Fig.10 $\phi_2=45^\circ$ sections of ODFs at different grain sizes (a) small, (b) large in sample C

Fig.11 shows the texture of the sample D with small and large grain sizes in $\phi_2=45^\circ$ sections. It can be found that the textures of two parts have a significantly different. A very strong texture of $\{111\} \langle 112 \rangle$ is found in small grain sizes which the maximum density of $\{111\} \langle 112 \rangle$ is 9.1. Also, it has Cube and $\{100\} \langle 490 \rangle$ textures in

small grain sizes, the maximum density of two textures is 1.5 and 2.8 respectively. But these have only one main texture in large grain sizes, which contain $\{111\} \langle 110 \rangle$ and $\{111\} \langle 112 \rangle$ textures, that is γ -fiber texture. The maximum density of $\{111\} \langle 110 \rangle$ and $\{111\} \langle 112 \rangle$ texture is 6.1 and 6.5 respectively.

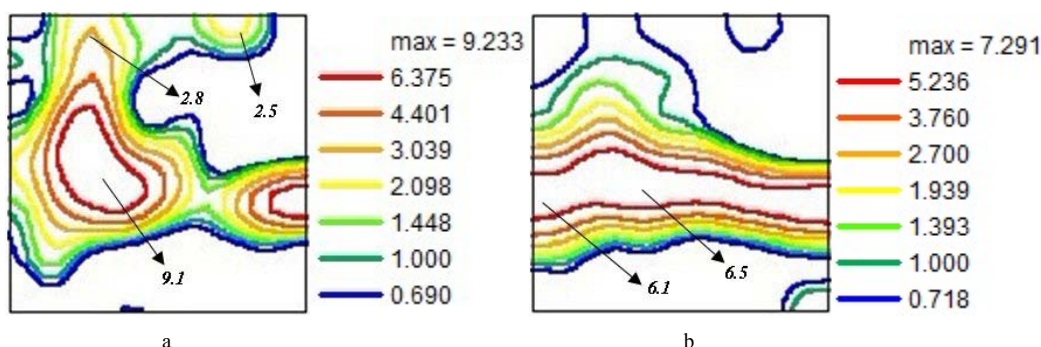


Fig.11 $\phi_2=45^\circ$ sections of ODFs at different grain sizes (a) small, (b) large in sample D

4 DISCUSSION

The reference [23] has pointed out that it was an important characteristic that precipitates formed mainly at grain boundaries during annealing process. Reference [1] has also pointed out that phosphorus segregates on grain boundaries and the amount of segregation becomes larger as its content increases. It is obvious that phosphorus which segregates on grain boundaries retards the migration of grain boundary during the grain growth. The effect of copper on the grain boundaries is similar with the phosphorus during annealing process [14]. Fig. 12 displays the phosphorus and copper segregation during annealing of samples. It can be found that much of phosphorus and copper segregate on the grain boundaries. A reference has reported that the copper can segregate on grain boundaries. Also, it can segregate at the crystal face of $\{100\}$ [24]. It is well known that it hinders the migration of grain boundaries at the crystal face of $\{100\}$ during grain growth, this cause the grain which has the orientation of $\{100\} \langle \mu\nu\omega \rangle$ growth slow, but the orientation of $\{110\} \langle \nu\gamma\omega \rangle$ and γ -fiber can grow free. As a result the grain sizes become smaller than that has not element to segregate on grain boundaries, which reference [25] has reported. That is one of the reasons why there has small and large grain sizes in samples, such as

Fig.3. It is well known that the microstructure of annealing samples can significantly influence the textures [26-28]. Reference [1] has also reported that the phosphorus segregates on grain boundaries can increase $\{222\}$ textures and reduce $\{110\}$ textures. However, It has not effect on the textures of $\{100\}$. But it has a different texture in samples, having a large density of $\{100\} \langle \mu\nu\omega \rangle$ and small γ -fiber textures in small grain sizes, however, the density of γ -fiber is high in large grain sizes. It has a significant effect on the textures except the segregate of phosphorus. On the other hand, the diffusion coefficient of copper is smaller than phosphorus, also, reference [15] has pointed out that the segregation of phosphorus started at 720K, but the copper start at range 770~970K during annealing. So, It is well known that the phosphorus can diffuse quickly than copper. There is an order between phosphorus and copper segregated to the grain boundaries, which phosphorus is the first. So as to the copper hinder the phosphorus diffusing to the matrix during the annealing process. As a result much more phosphorus stay at the crystal face $\{100\}$. This cause the grain growth of $\{100\}$ are hindered by the segregation of elements phosphorus and copper, so, the grain sizes significantly reduce at the $\{100\}$. This is the result why much more Cube texture in small grain sizes than large grain sizes.

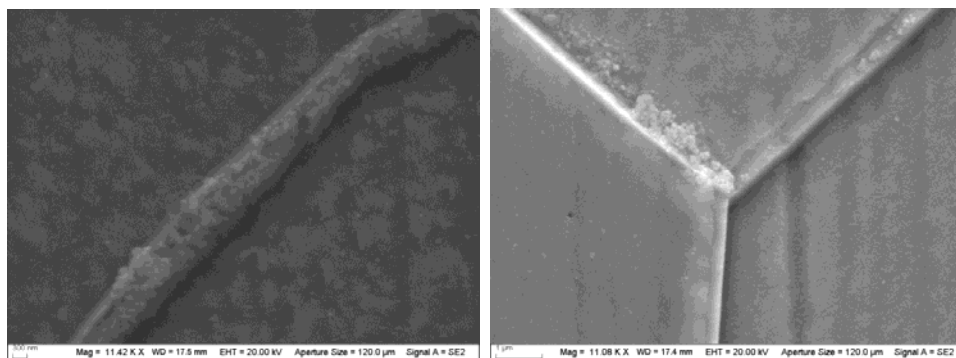


Fig. 12 Phosphorus and Copper segregation to grain boundaries

On the other side, the transmission of energy is different at the different position. The transmission speed of energy at the edge is fastest than central section which the atmosphere come in. However, it is also slowly than common samples in annealing process. As a result the content of copper and phosphorus segregate on the grain boundaries less than in central. It is clearly found that the grain sizes in the edge are larger than in central from Fig. 3. The content of phosphorus and copper reduce in the edge, so, the orientation of $\{100\} \langle \nu\omega \rangle$ significantly reduce from Fig. 8~11. Because of the content of phosphorus and copper segregate to the grain boundaries reduce at the grain boundaries of $\{100\} \langle \nu\omega \rangle$. The $\{111\} \langle 112 \rangle$ has the largest energy of migration of grain boundaries in all textures, So, it is much more nuclear in the deformation bands than any other orientations. As a result the $\{111\} \langle 112 \rangle$ is the larger texture in sample A and D. However, the transmission speed of energy in the middle is slowly than in edge. These are less energy to overcome the grain growth and the segregation of phosphorus and copper, as a result the grain sizes is much smaller than central. Also, much of phosphorus and copper is segregated on the grain boundaries of crystal face $\{100\}$. It is delaying nucleation in the unfavorable regions, consequently leading to the difference of favorable textures. The cube texture increase in the middle, the $\{111\} \langle 112 \rangle$ and $\{111\} \langle 110 \rangle$ texture reduce significantly.

5 CONCLUSIONS

In this study a new method to improve the density of favorable textures is found in non-oriented electrical steels. It is found that adding some segregation of elements, phosphorus and copper, can improve the density of favorable textures, such as $\{100\} \langle \nu\omega \rangle$ and $\{110\} \langle \nu\omega \rangle$, this can improve the magnetic properties of non-oriented electrical steels.

(1) The segregation of elements phosphorus and copper can segregate on grain boundaries, which hindered the growth of grain. On the other hand, the copper can segregate to the crystal face $\{100\}$, this results the grain which has the oriented of $\{100\} \langle \nu\omega \rangle$ grow slowly, but the other orientation can not grow free for their low energy with a new method. In other words, the copper can hinder the segregation of phosphorus because of the diffusion coefficient is different between phosphorus and copper. As a result the density of favorable textures can improve significantly in non-oriented electrical steels.

(2) The transmission speed of energy at the edge is different with the middle part of specimens. Which has the low temperature for much of atmosphere come to the surface of specimens in the middle. So, It has much more energy in edge than middle. This cause the growth of grain with different oriented in non-oriented electrical steels different. The grain at the edge can develop γ -fiber with large grain sizes for there has much more energy than central, also it can develop $\{100\} \langle \nu\omega \rangle$ textures in small grain size which effect by the segregation elements. But in central, the content of copper and phosphorus segregate on the grain boundaries more than in edge. It is delays nucleation in the unfavorable regions, consequently leading to the difference of favorable textures. It can develop Goss and $\{100\} \langle \nu\omega \rangle$ without distinction between small grain sizes and large grain sizes in the middle part of specimens with the new method.

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REFERENCES

- [1] J. T. Park, J. S. Woo, S. K. Chang, J. Magn. Magn. Mater. 182 (1998) 381-388.
- [2] S. Szymura, C. Adamczyk, H. Majchrzak, J. Mehliś, A. Zawada, J. Mater. Sci. Lett. 6 (1987) 1259-1260.
- [3] S. K. Chang, W. Y. Huang, ISIJ Int. 45 (2005) 918-922.
- [4] D. Moseley, Y. Hu, V. Randle, T. Itons, Mater. Sci. Eng. A. 392 (2005) 282-291.
- [5] J. T. Park, J. A. Szpunar, S. Y. Cha, ISIJ Int. 43 (2003) 1611-1614.
- [6] K. Verbeken, J. Schneider, J. Verstraete, H. Herremans, Y. Houbaert, IEEE Trans. Magn. 44 (2008) 3820-3823.
- [7] B. Cornut, A. K. Lebouc, Th. Waeckerle, J. Magn. Magn. Mater. 160 (1996) 102-108.
- [8] R. Premkumar, I. Samajdar, N. N. Viswanathan, V. Singal, V. Seshasri, J. Magn. Magn. Mater. 264 (2003) 75-85.
- [9] J. T. Park, J. A. Szpunar, ISIJ Int. 45 (2005) 743-749.
- [10] C. K. Hou, C. T. Hu, S. Lee, J. Magn. Magn. Mater. 109 (1992) 7-12.
- [11] I. Tanaka, H. Yashiki, J. Magn. Magn. Mater. 304 (2006) e611-e613.
- [12] I. Tanaka, H. Yashiki, ISIJ Int. 47 (2007) 1666-1671.
- [13] S. Lee, B. C. D. Cooman, Mater. Sci. Forum. 654-656 (2010) 302-305.
- [14] H. J. Cui, M.D. Thesis. University of Science and Technology Beijing, Beijing, China, 2010.
- [15] D. S. Petrović, D. Mandrino, S. Krajnović, M. Jenko, M. Milun, V. Doleček, M. Jeram, ISIJ Int. 46 (2006) 1452-1457.
- [16] J. K. Sung, D. N. Lee, D. H. Wang, Y. M. Koo, ISIJ Int. 51 (2011) 284-290.
- [17] C. F. Chang, R. L. Bye, V. Laxmanan, S. Das, IEEE Trans. Magn. 20 (1984) 553-558.
- [18] F. J. G. Landgraf, T. Yonamine, R. Takanohashi, F. Q. Silva, J. P. V. Tosetti, F. B. Noto, E. Albertin, V. N. G. Mazzarella, I. G. S. Falleiros, M. Emura, J. Mater. Magn. Mater. 254-255 (2003) 364-366.
- [19] N. Yoshinaga, L. Kestens, B. C. D. Cooman, Mater. Sci. Forum. 495-497 (2005) 1267-1272.
- [20] T. Tomida, J. Mater. Eng. Perform. 5 (1996) 316-322.
- [21] D. Stojakovic, R. D. Doherty, S. R. Kalidindi, F. J. G. Landgraf, Metall. Mater. Trans. A. 39 (2008) 1738-1746.
- [22] L. Cheng, P. Yang, Y. P. Fang, W. M. Mao, J. Magn. Magn. Mater. 324 (2012) 4068-4072.
- [23] S. W. Xin, Y. Q. Zhao, W. D. Zeng, H. Wu, Mater. Sci. Eng. A. 477 (2008) 372-378.
- [24] Z. C. Liu, F. L. Guo, H. Y. Wang, Heat Treatment. 23 (2008) 20-24. (in chinese)
- [25] J. T. Park, Ph.D. Thesis. McGill University, Montreal, Canada, 2002.
- [26] F. J. G. Landgraf, R. Takanohashi, F. C. Chagas, M. F. de Campos, I. G. S. Falleiros, J. Magn. Magn. Mater. 215-216 (2000) 92-93.
- [27] M. Dzubinsky, Y. Sidor, F. Kovac, Mater. Sci. Eng. A. 385 (2004) 449-454.
- [28] R. Takanohashi, F. J. G. Landgraf, J. Magn. Magn. Mater. 304 (2006) e608-e610.

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NATURAL FREQUENCIES OF A HYDRAULIC EXCAVATOR AND THEIR EFFECTS ON THE EXCAVATOR OPERATORS

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Key words: Natural frequencies, hydraulic excavator, dynamics.



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Abstract: This work describes the dynamic behavior of a hydraulic excavator with the analysis of its effects on excavator operators. The excavator system has been described by applying LaGrange's equations of the second kind within the model space of six degrees of freedom, i.e. six generalized coordinates. The analysis refers to the excavator that is put into operation by a mechanism with pneumatic wheels and a mechanism with outriggers built in the undercarriage section. The obtained mathematical model represents the system of six nonlinear equations, non-homogeneous, differential equations of the second kind resolved by applying MATLAB packet program. Resolving the system of equations describing the dynamic behavior of a hydraulic excavator makes it possible to determine its natural frequencies and the corresponding vectors. The focus was put on observing the oscillations in human body together with the analysis of the effects of natural frequencies on the excavator operators. Because of the possibility to anticipate its dynamic behavior, the dynamic model proposed here may be a good model for designers when constructing hydraulic excavators with better performances.

1. INTRODUCTION

Hydraulic excavators are machines with cyclic working mechanisms designed to dig earth in all terrain conditions. Possible errors in designing, manufacturing and exploiting itself may cause a large number of undesirable consequences: the system collapse, bad effects both on the environment and the operator. The need for developing dynamic-mathematical models of excavator systems has arisen from the fact that not many examinations can be carried out in real situations due to its dimensions, costs and operating system conditions. Physics of construction and the process of hydraulic excavator functioning can generate significant system vibrations reflecting themselves in additional dynamical forces and further system points shifts. An adequate dynamical system model is an essential precondition for examining dynamical payloads as well as the forces in the joints of excavator parts. Currently available reference books offer variety of approaches to modeling hydraulic excavators which mainly differ in their use, performance and the number of the degrees of freedom.

The analyses of the reference books have proved that the dynamic behavior of hydraulic excavator has been analyzed with maximum five degrees of freedom [1]. However, from the structure itself and the functioning of excavator, it would be quite natural to extend the model space by one more degree of freedom, that is by revolving around the main central inertia axis of the undercarriage part, which has been done in this work. Introducing the new generated coordinate and the nonlinear formulation improves the mathematical – dynamic model which describes the dynamic excavator behavior. The developed model makes it possible to examine hydraulic excavator movement points based on generalized coordinates. It also enables determining its natural frequencies.

2. THE DYNAMIC MODEL OF EXCAVATOR

When analyzing the dynamic stability of an excavator, its physical model is observed (Fig. 1).

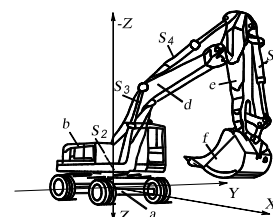


Figure 1. The physical model of an excavator: a - an undercarriage part; b - a revolving part; c - an arrow; d - an arm e - a bucket

For the physical model of excavators shown in figure 1 the dynamical model (Fig. 2) assumes the following: the dynamic model of excavator [3-6] is an unconservative system with steady and ideal connections; small system oscillations around the stable equilibrium position are observed; the support backing of excavators has elastic – suspending properties; parts of kinematic chain are rigid bodies; hydraulic actuators of the drive mechanisms are elastic – suspending elements. Excavator movement is defined by generated coordinates q :

$$[q] = [z_c \ \varphi \ \theta \ \alpha \ \beta \ \gamma]^T \quad (1)$$

whereby: z_c - is vertical movement of the center of the undercarriage section mass; φ - is the angle of revolving around the for-and-aft main central inertia axis O_1x_1 ; θ - is the revolving angle around the cross main central inertia axis O_1y_1 ; α - is the revolving angle of the manipulator arrow around the axis O_3y_3 ; β - is the revolving angle of the manipulator arm around the end of arrow joint axis O_4y_4 and γ - as the revolving angle of the manipulator bucket around the end of arm joint axis O_5y_5 .

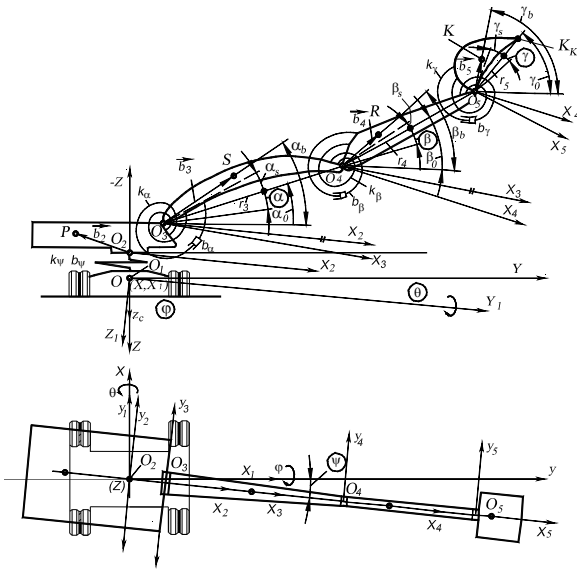


Figure 2. The dynamical model of hydraulic excavator

3. KINETIC SYSTEM ENERGY

Kinetic system energy equals the sum of the kinetic energies of the system segments:

$$E_k = E_{k1} + E_{k2} + E_{k3} + E_{k4} + E_{k5} \quad (2)$$

whereby: E_{k1} - is kinetic energy of the undercarriage section; E_{k2} - is kinetic energy of the platform; E_{k3} - is kinetic energy of the arrow; E_{k4} - is kinetic energy of the arm suspender and E_{k5} - is kinetic energy of the bucket. Individual energies are:

$$2E_{k1} = m_1 v_1^2 + J_{1x_1} \dot{\phi}^2 + J_{1y_1} \dot{\theta}^2 \quad (3)$$

$$2E_{k2} = m_2 v_P^2 + J_{2x_2} \dot{\phi}^2 + J_{2y_2} \dot{\theta}^2 \quad (4)$$

$$2E_{k3} = m_3 v_S^2 + J_{3x_3} \dot{\alpha}^2 \quad (5)$$

$$2E_{k4} = m_4 v_R^2 + J_{4x_4} \dot{\beta}^2 \quad (6)$$

$$2E_{k5} = m_5 v_K^2 + J_{5x_5} \dot{\gamma}^2 \quad (7)$$

$$2E_k = m_1 v_1^2 + J_{1x_1} \dot{\phi}^2 + J_{1y_1} \dot{\theta}^2 + m_2 v_P^2 + J_{2x_2} \dot{\phi}^2 + J_{2y_2} \dot{\theta}^2 + m_3 v_S^2 + J_{3x_3} \dot{\alpha}^2 + m_4 v_R^2 + J_{4x_4} \dot{\beta}^2 + m_5 v_K^2 + J_{5x_5} \dot{\gamma}^2 \quad (8)$$

Whereby: $m_i (i=1,2,3,4,5)$ - are masses of certain excavator parts; $v_i (i=1,P,S,R,K)$ - are absolute speeds of the mass centre of certain excavator parts; $J_{jx_k} (j,k=1,2,3,4,5)$ - are the main central axial moments of inertia of the mass of certain excavator parts for longitudinal axis $O_j x_k$; J_{1y_1} - is the main central axial moment of the mass inertia of the undercarriage section for the cross coordinate $O_1 y_1$ which intersects the center of the mass O_1 ; J_{2y_2} - is the main central axial moment of the mass inertia of the revolving part for the cross coordinate $O_2 y_2$ which intersects the center of the mass O_2 ; $\dot{\phi}$, $\dot{\theta}$ - are angle speeds of the undercarriage section around its longitudinal $O_1 x_1$ and cross $O_1 y_1$ inertia axis; $\dot{\alpha}$, $\dot{\beta}$,

$\dot{\gamma}$ - are angle speeds of the arrow, arm and bucket around their longitudinal $O_3 y_3$, $O_4 y_4$ and $O_5 y_5$ inertia axis.

4. POTENTIAL SYSTEM ENERGY

The potential energy of the adopted dynamical excavator model is:

$$2E_p = c_{11}(\lambda_{11} + p_{11})^2 + c_{12}(\lambda_{12} + p_{12})^2 + c_{21}(\lambda_{21} + p_{21})^2 + c_{22}(\lambda_{22} + p_{22})^2 - g \sum_{i=1}^5 m_i (z_i - z_i^0) + k_\phi \phi^2 + k_\theta \theta^2 + k_\alpha (\alpha_s + \alpha)^2 - k_\alpha \alpha_s^2 + k_\beta (\beta_s + \beta)^2 - k_\beta \beta_s^2 + k_\gamma (\gamma_s + \gamma)^2 - k_\gamma \gamma_s^2 \quad (9)$$

Whereby: $c_{ij} (i, j=1,2)$ - reduced rigidity of the base and support (prop); $\lambda_{ij} (i, j=1,2)$ - corresponding static deformations; $p_{ij} (i, j=1,2)$ - reduced dynamic deformations of the base and support (prop); g - gravity force; z_i, z_i^0 - momentary and initial coordinates of the position of the mass centre within excavator elements system relative to the overall coordinate system; m_i - masses of certain parts within excavator elements system; k_α , k_β , k_γ - torsion spring rigidity equal to the rigidity of the elastic hydraulic actuators of the drive mechanisms: arrows, arms and buckets; $\alpha_s, \beta_s, \gamma_s$ - static deflection of the torsion springs: arrows, arms and buckets; $\alpha_0, \beta_0, \gamma_0$ - positioning angles of the arrow, arm and the bucket in static equilibrium position; k_ϕ, k_ψ, k_θ - are rigidities of the revolving around central axis O_x, O_z and O_y .

5. SYSTEM MOVEMENT EQUATIONS

LaGrange's equations of the second kind have been used for deriving differential equations of movement [7]:

$$\frac{d}{dt} \left(\frac{\partial E_k}{\partial \dot{q}_r} \right) - \frac{\partial E_k}{\partial q_r} + \frac{\partial E_p}{\partial q_r} = 0, \quad (10)$$

$$q_r = z_c, \phi, \theta, \alpha, \beta, \gamma, \quad (r=1,2,3,4,5,6)$$

Equation (10) includes expressions for kinetic and potential energy (8) and (9) representing the system of six nonlinear, homogeneous differential equations of the second kind that can be resolved by using discrete numerical methods, after transforming into metrical shape:

$$\mathbf{A} \cdot \ddot{\mathbf{q}} + \mathbf{C} \cdot \dot{\mathbf{q}} + \mathbf{B} \cdot \mathbf{q} = \mathbf{D} \quad (11)$$

where the corresponding matrixes $\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D}$ are functions of the generated coordinates and speeds the dimensions of which are 6x6. MATLAB program packet enables resolving the derived system of nonlinear differential equations.

6. DETERMINING THE NATURAL FREQUENCIES OF A HYDRAULIC EXCAVATOR

Resolving the system of equations (11), describing the dynamical behavior of hydraulic excavators, can be separated into determining the movement vector q_i ($q_i = z_c, \phi, \theta, \alpha, \beta, \gamma$) and determining their natural frequencies and oscillatory forms. Natural frequencies and the corresponding vectors can be worked out by means of free vibration system analysis when homogeneous part of

equation (11). $\mathbf{A} \cdot \ddot{\mathbf{q}} + \mathbf{B} \cdot \dot{\mathbf{q}} = \mathbf{0}$. is observed. For the needs of mathematical free vibrations system modeling and with the purpose of determining their natural frequencies, it can be assumed that damping within the system is negligible. According to the well known procedure related to determining natural frequencies, the dynamic matrix is formed, together with the characteristic determinant with reference to the characteristic equation of the system:

$$\det(\lambda \cdot \mathbf{I} - \mathbf{U}) = 0 \quad (12)$$

Whereby:

$\mathbf{U} = \mathbf{A}^{-1} \cdot \mathbf{B}$ - dynamical system matrix with $\mathbf{A}$ and $\mathbf{B}$ as inertia matrix;

$\mathbf{I}$ - system rigidity matrix,

$\lambda = \frac{1}{\omega^2}$ - i.e. ω is the system natural frequency.

The hydraulic excavator observed is described by means of nonlinear differential equation which means that during the dynamical process the system dynamical properties cannot be regarded as constant values. This applies to both rigidity and damping coefficients and to their matrices coefficients as well. In such cases transformations into a set of independent equations based on forms properties and the use of normal coordinates are impossible. For this kind of system analysis, the possibility of step by step numerical integration is used - the system is considered to be linear for certain period of time having all the characteristics it had at the beginning of that period of time. This means that nonlinear analysis is approximated by a series of analyses of completely variable systems [8]. Numerical analysis refers to the concrete excavator construction (Table 3).

Eigenvalues of the matrix $\mathbf{U}$ are the zero of the characteristic polynomial i.e. the roots of the characteristic equation (12). In order to be able to work out the Eigenvalues and their characteristic vectors, the parameters of the system at certain point of time were observed. These were taken out from the result of the analysis of the system of differential equations at certain point of time, for example at the point of time $t = 0.100 \text{ s}$ in iteration $n = 19999$ with very low system excitation. This is necessary because the mass and rigidity system matrices are dependent on the generalized coordinates and their speeds, and as such they cannot be used for obtaining the dynamic matrix of the system. This procedure makes it possible to obtain the matrices of rational values. The system state vector at that particular moment is described in table 1.

Table 1. The system state vector

z_c [m]	$\dot{z}_c$ [deg/s]	φ [deg]	$\dot{\varphi}$ [deg/s]	θ [deg]	$\dot{\theta}$ [deg/s]
-0.0022	0.0913	-0.0010	-0.9068	-0.0013	0.0105

α [deg]	$\dot{\alpha}$ [deg/s]	β [deg]	$\dot{\beta}$ [deg/s]	γ [deg]	$\dot{\gamma}$ [deg/s]
0.0049	-0.1762	-0.0903	-3.2058	0.0398	8.7507

Table 2. Natural frequencies of hydraulic excavators

Natural frequencies	ω_{z_c}	ω_{φ}	ω_{θ}	ω_{α}	ω_{β}	ω_{γ}
rad/s	121.6164	92.0227	49.4916	16.7553	11.4087	6.4191
Hz	19.3558	14.6459	7.8768	2.6667	1.8158	1.0216

7. OSCILLATIONS IN HUMAN BODY

Human body may be treated as a complex oscillatory system within which some organs are not firmly but elastically attached to the skeleton. Each of our main organs has its own resonant frequency dependent on its mass and elastic forces affecting it. Natural

Matrix of inertia $\mathbf{A}$ and matrix of rigidity $\mathbf{B}$ of the system at the observed moment are:

$$\mathbf{A} = 1.0\text{e}+004 \cdot$$

$$\begin{bmatrix} 1.0633 & 0.9423 & -0.2444 & -1.5645 & -0.2090 & 0.0080 \\ 0.9423 & 6.6536 & -0.3062 & -5.8923 & -1.8336 & 0.8307 \\ -0.2444 & -0.3062 & 4.1787 & 0.4836 & 0.0661 & -0.0009 \\ -1.5645 & -5.8923 & 0.4836 & 9.1443 & 1.3128 & -0.3437 \\ -0.2090 & -1.8336 & 0.0661 & 1.3128 & 0.8656 & -0.3928 \\ 0.0080 & 0.8307 & -0.0009 & -0.3437 & -0.3928 & 0.4432 \end{bmatrix}$$

$$\mathbf{B} = 1.0\text{e}+008 \cdot$$

$$\begin{bmatrix} 0.6000 & 0 & -0.6120 & 0 & 0 & 0 \\ 0 & 1.6869 & -0.9890 & 0 & 0 & 0 \\ -0.6120 & -0.9890 & 2.4970 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.1169 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.0056 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.0038 \end{bmatrix}$$

By applying function $[V, D] = \text{eig}(U)$ from MATLAB packet program, it is possible to work out the diagonal matrix $\mathbf{D}$ that contains Eigenvalues on the main diagonal and the full matrix $\mathbf{V}$ whose columns represent the corresponding matrix $\mathbf{U}$ vectors.

$$\mathbf{D} = 1.0\text{e}+004 \cdot$$

$$\begin{bmatrix} 1.4791 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.8468 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.2449 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.0281 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.0130 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.0041 \end{bmatrix}$$

$$\mathbf{V} = \begin{bmatrix} -0.1588 & -0.8613 & -0.6478 & -0.0059 & -0.0169 & 0.0071 \\ -0.5614 & 0.2806 & -0.3303 & -0.0034 & -0.0115 & 0.0088 \\ 0.1679 & 0.1327 & -0.4723 & -0.0027 & -0.0082 & 0.0051 \\ -0.2906 & -0.0266 & -0.2479 & 0.1243 & 0.2179 & -0.0655 \\ -0.7119 & 0.2957 & -0.4279 & -0.6816 & 0.1570 & -0.7386 \\ 0.2004 & -0.2715 & 0.0603 & -0.7210 & 0.9630 & 0.6708 \end{bmatrix}$$

The spectrum of natural frequencies can be calculated if the solution of the diagonal matrix $\mathbf{D}$ is rooted and divided by 2π (Table 2).

frequencies of some parts of the human body vary from 1 – 20 Hz. The model of the body as an oscillatory system is described in figure 3. Figure 3. shows the vibration frequency values causing pain in some parts of the body. The vibrations reach the man through the surface which he / she sits or stands on and via other vibrating things he / she is directly or indirectly in contact with. The effects of these

vibrations on human health is given in ISO standard 2631 [10].

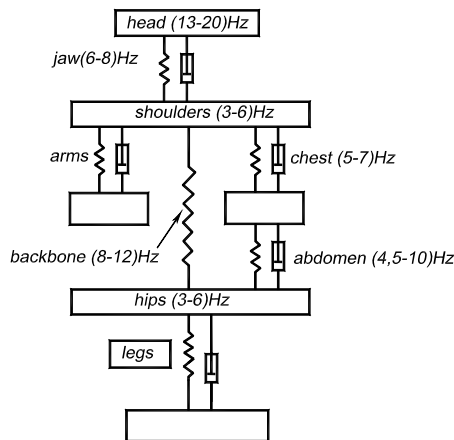


Fig. 3. Resonant frequency values for some parts of the body

If certain organ or part of the body is exposed to the vibrations the frequencies of which are equal to its natural frequencies, the resonant effect will certainly appear. Most of these effects do not cause disastrous consequences due to the damping coefficient that is high enough to damp down the oscillations within biological systems quickly. If the resonant effect lasts over a longer period of time, it may cause pain or annoying feelings.

8. RESULT ANALYSIS

The analysis of the previously described numerical experiments clearly shows that natural frequencies of a mechanical structure are, to some degree, within the limits of human organs frequencies. The strongest effect on the excavator operator comes from the frequencies following axis z which is in the direction of the operator's backbone. Besides these vibrations, the operator is exposed to the vibrations along generalized coordinates φ and θ in the direction of axis x and y which are less harmful to the operator's health, comfort or perception, while the vibrations along other coordinates have negligible effects. The highest natural frequency of all obtained by the mathematical model is $\omega_{zc} = 19.3558$ Hz and compared with the resonant frequencies of some organs in the human body 3-20 Hz, it can be seen that they overlap to some degree. Natural frequency values of hydraulic excavators, obtained by analytical calculations, are of such intensity that, in case of being provoked and active for a longer period of time, they might affect the excavator operator's comfort, perception and health.

8. REFERENCE

- [1] D. Janošević: *Optimal synthesis of hydraulic excavator drive mechanisms*, Doctoral dissertation, Faculty of Mechanical Engineering, University of Nis 1997.
- [2] D. Janošević: (2002). *Analysis of hydraulic excavator dynamic stability*, XVII International Conference on Material Flow, Machine and Devices in Industry, Belgrade, p. 7-12.
- [3] Vähä, P.K., Skibniewski, M.J.: (1993). *Dynamic Model of Excavator*. Journal of Aerospace Engineering, 6(2), pp.148-158.
- [4] Frimpong, S., Hu, Y., Inyang, H.: (2008). *Dynamic Modeling of Hydraulic Shovel Excavators for Geomaterials*, International Journal of Geomechanics, vol. 8, no. 1, p. 20-29.

- [5] Vähä, P.K., Skibniewski, M.J.: (1993). *Dynamic Model of Excavator*. Journal of Aerospace Engineering, 6(2), pp.148-158.
- [6] Park, C., Lim, K. (2004). A.: *Simulation Environment for Excavator Dynamics*, Virtual Product Development Conference, Huntington Beach, CA: MSC Software Corporation's.
- [7] Li, Y., Hi, Q., Zhang, D.: (2006). *Dynamic Analysis and Simulation with Lagrange Equation on Hydraulic Excavator*. Machine Tool and Hydraulics, vol. 10, p. 060.
- [8] Brčić V.: *Construction Dynamics*, Građevinska knjiga, Beograd, 1981.
- [9] Drugă, C., Barbu, D., Lache, S.: (2007). *Vibration and the human body*, Annals of the Oradea University, Fascicle of Management and Technological Engineering, vol. 6, no. 16, p. 168-173.
- [10] ISO 2631: Mechanical vibration and shock-Evaluation of human exposure to whole-body vibration, 01.May 1997.

Table 3. Parameters of the observed excavator

Masses [kg]	$m_1 = 6480$, $m_2 = 1.1002e3$, $m_3 = 1725$, $m_4 = 760$, $m_5 = 568$
Moment of inertia [kgm ²]	$I_1 x_1 = 8210$, $I_1 y_1 = 12746$, $I_2 x_2 = 4581$, $I_2 y_2 = 8590$, $I_3 x_3 = 267$, $I_4 x_4 = 564$, $I_5 x_5 = 82$
Position angles [deg]	$\alpha_0 = -35$, $\beta_0 = -80$, $\gamma_0 = 160$
Static deflections [deg]	$\alpha_s = 0.5$, $\beta_s = 0.5$, $\gamma_s = 0.5$
Vectors of the characteristic points positions [m]	$r_1 = 0.55$, $r_{1z} = 0.55$, $r_2 = 0.65$, $r_{2x} = 0.325$, $r_3 = 5.20$, $r_4 = 2.95$, $r_5 = 1.38$, $b_2 = 1.40$, $b_{2x} = 1.32$, $b_{2z} = 0.48$, $b_3 = 2.75$, $b_4 = 1.50$, $b_5 = 0.63$
Rigidity between the surface and support [N/m]	$c_{11} = 150e5$
Static deformations of the surface and support [m]	$\lambda_{11} = 5e-3$
Distances [m]	$l_1 = 2.04$, $l_3 = 1.616$
Rigidity of the rotation around axis [Nm/rad]	$k_\varphi = 1.2e7$, $k_\theta = 1.2e7$, $k_\psi = 4e6$
Torzione krutosti [Nm/rad]	$k_\alpha = 1.1694e7$, $k_\beta = 5.6129e5$, $k_\gamma = 3.7919e5$

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EFFECT OF ELECTROMAGNETIC STIRRING IN MOLD ON THE MACROSTRUCTURE OF TP347H HEAT-RESISTANT STEEL BILLETS

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Key words: Continuous casting; TP347 heat resistant steel; Electromagnetic Stirring; Center Equiaxed Grain; Center porosity

Abstract: To understand the solidification behavior of austenitic heat-resistant stainless steel (TP347) in rotary electromagnetic-field, the influence of electromagnetic stirring in mold (M-EMS) on solidification structure of TP347 heat resistant steel in a round billet continuous casting was investigated based on industrial experiments. The results indicate that the excellent billet solidification structure of TP347 heat resistant steel can be obtained with appropriate electromagnetic stirring parameters. The solidification structure of TP347 heat resistant steel can be remarkably refined, central porosity and shrinkage cavity can be remarkably decreased and equiaxed grains zone widens was enlarged. The industrial trials verify that the stirring intensity of TP347 heat resistant austenitic stainless steel should be higher comparing with plain carbon steel. Due to a higher viscosity, rotating speed of molten stainless steel was 20~30% lower than that of molten carbon steel in the same magnetic flux density.



Shu-cai ZHOU

1. INTRODUCTION

In recent years, the development of ultra super critical (USC) plants is accelerated by the demands of environment protection and energy saving, and USC plants with steam temperature and pressure conditions in excess of 593°C and 24.1MPa respectively were constructed[1]. TP347H steel is promising austenitic heat-resistant steel, which is used as superheater/reheater tube material and is extensively used for high temperature components and fossil-fired power plants, and suitable to be used in USC boilers plant. This kind steel contains with about 0.7%Nb and it keeps higher allowable stress and creep rupture strength than TP304 and TP321H [1-2]. However, TP347H steel has conventionally been produced by ingot casting followed by forging and rolling. Recently, in order to decrease the production cost, challenging trials to produce these types of alloys by a continuous casting (CC) process have been attempted. However, the solidification structure of TP347H austenitic stainless steel is one of the key issues that attract more attention. Due to the low thermal conductivity of TP347H heat resistant stainless steel (much smaller than that of plain carbon steel), pronounced defects during continuous casting of TP347H heat-resistant steel such as coarse columnar, center porosity and coarse bridging, greatly influence mechanical properties of finished products. Grain refinement and the equiaxed structure of the solidified structure have another advantage of reducing segregation, center porosity and coarse bridging. Thus, a lot of methods to reduce the grain size and increase equiaxed grain rates in the structure have been proposed and have been investigated up to now.

A widely used technique in metallurgy is the inductive drive of molten metals using electro-magnetic fields. Recently, rotary electromagnetic stirring (EMS) has been applied to reducing various defects and improving increase the solidification structure of the metals in the continuous casting of steel, Al-based alloys and Mg-based alloys [3-8]. Electromagnetic stirring of plain carbon and low alloy steel in the continuous casting bloom and slab is well established for improving the quality of cast products [9-11] and is widely used in industry. However, very few literatures on electromagnetic casting of heat resistant stainless steel have reported. In this work, an industrial plant trial was performed to clarify the effect of M-EMS on the macroscopic quality of TP347 heat resistant steel billet, in which the regularity and mechanism of the influence of EMS on solidification casting billet were discussed.

2. EXPERIMENTAL PROCEDURES

The steel-making system along with the process program for the production of TP347H heat-resistant steel consists of a 40tEAF→40tVOD→40tLF→continuous casting (200mm×200mm). The parameters for the continuous caster are shown in Table 1.

Table 1 Major parameters of continuous caster

Item	Parameter
Casting machine style	Cure caster
Mold size,mm	200×200mm
Number of strands	3
Tundish capacity,t	16
Casting radius,m	9
Casting speed,m.min ⁻¹	Max1.1
Mould length,mm	850
Straight/cure points	9/17.5
MLAC	Cs137

The compositions of the TP347H heat resistant steel are shown in Table2. First, the raw materials are melted in an electric furnace, decarburization, desulfurization and deoxidized are given in VOD furnace, subsequently. Next, slag refinement and adjustment of components and temperature of molten steel are given in ladle furnace. Third, vacuum degassing with gas stirring is applied to promote oxygen and hydrogen refining and ladle was transported to CC process. The specified addition times are given in minutes from the start of casting. The tundish and nozzle were preheated to approximately ~1373K and 1273K respectively before the pouring trials begun. The frequency of rotary EMS was modulated in the range of 0~8 Hz. The current of EMS was modulated in the range of 1~400 A.

Table 2 Chemical Composition (wt%) of TP347 steel

C	Si	Mn	P	S	Cr	Ni	Nb	Fe
0.07	0.35	1.35	0.03	0.012	18.08	11.22	0.68	bal

The speed of continuous casting machine was (0.8~0.9) m/min in all experiments; the superheat value steel was 30~40℃. The steel samples were solidified under five different electromagnetic conditions, shown in Table3 and those were compared each other under the different electromagnetic stirring conditions to examine the effect of the electromagnetic fields on the solidified structure. The macrostructure was obtained on sections taken from the continuously cast billets at the beginning, middle, and end of pouring. Then, the samples were etched in the industrial hydrochloric acid and continuous being heated 30min, the concentration of acid is 30% and its temperature is 80℃. Finally, quality examination of samples including the central porosity, central pipe, subsurface crack, core crack and skin blowhole were completed in the laboratory.

Table.3 Experimental conditions relating electromagnetic field in this investigation

Sample number	Magnetic field intensity(Gs)	Current(A)	Frequency(Hz)
1	0	0	0
2	700	320	5
3	880	360	3
4	800	360	5

3. RESULTS AND DISCUSSION

3.1 Macrostructure with and without Electromagnetic Stirring

Two samples were solidified to examine the effect of the electromagnetic field imposition on the solidified structure. One was solidified without the electromagnetic field imposition (sample1: 0 Gs, 0 A) and the other was solidified under the different electromagnetic stirring conditions. Macrostructure of the samples 1 and 2 are shown in Figs.1,2,3 and 4, respectively.

From the results of all of the experiments, it is obvious that the macrostructure of the billets with the electromagnetic stirring is finer than that of the billets with direct chill process. Fig.1 shows the coarse macrostructure of the billet without EMS. Obviously, the macrostructure are characterized by coarse columnar grains, shrinkage cavity and columnar grains spreading almost the whole of billet. By contrast, casting under an electromagnetic field, the macrostructure of the billet is dominated by fine columnar and equiaxed grains as shown in Fig.2. In addition, EMS reduce centerline porosity and shrinkage cavity and eliminate

intracrystalline. So it is necessary to optimize the stirring parameters of EMS in order to further improve the billet quality.



Fig.1. Macrostructures of sample 1 without Electromagnetic Stirring



Fig. 2. Macrostructures of sample 2 under conditions of 5Hz and 320A

3.2. Effect of Electromagnetic Stirring Current and Frequency on Macrostructure

To study the effect of the electromagnetic stirring current and frequency, two samples (samples 3, 4) were solidified under the different frequency of 3Hz and 5Hz, while electromagnetic stirring current were constants of 80 A. The macrostructure of typical defects for TP347 steel samples with different optimum stirring parameters are presented in Fig.2-4, respectively.

As shown above the macrostructure of EMS billets is fine columnar and equiaxed grains. Fig.2-4 shows that the transition from very coarse columnar grains to finer columnar and to equiaxed grains as the current increasing from 300 to 360A. As seen in Fig.3 and 4, columnar structure and equiaxed structure coexist as shown in macrostructure picture of sample 3 and 4. But the uniformity of macrostructure for sample 3 is rather better than the case as shown in Fig.4.



Fig.3. Macrostructures of sample 3 under conditions of 3Hz and

360A



Fig.4. Macrostructures of sample 4 under conditions of 5Hz and 360A

Fig.3 shows the macrograph of TP347H steel billet with the stirring parameters of 360 A and 3Hz. It shows that the billet structure is characterized by a complete absence of the area of shrinkage cavity. Instead, a fine columnar grains and equiaxed grain structure is predominant and it has no obvious other inner defects. The uniformity and compactness of the sample macrostructure is the best than all other.

According to solidification theory^[12], the drive force for crystallization is expressed by:

$$\Delta G \approx \frac{\Delta H_m \Delta T}{T_m} \quad (1)$$

And the degree of solute supercooling:

$$\Delta T_c = \frac{mc_o(1-k)}{k} (1 - e^{-\frac{Rx}{D}}) - Gx \quad (2)$$

where ΔT_c is the degree of supercooling, ΔH_m is solidification

latent heat, k is alloy constant, m is liquidus slope, R is Growth

rate, G is temperature gradient ahead of the solidification front, C_0 is

solute concentration, D is solute diffusion coefficient(in liquid).

According to equations (1) and (2), ΔG will increase with G

and ΔT_c decreasing Therefore, temperature gradient (G) directly

influences the type of grain morphologies.

As shown in Fig.1, the solidification structure at the cross-section of the billet without EMS is coarse columnar grain. This is mainly due to considerable temperature gradient at the interface (G) in mold. The Fig.2, 3 and 4 is different for the magnetic flux density and frequency of EMS. The results suggest that the magnetic flux density and frequency of EMS has obvious effect on the solidification structure.

Under the effect of the alternative current, the inductor generates a variable magnetic field in the melt, which, in turn, gives rises to induced currents well as horizontal electromagnetic volume force and vertical electromagnetic volume force, which makes the low temperature melt near the mold, moving inwards into the center, and high temperature melt moving outwards to the border. These results in a forced convection flow in the melt and a reduction of the temperature gradient ahead of the solidification front, which had been identified experimentally^[13]. All the effects can effectively refine the microstructures and broaden the equiaxed zone. So the structure of the casting billet with EMS are much finer than that of direct chill billet, as shown Fig.1. When the magnetic flux density (stirring current) of EMS keep increase, the solidification structure of austenitic stainless has no obvious alternation as shown in Fig.4, which indicates that the volume force is too small. The

electromagnetic stirring is typically a multiphase induction motor. The average volume force for a two-pole axisymmetric system is given by^[14]:

$$F = \frac{1}{2} \sigma B^2 \omega_s r \quad (3)$$

where B is magnetic flux density, f is the frequency of current, σ is the electrical conductivity of the liquid metal, ω_s is angular frequency of eddy current expressed as velocity slip.

According to equation (3), the calculated electromagnetic force is shown in Fig.5. The notably increased volume force to the melt may be mainly attributable to an appropriate higher or an optimal frequency utilized in Fig.3. Therefore, these parameters will determine the input in kVA need to generate required volume force. The effect of each of these parameters on the stirrer characteristics as well as metallurgical performance shall be considered in context of their interaction rather than as an independent impact.

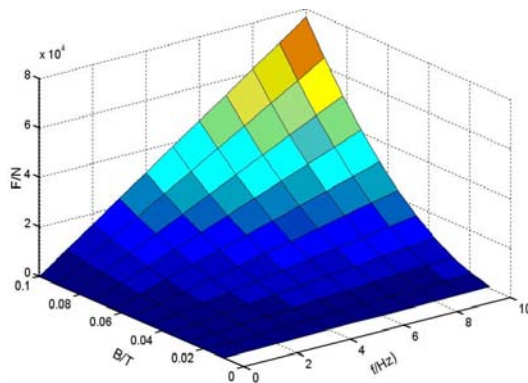


Fig.5. Evolutions of electromagnetic force with frequency and current.

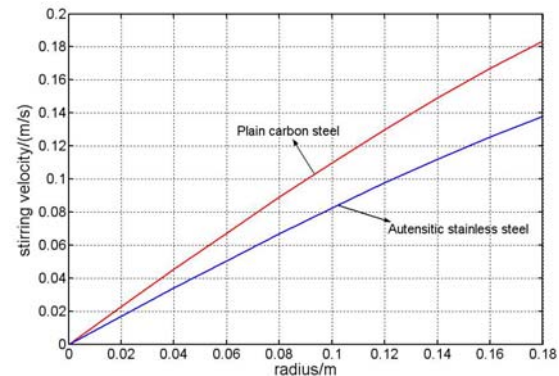


Fig.6 calculated distributions of stirring velocity in cross-sectional view

3.3 Effect of thermophysical properties of heat-resistant stainless steel on macrostructures.

As shown in Fig.1, with application of electromagnetic stirring, the equiaxed and columnar grain sizes were found to be decreased, but the increase of the area of equiaxed grains is not obvious. There are mainly two reasons for this effect. Firstly, due to the low thermal conductivity of stainless steel, as shown in Table 4, a reduction of the temperature gradient in stainless steel melt by the magnetic forced convection is too small. Secondly, because of high kinematic viscosity of stainless steel, as shown in Table1. In the low frequency and low induction limit, the magnetic Taylor number Ta can be taken as the characteristic non-dimensional parameters to describe the flow field. The Taylor number is given by^[15]:

$$T_a = \frac{\sigma \omega B^2 R^4}{2 \rho \nu^2} \quad (4)$$

Where ρ and ν denote the density and the kinematic viscosity of the fluid separately.

The heat transfer coefficient, due to convection, increases with increasing Taylor number. A distinct reduction of the temperature gradient with growing Taylor number becomes visible, indicating a thermal homogenisation of the melt. Based on equation (4), the magnetic Taylor number Ta of stainless steel is 40% lower than that of plain carbon steel at a given kVA input and dimensional parameters of the stirrer. Moreover, the stirring velocity calculated by the formula suggested by Qi et al^[14] is shown in Fig.6. Due to a higher viscosity, rotating speed of molten stainless steel was 20%~30% lower than that of molten carbon steel in the same magnetic flux density^[17], which had been identified experimentally^[16]. So a reduction of the temperature gradient of stainless steel billets is low and lead to growth is columnar grains generally.

Table 4. Thermophysical properties of the melt steel used in calculation^[15,16]

Thermophysical property	Austenitic stainless steel	Plain carbon and alloy steel
thermal conductivity at solidus/ $W \cdot m^{-1} \cdot K^{-1}$	14~17	47~58
thermal conductivity at liquidus/ $W \cdot m^{-1} \cdot K^{-1}$	30.3	120~170
Electrical conductivity/ $\Omega^{-1} \cdot m^{-1} (10^7)$	7.20	7.14
Kinematic viscosity/ $m^2 \cdot s^{-1} (10^{-7})$	11.26	8.57
Ta (70mT, 7 Hz, $R = 70$ mm)(10^9)	2.09	3.59

4. CONCLUSIONS

The macroscopic qualities of TP347 heat resistant steel billets with M-EMS for different stirring parameters were tested by industrial plant trials. The following conclusions are obtained.

(1) Under the low-frequency rotary electromagnetic field, the rotary volume force produces a forced convection flow in the melt, as well as a reduction of the temperature gradient at the ahead of the solidification, which facilitates heat transfer and mass transfer as well as uniformity of shell solidifying shell.

(2) Stirring intensity produced by EMS and its metallurgical performance at a given kVA input are determined by the relationships between intensity and frequency of magnetic field and the electrical conductivity of the melt

(3) M-EMS as a good casting technique has a significant effects for improving the whole quality of TP347 heat resistant steel and promoting the final product performance. The billet qualities of TP347 heat resistant steel are all improved in different degree. The subsurface crack and central pipe and intracrystalline are all disappeared, besides the central porosity and grain refinement is

improved obviously, but the increase of the area of equiaxed grain zone is not obvious as expected.

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REFERENCES

- [1] MASUYAMA F. History of Power Plants and Progress in Heat Resistant Steels[J]. ISIJ International, 2001. 41 (6): 612–625.
- [2] Chi Cheng-yu, Yu Hong-yao, Dong Jian-xin, Liu Wen-qing, Cheng Shi-chang. The precipitation strengthening behavior of Cu-rich phase in Nb contained advanced Fe–Cr–Ni type austenitic heat resistant steel for USC power plant application[J]. Progress in Natural Science: Materials International 2012;22(3):175–185.
- [3] Du Yan-yan, Lu Yi-ping, Wang Tong-min, Li Ting-lu, Zhang Guo-liang. Effects of electromagnetic stirring on micro-structure

and properties of $Al_{10}CoCrCuFeNi$ alloy [J]. Procedia Engineering, 2012, 27: 1129-1134

[4] YAO Lei, HAO Hai, GU Song-wei, DONG Han-wei, ZHANG Xing-guo. Effects of electromagnetic stirring on microstructure and mechanical properties of super light Mg-Li-Al-Zn [J]. Transactions of Nonferrous Metals Society of China, 2010, 20(Supplement 2): 388-392

[5] Mapelli C, Gruttadauria A, Peroni M. Application of electromagnetic stirring for the homogenization of aluminum billet cast in a semi-continuous machine [J]. Journal of Materials Processing Technology, 2010, 210(2): 306-314.

[6] Wang Xiang-jie, Cui Jian-zhong, Zuo Yu-bo, Zhao Zhi-hao, and Zhang Hai-tao. Effects of low-frequency electromagnetic field on the surface quality of 7050 aluminum alloy ingots during the hot-top casting process [J]. International Journal of Minerals, Metallurgy and Materials, 2011, 18(2): 165-168

[7] Sha Ming-hong, Wang Tong-min, Bai Fu-dong, Li Jun, and Li Ting-ju. Simulation on solidification of an Al-Ni alloy under electromagnetic stirring [J]. CHINA FOUNDRY, 2012, 9(3): 258-262

[8] LIU Sheng-fa, KANG Liu-gen, HAN Hui, ET. Influence of electromagnetic stirring on microstructure of AZ91-0.8%Ce magnesium alloy [J]. Journal of central south university of technology, 2006, 13(6): 613-617.

[9] YANG Jing, DANG Jing-zhi, PENG You-gen. Design method of electromagnetic field applied to Al-alloy electromagnetic casting [J]. Trans Nonferrous Met. Soc China 2006, 16: s1437- s1441

[10] Takehiko T, Eiichi T, Masatake H. Electromagnetic control of initial solidification in continuous casting of steel by low frequency alternating magnetic field [J]. ISIJ International, 1997, 37(11):

1112~1119.

[11] Cho Y W, OH Y J, Chung S H. Mechanism of surface quality improvement in continuous cast slab with rectangular cold crucible mold [J]. ISIJ International, 1998, 38 (7): 723~729.

[12] LI Qing-Chun. The theoretical foundation of casting forming [M]. Beijing: Mechanical Industry Press, 1982 (in Chinese)

[13] B. Willers, S. Eckert, U. Michel, I. Haase. The columnar-to-equiaxed transition in Pb-Sn alloys affected by electromagnetically driven convection [J]. Materials Science and Engineering A, 2005, 402(1-2): 55-65

[14] QI Ya-li, JIA Guang-lin, ZHANG GUO-zhi. Effect of electromagnetic stirring on liquid metal fluid flow and solidification structure [J]. Foundry Technology, 2005, 26(2): 118~120 (in Chinese)

[15] Keisuke Fujisaki. In-Mold Electromagnetic Stirring in Continuous Casting [J]. IEEE Transactions on Industry Application, 2001, 37(4): 1098-1104.

[16] Kenneth C. MILLS, Yuchu SU, Zushu LI. Equations for the Calculation of the Thermo-physical Properties of Stainless Steel [J]. ISIJ International, 2004, 44(10): 1661-1668

[17] ZHONG Yun-bo, MENG Xian-jian, NI Dan. Experimental Study on Purifying Molten Steel by Superimposing Rotating Magnetic Field [J]. Shanghai Metals, 2006, 28(2): 9-14 (in Chinese)

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NUMERICAL SIMULATION STUDY OF GAS-CAP RESERVOIR BARRIER WATER INJECTION FLUID INTERFACE MIGRATION LAWS

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Key words: Gas-cap reservoir, barrier water injection, numerical simulation, reservoir engineering method, fluid interface, development mechanism

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Abstract: Based on the reservoir property of Zhanazhol oil reservoir with gas cap in Kazakhstan, the numerical model of oil reservoir is built to explore the migration law for oil reservoir with gas cap barrier waterflooding: before the barrier formation, barrier water flows towards gas cap and oil ring according to the migration law of radial flow to supplement the formation energy of the oil area and gas area, respectively, effectively inhibit the expansion energy of gas cap, reduce the migration velocity of the oil-gas interface. After the barrier formation, the barrier cuts off the channel communicating the oil area with the gas area to separate the oil reservoir with gas cap into an oil reservoir with big gas cap and an oil reservoir with small gas cap, so as to realize the separate exploitation of gas cap and oil ring and effectively prevent the mutual channeling of oil and gas. In combination with the barrier water injection migration laws, the reservoir engineering methods of gas-cap reservoir barrier water injection exploitation before and after the formation of the barrier are set up and the fluid interface migration speeds at different development phases are calculated according to the material-balance principle. And in accordance with the calculation results, before the formation of the barrier, the oil-gas interface migration speed decreases with the increasing of the barrier injection-production ratio, and it slows down more seriously when the barrier well is nearer the outside oil-gas interface, however, there are risks of invasion of crude oil into gas cap. After the formation of the barrier, the oil gas interface is translated into oil-water interface and gas-water interface, the oil-water interface migration speed increases with the increasing of oil recovery rate, and the gas-water interface migration speed increases with the increasing of gas production rate. The fluid interface migration laws at different stages of gas-cap reservoir barrier water injection are further studied respectively by means of laboratory experiments and reservoir engineering methods and the study results have guiding significance for field personnel in the control of fluid interface migration direction and speed.

1. INTRODUCTION

The gas cap together with the oil rim is a united hydrodynamic power system, they are in a state of pressure balance, and the pressure change in any part after development will affect the other part. The channeling of natural gas into the oil area does not have great influence on the recovery ratio of the natural gas itself, but the well yield will be reduced, and, if serious, only gas but not oil will be produced to affect the stable yield of the oil well. The immersion of crude oil into gas cap will result in great waste, and the recovery ratio of crude oil will be affected [1]. Therefore, the core problem for mining oil reservoir with gas cap is to get the highest recovery percent of reserves for gas cap and oil ring by using the most economical and effective method [2,3,4]. One of the more conventional method is to waterflood the oil reservoir for keeping energy exploitation, but when the waterflooding well is in the oil ring, it will lead to the rise of oil-gas interface, the crude oil will enter the gas bearing bed, and a lot of crude oil will be absorbed to the pore surface and stagnated in the oil reservoir to result in great loss [5]. For this method, the waterflooding well is drilled near the oil-water interface, the mixture of water with gas will displace the oil ring, and it has a better displacement effect [6]; meanwhile, the waterflooding can separate the oil ring from the gas cap, thus this development method is called barrier waterflooding [7,8,9], and the method is applicable to oil reservoirs with smaller dip angle [10]. The development method of barrier waterflooding was applied in oil reservoirs of Hungarian Algyo oilfield [11]. The 7 oil reservoirs all have big gas caps and thinner oil-bearing edges, and this method enables the operators to increase the oil yield by 10% as compared with the original oil in place. Deboni and Field[12] researched the development method of barrier waterflooding in Canadian Kaybob South Oilfield by means of numerical simulation. The research results showed that the method could build a proper water wall

between gas cap and oil area and increased the oil yield by 10% and above. Afterwards, Travis C.Billiter[13] systematically introduced the mining method of barrier waterflooding, and compared the development effects of different development programs (depletion development, area waterflooding development, barrier waterflooding development, and simultaneous development of gas cap and oil ring in combination with barrier waterflooding development) through numerical simulation, and proved that better development effect could be obtained by waterflooding on the oil-gas interface. At present, the establishment of barriers by water injection to exploit gas-cap reservoir is popular. However, few studies are focused on the migration laws of the barrier upon injection into stratum. By means of numerical simulation and reservoir engineering methods, in-depth analysis of the water injection migration laws before and after the formation of barriers is carried out in this paper.

2. MIGRATION LAW OF BARRIER WATERFLOODING

2.1 Building of Experimental Model

Based on the reservoir property of Zhanazhol Oil Field A South Oil Reservoir, an ideal geologic model was built as shown in Figure 1, wherein, red represents gas cap and green represents oil ring. The characteristic parameters of reservoir and fluid in the geologic model were originated from the actual data of Zhanazhol oil reservoir. The viscosities of formation oil and formation water are 0.6 mPa·s and 0.6 mPa·s, respectively, the original formation pressure is 20MPa, the effective thickness of formation is 80m, the porosity is 0.13, and the permeability is $54.5 \times 10^{-3} \mu\text{m}^2$. The grid is $35 \times 250 \times 8$ with the step size of 10m for dx, dy and dz. The pore volume of the gas cap is 3.13 times of that of the oil ring.



Fig.1 Schematic Chart of Numerical Model for Oil Reservoir

After flooding barrier water into formation, it had to take a certain period of time to form the barrier. By means of numerical simulation of oil reservoir, the forming process of barrier waterflooding was studied with the oil recovery rate of 0.7%, gas recovery rate of 4% and the barrier injection-production ratio of 0.5, and the migration law of barrier waterflooding before and after barrier formation was analyzed.

2.2 Before Barrier Formation

As shown in Figure 2, after flooding barrier water into formation, since the oil area is communicated with the gas area, barrier water flow towards gas cap and oil ring according to the migration law of radial flow to supplement the formation energy in the oil area and gas area, respectively, extend the development duration of oil reservoir, and improve the development effect of oil reservoir. After the gas cap and the oil ring were completely separated by the flooded water, the barrier was formed. In the figure, red represents gas cap, green represents oil ring, and blue represents barrier water.

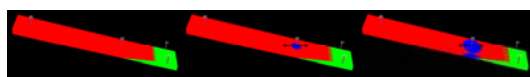


Fig.2 Migration Process of Barrier Waterflooding before Barrier Formation

After flooding barrier water to formation, formation energy was supplemented, the speed of pressure drop became slower, the expansion energy of gas cap was effectively inhibited, the migration speed of oil-gas interface slowed down, and the gas breakthrough time of oil well was prolonged.

2.3 After Barrier Formation

After barrier formation, the barrier cut off the communicated channel (oil-gas interface) between oil area and gas area to divide the oil reservoir with gas cap into an oil reservoir with big gas cap and small oil ring and an oil reservoir with small gas cap and big oil ring, wherein, barrier waterflooding served as an energy supply source for the two "oil reservoirs", and it migrated towards the two "oil reservoirs" at different speeds according to the oil recovery rate and gas recovery rate. As shown in Figure 3, owing to the high gas recovery rate for gas cap, the speed of pressure drop was higher, and the migration speed of water flooding towards gas area was also higher.

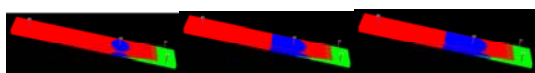


Fig.3 Migration Process of Barrier Waterflooding after Barrier Formation

After the formation of barrier, the function of the barrier water injection is mainly to isolate gas region from oil region, get free of streamline for channeling between gas cap and oil ring, and supplement energy to gas region and oil region through barrier wells, so that independent exploitation of gas region and oil region is realized. At the same time, the barrier water injection has realized the conversion of oil-gas interface into oil-water interface and gas-water interface so that oil and gas channeling into each other is effectively prevented, and the substitution of oil-gas interface by oil-water interface can avoid the severe fingering phenomenon in case of gas flooding so that the oil ring development effect is improved, and the

substitution of oil-gas interface by gas-water interface can retard the invasion of oil into gas cap resulting in decreased loss of crude oil.

3. COMPUTING METHODS OF GAS-CAP RESERVOIR BARRIER WATER INJECTION FLUID INTERFACE MIGRATION LAWS

3.1 Establishment of Gas-cap Reservoir Barrier Water Injection Matter Balance Equation

According to the material balance principle, the cumulative production in the surface indicated through underground conditions shall be equal to the sum of swelling amount of fluid and the amount of intrusive fluid caused by pressure drop in oil reservoirs. For the convenience of formula derivation, the actual reservoir model is simplified and is imaged as a storage tank. Under the original reservoir pressure (P_i), the tank will be fully filled with the oil and gas in the actual reservoir. In this paper, the impact of the incursion of edge and bottom water has been not taken into consideration.

As voidage formation caused by production, when the formation pressure drop is ΔP , the expansion volume of fluid in the reservoir is $A1+A2+A3+A4$, where $A1$ means the increased volume of oil and initial solution gas after expansion, $A2$ means the increased volume of initial gas cap after expansion, and $A3$ means the decreased hydrocarbon pore volume caused by the expansion of bound water and the volume drop of reservoir pore volume. $A4$ means the decreased amount of hydrocarbon pore volume caused by the injection of barrier water into stratum. According to the material balance principle, under the present formation pressure, the underground production is $A1+A2+A3+A4$.

$$N_p B_o + N_g B_g = \quad (1)$$

$$NB_{oi} \left[\frac{B_o - B_{oi} + (R_{si} - R_s) B_g}{B_{oi}} + m \left(\frac{B_g}{B_{gi}} - 1 \right) + (1 + m) \left(\frac{C_w S_{wc} + C_f}{1 - S_{wc}} \right) \Delta p \right] + W_B B_w$$

Where, N is primary reserves of oil rim under standard conditions, m^3 ; m is index of gas cap, i.e. the ratio of the pore volume occupied by the gas cap under initial conditions to the pore volume occupied by the oil rim under initial conditions; N_p is cumulative oil production under standard conditions, m^3 ; N_g is cumulative gas production under standard conditions, m^3 ; B_g is volume coefficient of gas under pressure P , m^3/m^3 ; B_{gi} is volume coefficient of gas under initial formation pressure P_i , m^3/m^3 ; B_o is volume coefficient of crude oil under pressure P , m^3/m^3 ; B_{oi} is volume coefficient of crude oil under initial formation pressure P_i , m^3/m^3 ; R_{si} is solution gas-oil ratio under initial formation pressure P_i ; R_s is solution gas-oil ratio under current pressure P ; C_w is compressibility factor of formation water, MPa^{-1} ; C_f is compressibility factor of pore, MPa^{-1} ; S_{wc} is bound water saturation; ΔP is the current pressure drop, equal to the difference between the initial formation pressure P_i and the current formation pressure; W_B is the barrier water injection amount, m^3 .

3.1.1 Before the Formation of Barriers

In accordance with the barrier formation study results, before the formation, the barrier water flows towards gas cap and oil ring in a radial manner to respectively supplement oil-region and gas-region stratum energy, as is shown in Fig.4, the barrier injected water amount is divided based on a coefficient, some water is used to supplement the gas cap voidage, and some the oil ring voidage. In this paper, the water amount is divided based on perforating thickness.

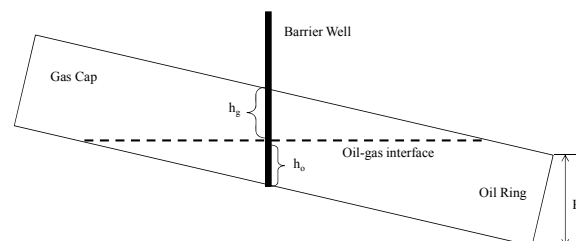


Fig.4 Before the Formation of Barrier, Barrier Injected Water Amount Divided based on Perforating Thickness.

The left part of Equation (1) is the volume of the oil output under the current stratum pressure, and the right part is the expansion volume of stratum fluid. If the formula at the right equation sign is regrouped, the oil ring expansion volume and gas cap expansion volume can be obtained.

Oil ring expansion volume:

$$NB_{oi} \left[\frac{B_o - B_{oi} + (R_{si} - R_s)B_g}{B_{oi}} + \frac{(C_w S_{wc} + C_f)\Delta p}{1 - S_{wc}} \right] + n \times W_B B_w \quad (2)$$

Gas cap expansion volume:

$$NB_{oi} m \left[\left(\frac{B_g}{B_{gi}} - 1 \right) + \frac{(C_w S_{wc} + C_f)\Delta p}{1 - S_{wc}} \right] + (1 - n) \times W_B B_w \quad (3)$$

Wherein n means the division coefficient of barrier water injection amount to gas cap and oil ring, here is its expression:

$$n = \frac{h_o}{h_o + h_g} = \frac{h_o}{H} \quad (4)$$

The invasion amount of gas cap into oil ring or that of oil ring into gas cap can be obtained by gas cap (oil ring) produced amount and gas cap (oil ring) expansion amount.

$$V_{o,GIN} = NB_{oi} m \left[\left(\frac{B_g}{B_{gi}} - 1 \right) + \frac{(C_w S_{wc} + C_f)\Delta p}{1 - S_{wc}} \right] + (1 - n) \times W_B B_w - N_g B_g \quad (5)$$

Oil-gas interface migration speed is calculated based on gas cap invasion amount. Suppose the oil-gas interface moves down horizontally, as is shown in Fig.5, the migration speed of oil-gas interface can be expressed as:

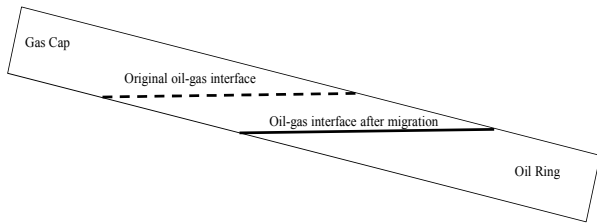


Fig.5 Comparison Diagram before and after the Ideal Oil-gas Interface Migration

$$V_{o,g} = \frac{V_{o,GIN}}{t \cdot H \cdot W \cdot \phi \cdot (1 - S_{or})} \quad (6)$$

Where, t is production time, year; $v_{o,g}$ is the migration speed of oil gas interface, m/y; H is the thickness of the reservoir, m; W is well spacing, m; Φ means porosity; S_{or} is residual oil saturation.

3.1.2 After the Formation of Barriers

When the barrier wells are with fixed well spacing, the volume method may be used to determine the formation of barrier. Here the influence of gravity on injected water is ignored. When Formula (7) is no less than 1, it means the barrier has formed.

$$\frac{Q_B \times t}{\pi R^2 \times H \times \phi \times (1 - S_{or})} \geq 1 \quad \text{Barrier formed} \\ < 1 \quad \text{Barrier unformed} \quad (7)$$

After the formation of barriers, the gas-cap reservoir is isolated into one big-gas-cap small-oil-ring reservoir and one small-gas-cap big-oil-ring reservoir, and the barrier becomes the energy supply source of the two "reservoirs" to respectively supplement the voidage of the two "reservoirs".

By regrouping Formula (1), volume voidage of oil ring can be obtained:

$$V_{od} = N_p B_o - NB_{oi} \left[\frac{B_o - B_{oi} + (R_{si} - R_s)B_g}{B_{oi}} + \frac{(C_w S_{wc} + C_f)\Delta p}{1 - S_{wc}} \right] \quad (8)$$

And the volume voidage of gas cap can be obtained as well:

$$V_{GD} = N_{gp} B_g - NB_{oi} m \left[\left(\frac{B_g}{B_{gi}} - 1 \right) + m \times V_c + m \frac{(C_w S_{wc} + C_f)\Delta p}{1 - S_{wc}} \right] \quad (9)$$

So that the inrush volume of barrier water into oil ring is:

$$V_{W,GIN} = V_{od} \quad (10)$$

And the inrush volume of barrier water into gas cap is:

$$V_{W,GIN} = V_{GD} \quad (11)$$

And the volume method may be also used to calculate the migration speed of oil-water interface and gas-water interface:

$$V_{w,o} = \frac{V_{W,GIN}}{t \cdot H \cdot W \cdot \phi \cdot (1 - S_{or})} \quad (12)$$

$$V_{w,g} = \frac{V_{W,GIN}}{t \cdot H \cdot W \cdot \phi \cdot (1 - S_{gr})} \quad (13)$$

Wherein, $v_{w,o}$ means the oil-water interface migration speed, $v_{w,g}$ means the gas-water interface migration speed.

3.2 Oil-gas Interface Migration Speed

Before the barrier formation, the gas cap and oil ring connect each other through oil-gas interface, so that the migration laws of oil-gas interface can directly influence the development effect of gas-cap reservoir. In this paper, reservoir engineering methods are used to analyze the barrier well locations and the impact of barrier injection-production ratio n oil-gas interface migration laws. For the convenience of analysis and mapping, R is defined to be as the measurement index of barrier well relative position, and R is the ratio of the distance between the barrier well and the original inner oil-gas interface to that between the original inner oil-gas interface and the external oil-gas interface.

3.2.1 Barrier Well Position

For the gas-cap reservoir with gas cap index of 3.13, the gas cap reservoir development by means of barrier water injection with barrier well positions (R) respectively of 0, 0.2, 0.5, 0.8, and 1.0, oil production rate of 0.7%, barrier injection-production ratio of 0.5 at different gas production rate (0%, 1%, 2%, 4%, 8%) are respectively simulated; and upon calculation, the oil-gas interface migration laws under different development conditions are obtained.

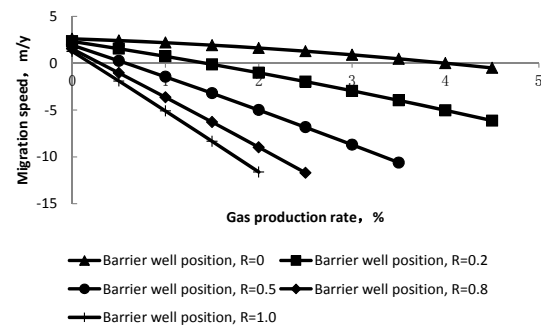


Fig. 6 The Relation between Gas Production Rate and Oil-gas Interface Migration Speed with Different Barrier Well Positions

If the barrier wells are located at the same place, with the increasing of gas production rate, the stratum pressure falls rapidly. At the same time, as the gas cap is employed, partial gas cap expansion volume is used to intrude into oil ring, and the left is exploited, so that gas cap expansion can be effectively restrained, and the oil-gas interface migration slows down; oil-gas interface might migrate towards gas cap due to big gas production rate. And when the oil production rate, barrier well locations, and barrier injection-production ratio become fixed, there is always a reasonable gas production rate with zero of oil-gas interface migration speed, so that oil inrush or gas inrush can be effectively avoided, as shown in Figure 6.

Under the same gas production rate, with the increasing number of barrier well positions, R is greater, i.e. the barrier well has bigger perforating thickness within oil ring if it is nearer external oil-gas interface. More sufficiently the oil ring energy is supplemented, the oil ring volume voidage decreases more gradually, the oil-gas

interface migrates more gradually, and even the inrush of oil to gas cap may happen.

3.2.2 Barrier Injection-production Ratio

For the gas-cap reservoir with gas cap index of 3.13 and fixed barrier wall position (R) of 0.5, the gas cap reservoir development under different development conditions such as oil production rate of 0.7%, different gas production rates (0%, 1%, 2%, 4%, 8%) and barrier injection-production ratios (0, 0.2, 0.5, 0.8, 1.0) are respectively simulated.

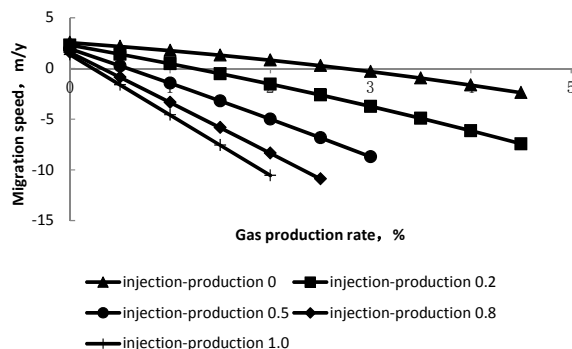


Fig. 7 The Relation between Gas Production Rate and Oil-gas Interface Migration Speed with Different Injection-production Ratios

When with the same barrier injection-production ratio, it is the same to previous conclusions, i.e. with the increasing of gas production rate, gas cap expansion can be effectively restrained, so that the oil-gas interface migration slows down and the oil inrush or gas inrush is effectively prevented, as shown in Figure 7.

Under the same gas production rate and barrier well positions, with the increasing of barrier injection-production ratio, (1) gas cap expansion can be effectively restrained as the gas-cap reservoir stratum pressure is supplemented; (2) with the increasing amount of barrier water injection, the water amount entered oil ring increases, oil ring volume voidage decreases, resulting in the slowing down of oil-gas interface migration with the increasing of barrier injection-production ratio. The results are the same to the laboratory experiment results.

3.3 Oil-water Interface and Gas-water Interface Migration Laws

Upon the formation of barriers, the barriers isolate gas cap from oil ring, and convert oil-gas interface into oil-water interface and gas-water interface. In this paper, reservoir engineering methods are adopted to analyze the influence of oil production rate and gas production rate, etc. on oil-water interface and gas-water interface migration laws upon the formation of barriers.

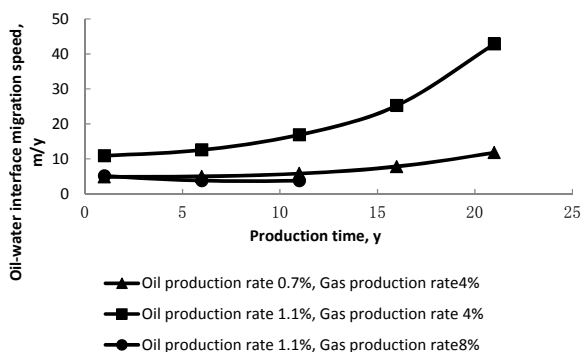


Fig.8 Oil-water Interface Migration Speed under Different Development Conditions upon Barrier Formation

Gas cap and oil ring are available to be independently exploited, and the barriers are used for the energy transmission between gas and oil ring. Shown in Fig.8 are oil-water interface migration speeds under the same injection-production ratio and different oil production rates and gas production rates. With the increasing of oil production rate, due to the increasing speed of oil region volume voidage, the

inrush amount of barrier injected water to oil ring increases under the same injection-production ratio, and the oil-water interface migrates faster. With the increasing of gas production rate, stratum pressure decreases within the same production time, oil ring expansion volume increases, resulting in that the inrush amount of barrier injection water to oil ring decreases, oil-water interface migrates slower, but the changes are moderate.

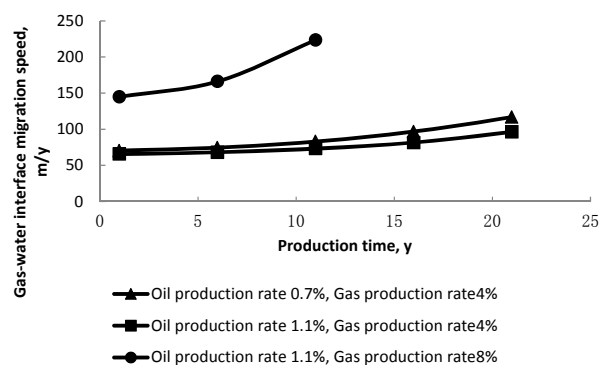


Fig.9 Gas-water Interface Migration Speed under Different Development Conditions upon Barrier Formation

Shown in Fig.9 are oil-gas interface migration speeds under the same injection-production ratio and different oil production rates and gas production rates. With the increasing of gas production rate, due to the increasing speed of gas region volume voidage, the inrush amount of barrier injected water to gas cap increases under the same injection-production ratio, and the gas-water interface migrates faster. With the increasing of oil production rate, stratum pressure decreases within the same production time, gas cap expansion volume increases, and gas cap volume voidage decreases, resulting in that the inrush amount of barrier injection water to gas cap decreases, gas-water interface migrates slower, but the changes are moderate.

4. CONCLUSION

(1) The barrier injected water migration laws are respectively discussed respectively before and after the barrier formation. Before the formation of the barrier, the barrier water flows towards gas cap and oil ring in a radial manner to respectively supplement oil-region and gas-region stratum energy; after the formation of the barrier, the barrier cuts off the access between oil region and gas region, divides the gas-cap oil-ring reservoir into one big-gas-cap small-oil-ring reservoir and one small-gas-cap big-oil-ring reservoir, and the barrier supplies energy for the two "reservoirs" and migrates towards them at different speeds based on the oil production rate and gas production rate.

(2) Based on the study of barrier water injection migration laws by numerical simulation, in combination with the material-balance principle, the computing methods of oil-gas interface, oil-water interface, and gas-water interface migration laws are set up before and after the barrier formation. Before the barrier formation, when the barrier well position is fixed, with the increasing of barrier injection-production ratio, the oil-gas interface migrates more slowly. After the formation of the barrier, the oil gas interface is translated into oil-water interface and gas-water interface, the gas-water interface migration speed increases with the increasing of gas recovery rate, and the oil-water interface migration speed increases with the increasing of oil production rate.

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5. REFERENCES

- [1] **E. A. Razak:** Breaking oil recovery limit in Malaysian thin oil rim reservoirs: Enhanced oil recovery by gas and water injection. SPE Enhanced Oil Recovery Conference, Kuala Lumpur, Malaysia. (July, 2011) page numbers(356-363) ISBN-13- 9781618390929.
- [2] **D. T. Vo:** Gulf of Mexico Horizontal Well Improves Attic-Oil Recovery in Active Waterdrive Reservoir. SPE/DOE Symposium on Improved Oil Recovery, Tulsa, Oklahoma. (April, 1999) page numbers(163-168) ISSN-0885-9248.
- [3] **D. T. Vo:** Development of Thin Oil Columns Under Water Drive: Serang Field Examples. Asia Pacific Oil and Gas Conference and Exhibition, Jakarta, Indonesia. (April, 1999) page numbers(635-660) ISBN-978-1-55563-366-0.
- [4] **C. S. Kabir:** Production Strategy for Thin-Oil Columns in Saturated Reservoirs. SPE Reservoir Evaluation & Engineering.(Nov, 2008) page numbers(73-82) ISSN-1094-6470.
- [5] **E. A. Razak:** Risk of Losing Oil Reserve by Gas-Cap Gas Production in Malaysian Thin Oil Rim Reservoirs. International Oil&Gas Conference and Exhibition, China, Beijing. (June, 2010) page numbers(2804-2815) ISBN-13-978-1-61738-886-6.
- [6] **T. P. Fishlock:** Experimental Studies on the Waterflood Residual Gas Saturation and Its Production by Blowdown. SPE Reservoir Engineering. (Mar, 1988) page numbers(387-394) ISSN-0885-9248.
- [7] **A. K. Dandona:** Down Dip Waterflooding at an Oil Reservoir having a Gas Cap. Journal of Petroleum Technology. vol. 27, (12, 1975) page numbers(1005-1016) ISSN-0149-2136.
- [8] **E. Hegre:** IOR Potential with Updip Water Injection in the Stratford FM at the Stratford Field. European Petroleum Conference held in London, U.K. (Oct, 1994) page numbers(347-360) CODEN-001662.
- [9] **J. K. Forrest:** Samarang Field – Seismic to Simulation Redevelopment Evaluation brings New Life to an Old Oilfield, Offshore Sabah, Malaysia. Society of Petroleum Engineers - International Petroleum Technology Conference.(Jan, 2009) page numbers(385-400) ISBN-978-1-55563-264-9.
- [10] **T. C. Billiter:** Simultaneous production of gas cap and oil column with water injection at the gas/oil contact. SPE Reservoir Evaluation & Engineering. vol. 2, no. 5,(Feb, 1999) page numbers(412-419) ISSN-1094-6470
- [11] **V. Werovsky:** Case History of Algyo Field, Hungary. European Petroleum Conference, The Hague, Netherlands. (Oct, 1990) page numbers(22-24) CODEN-PEOD8.
- [12] **W. Deboni:** Design of a Waterflood Adjacent to a Gas-Oil Contact. SPE Annual Meeting, Houston. (Oct, 1974) page numbers(6-9) ISBN-978-1-55563-763-7
- [13] **T. C. Billiter:** Breaking of a Paradigm: The Simultaneous Production of the Gas cap and Oil Column. SPE International Oil and Gas Conference and Exhibition in China, Beijing, China. (Nov, 1998) page numbers(417-431) ISBN-978-1-55563-377-6.

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OPTIMIZATION OF T6 HEAT TREATMENT PROCESS OF AlSi9Cu3(Fe) ALLOY IN ASPECT OF IMPROVEMENT OF ITS MECHANICAL PROPERTIES

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Key words: aluminum alloys, thermal analysis, heat treatment, mechanical properties

Abstract: The paper presents test results concerning an effect of the T6 heat treatment on mechanical properties of the EN AC- AlSi9Cu3(Fe) alloy (tensile strength - R_m , elongation - A_5 and hardness - HB10/1000/30), modified with the AlSr10 master alloy. Solution heat treatment and ageing treatment temperature ranges were selected on the base of heating (melting) curves recorded with use of the ATD method. Temperatures of the solution heat treatment amounted to 485 °C, 510 °C, and 545 °C $\pm$ 5 °C, while the solution time ranged from 0,5 to 3 h (0,5; 1,5 and 3 h). Temperature of the ageing heat treatment amounted to 175 °C, 240 °C and 320 °C, while the ageing time ranged from 2 to 8 h (2, 5 and 8 h). On the base of obtained test results one determined optimal temperatures and durations of the solutioning and ageing treatments, being condition of improved mechanical properties of the investigated alloy.

1. INTRODUCTION

Alloys based on the Al-Si equilibrium system belong to the most widespread group of aluminum alloys used in the foundry industry. It results from their excellent casting and functional properties; among these, mention should be made of excellent castability, corrosion resistance and a high strength-to-mass ratio, predisposing them as a material for castings of many heavy-duty components that imposed a requirement of high strength at low mass.

The structure of these alloys consists mainly of two main phases, i.e. a plastic matrix formed from the solid solution α on the basis of Al and hard and brittle crystals of silicon. Hence, mechanical properties of these alloys depend on the extent of ramification and change of morphology of silicon crystals, Al grain size, shape and dendrite parameters [1-4] obtained as a result of the implemented processes of modification of the alloy, among others [5-9].

Metallographic testing, static tensile test, hardness measurement, and spectrometric measurement of the contents of the modifier can include classical methods to determine the effects of the modification. Quick and accurate, quantitative determination of the modification effects is also enabled by a method based on thermal analysis of the crystallization process of the alloy [10-13]. The implemented methods of thermal derivative analysis (ATD in short) enable the accurate determination of the temperature of phase transformations, being a reference point to attempt the determination of their quality during the time of preparation (melting) of a metal [14,15].

Additional alloy-forming elements (inclusive of Mg and Cu mainly) enable further improvement of mechanical properties of a casting obtained due to the performed heat treatment [16,17].

In such a case, the heat treatment consists in the solutioning and ageing, aimed at the growth of the hardness, tensile strength and plasticity of castings, achieved as a result of precipitation hardening. The basic condition, on which the process of precipitation hardening of the alloys is based, is diminishing the limiting solubility of the alloy-forming elements in the solid state together with a reduction of temperature. Change of the alloy properties also results from precipitation of the dissolved component from the supersaturated solution α during cooling down. Precipitation of the phase from a supersaturated solid solution is obtained through annealing at a temperature, in which the solid solution constitutes the equilibrium structure, and subsequent cooling down to a lower temperature, in which the solid solution is metastable, whereas a mixture of two phases constitutes the stable structure. The implemented treatment of heating the castings in the process of solutioning results not only in the growth of ageing in the solid solution α of chemical elements constituting the potential source of precipitation processes, but also can cause advantageous transformation of the morphology and crystals of eutectic silicon - their coalescence and spheroidization [18,19].

Improvement of the mechanical properties as a result of the implemented heat treatment is conditioned by the selection of suitable parameters of individual treatments [20-23].

The objective of the present paper is the determination of optimal parameters of the T6 heat treatment of the AlSi9Cu3(Fe) alloy in the aspect of improving its mechanical properties (R_m , A_5 and HB hardness) with a simultaneous limitation, to necessarily minimization, of the duration of the solutioning and ageing treatments.

2. METHODOLOGY OF THE INVESTIGATIONS

The investigated alloy is characterized by very good casting and technological properties. Due to very good mechanical properties, this alloy is used for heavy duty components of machinery, like cylinder heads and engines pistons. Chemical constitution of the investigated alloy is presented in the Table 1.

Table 1. Chemical composition of the investigated alloy

Chemical composition / % mass									
Si	Cu	Zn	Fe	Mg	Mn	Pb	Ti	Ni	Al
8,5	4,2	0,65	0,65	0,3	0,4	0,05	0,17	0,03	rest.

The first stage of the investigations consisted in performed treatment of refining with use of the Rafal 1 preparation in quantity of 0,4% mass of metallic charge. After completion of the refining there were removed oxides and slag from metal-level, and performed operation of modification with strontium, making use of the AlSr10 master alloy in quantity of 0,5% mass of metallic charge.

After performed modification, one accomplished recording of crystallization process in the investigated alloy with use of the ATD method (thermal-derivative analysis), using to this purpose the Crystaldimat analyzer. In the Fig. 1 are shown recorded curves of heating (melting) and crystallization of refined and modified alloy, recorded with use of the ATD method, with marked temperatures of solutioning and ageing treatments.

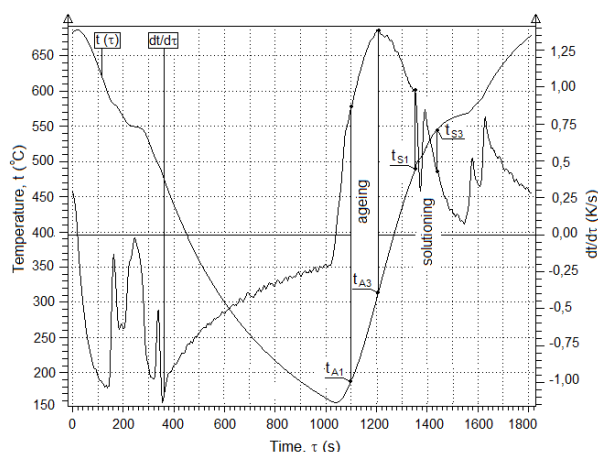


Fig. 1. Curves of the ATD method for refined and modified EN AC-46000 alloy

Modified alloys were poured into permanent mould to production of standardized test pieces of castings to strength tests. Permanent mould was heated to temperature of 250 °C. The heat treatment was performed for the refined and modified alloy. Poured specimens had undergone dispersion hardening, holding them at temperature near to temperature of solidus. The treatment consisted in heating of poured test pieces to temperature of the solutioning, holding in such temperature, and next cooling down in cold water (20 °C), and next artificial ageing.

In the Table 2 are listed parameters of heat treatment operations for three stage plan of the testing with four variables, on base of this plan there was determined an effect of the temperature and duration of the solutioning and ageing treatments on the tensile strength R_m , elongation A_5 , impact strength and hardness HB 10/1000/30 of the investigated alloy.

Table 2. Heat treatment parameters of AISi9Cu3(Fe) alloy

Solutioning temperature t_s [°C]	Solutioning duration τ_s [hours]	Ageing temperature t_A [°C]	Ageing duration τ_A [hours]
$t_{s1} - 485$	0,5	$t_{A1} - 175$	2
$t_{s2} - 510$	1,6	$t_{A2} - 240$	5
$t_{s3} - 545$	3	$t_{A3} - 320$	8

To determine temperatures and durations of solutioning and ageing treatments, aimed at improvement of mechanical properties of the investigated alloy, one implemented three-stage fraction plan of the investigations with four variables, three blocks and 27 systems.

In the Figure 2 is presented a scheme of the investigations, taking into account all parameters having effect on course of performed process of the heat treatment.

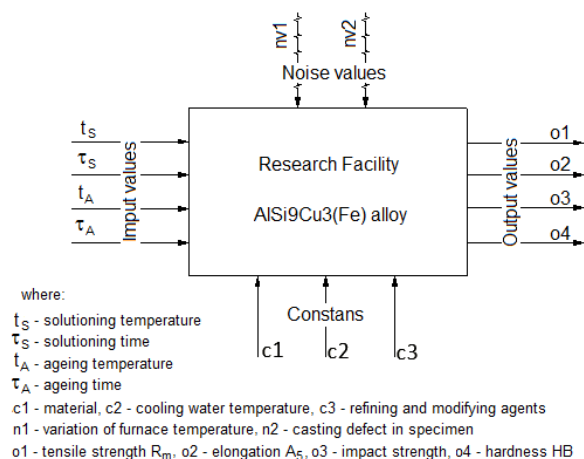


Fig. 2. Scheme of the testing

After performed heat treatment, to determine obtained mechanical properties of the investigated alloy, one carried out:

- static tensile test according to the EN ISO 6892-1:2010 standard.
- hardness test with the Brinell method according to the EN ISO 6506-1:2008 standard, using Brinell hardness tester of PRL 82 type, with steel ball having diameter of 10 mm, under load of 9800 N sustained for 30 seconds.

3. DESCRIPTION OF OBTAINED TEST RESULTS

3.1. Tensile strength R_m

The tensile strength R_m of the investigated alloy after the modification amounted to 250 MPa. After performed T6 heat treatment, the tensile strength amounted from 114 to 406 MPa.

In the Fig. 3 are shown average values of the R_m tensile strength for the AISi9Cu3(Fe) alloy after the heat treatment, with respect to values obtained in case of the alloy without the heat treatment (number "M" - Fig. 3).

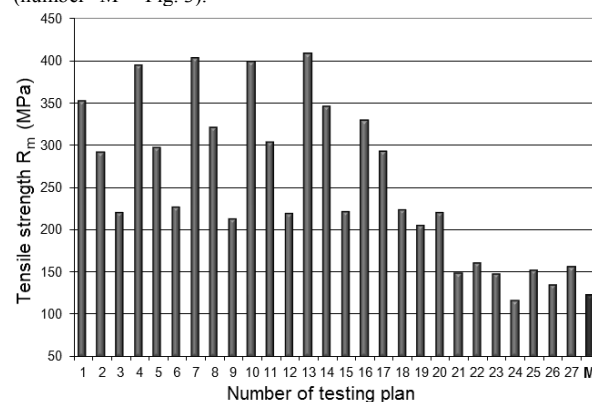


Fig. 3. Change of R_m tensile strength of the investigated alloy for individual configurations of the testing plan

Making comparison of obtained values of average parameters from the test of the alloy after heat treatment and without heat treatment (Fig. 3), one ascertained the highest growth of the tensile strength R_m in case of the system No. 13 (solutioning temperature - 510 °C; solutioning time - 1,5 hour; ageing temperature - 175 °C; ageing time - 2 hour) - 407 MPa, system No. 10 (solutioning temperature - 510 °C; solutioning time - 0,5 hour; ageing temperature - 175 °C; ageing time - 2 hour) - 398 MPa, system No. 7 (solutioning temperature - 485 °C; solutioning time - 3 hour; ageing temperature - 240 °C; ageing time - 2 hour) - 402 MPa, and the system No. 4 (solutioning temperature - 485 °C; solutioning time - 1,5 hour; ageing temperature - 240 °C; ageing time - 2 hour) - 393 MPa.

The lowest tensile strength R_m was obtained for the system No. 24 (solutioning temperature - 545 °C; solutioning time - 1,5 hour; ageing temperature - 320 °C; ageing time - 5 hours) - 115 MPa, and the system No. 26 (solutioning temperature - 545 °C; solutioning time - 3 hour; ageing temperature - 240 °C; ageing time - 5 hours) - 133 MPa, what constitutes a distinct drop with respect to modified alloy.

In the Figs. 4-5 are presented spatial diagrams of influence of temperature and time of solutioning and ageing treatments on change of the tensile strength R_m of the investigated alloy.

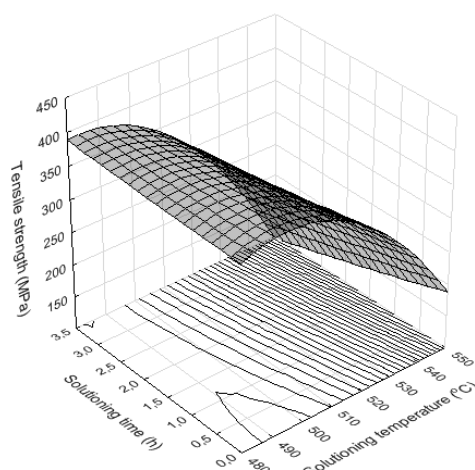


Fig. 4. Effect of temperature and time of solutioning (for $t_A = 175^\circ\text{C}$ and $t_A = 5$ hours) on the R_m tensile strength of the AlSi9Cu3(Fe) alloy

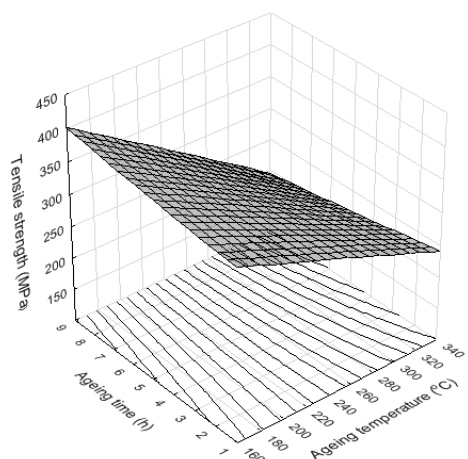


Fig. 5. Effect of temperature and time of ageing (for $t_S = 510^\circ\text{C}$ and $t_S = 1$ hour) on the R_m tensile strength of the AlSi9Cu3(Fe) alloy

3.2. Elongation A_5

Modification treatment effected in growth of the elongation, which amounted from 2,4 to 3 %. After the T6 heat treatment, elongation A_5 of the investigated alloy was included within limits of 0,6 - 7,8 %. In the Fig. 5 are shown average values of the elongation A_5 for the AlSi9Cu3(Fe) alloy after the heat treatment, with respect to values obtained in case of the alloy without the heat treatment.

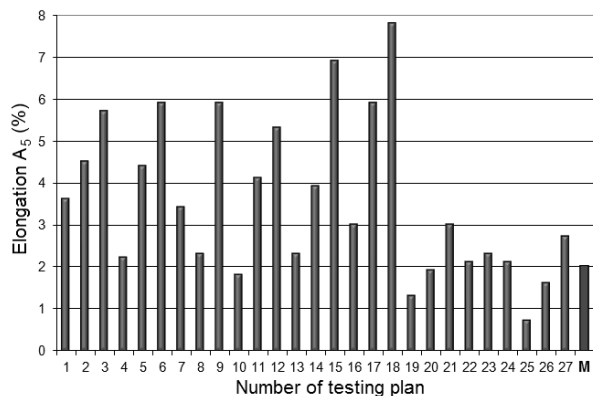


Fig. 5. Change of elongation A_5 of the investigated alloy for individual configurations of the testing plan

Making comparison of obtained values of average parameters from the test of the alloy after heat treatment and without heat treatment (Fig. 5), the highest growth of the elongation A_5 was

obtained for the system No. 18 (solutioning temperature - 510°C ; solutioning time - 3 hour; ageing temperature - 320°C ; ageing time - 5 hours) - 7,8 %, and the system No. 15 (solutioning temperature - 510°C ; solutioning time - 1,5 hour; ageing temperature - 320°C ; ageing time - 8 hours) - 6,9 %.

The lowest elongation A_5 was obtained for the system no. 25 (solutioning temperature - 545°C ; solutioning time - 3 hour; ageing temperature - 175°C ; ageing time - 8 hours) - 0,6 %, and the system No. 26 (solutioning temperature - 545°C ; solutioning time - 3 hour; ageing temperature - 240°C ; ageing time - 5 hours) - 1,6 %.

In the Fig. 6 are shown a spatial diagrams of influence of temperature and time of solutioning and ageing treatments on change of the elongation A_5 of the investigated alloy.

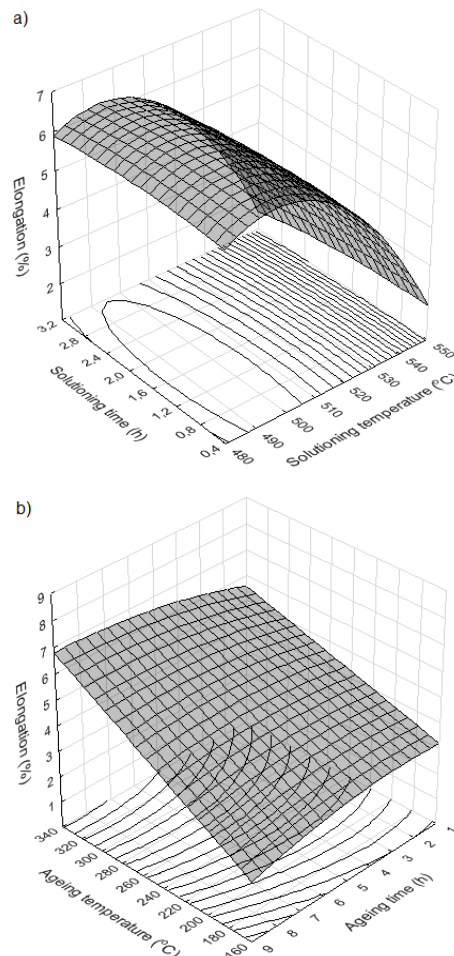


Fig. 6. Effect of temperature and time of: a) solutioning (for $t_A = 320^\circ\text{C}$ and $t_A = 5$ hours), b) ageing (for $t_S = 510^\circ\text{C}$ and $t_S = 3$ hours) on the elongation A_5 of the AlSi9Cu3(Fe) alloy

3.3. Hardness HB

Hardness of the alloy after modification amounted to 61 HB 10/1000/30. In the Fig. 7 are shown average values of the HB hardness for the AlSi9Cu3(Fe) alloy after the heat treatment, with respect to values obtained in case of the alloy without the heat treatment (number "M" - Fig. 7).

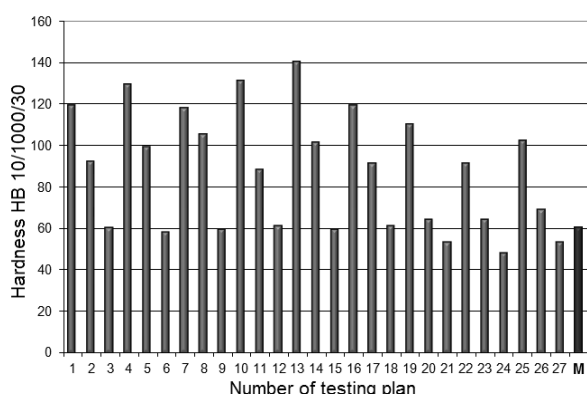


Fig. 7. Change of HB hardness of the investigated alloy for individual configurations of the testing plan

Making comparison of obtained values of average parameters from the test of the alloy after heat treatment and without heat treatment (Fig. 7), one confirmed the highest growth of the HB hardness for the system No. 13 (solutioning temperature - 510 °C; solutioning time - 1,5 hour; ageing temperature - 175 °C; ageing time - 2 hour) - 140 HB 10/1000/30, and the system No. 10 (solutioning temperature - 510 °C; solutioning time - 0,5 hour; ageing temperature - 175 °C; ageing time - 2 hours) - 134 HB10/1000/30. A little bit lower hardness, amounted to 118 - 129 HB10/1000/30 featured the test pieces from the system No. 1 (solutioning temperature - 485 °C; solutioning time - 0,5 hour; ageing temperature - 175 °C; ageing time - 2 hour, and the system No. 4 (solutioning temperature - 485 °C; solutioning time - 1,5 hour; ageing temperature - 175 °C; ageing time - 8 hours).

The lowest hardness was obtained for the systems No. 21, 24, 27 (Fig. 7) which featured long lasting time of the ageing (5 do 8 hours) in temperature 320 °C. Its value was within limits of 31 - 57 HB10/1000/30, what constitutes a drop with respect to refined and modified alloy.

In the Fig. 8 are presented spatial diagrams of influence of temperature and time of solutioning and ageing treatments on the hardness HB10/1000/30 of the investigated alloy.

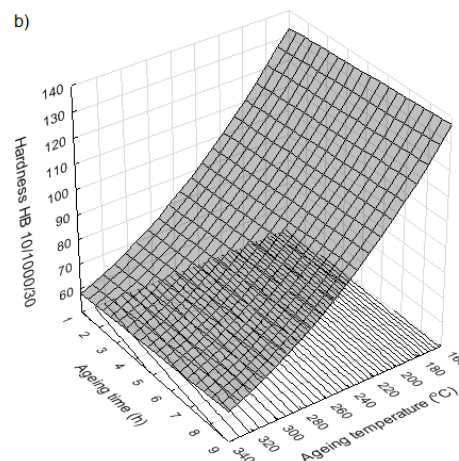
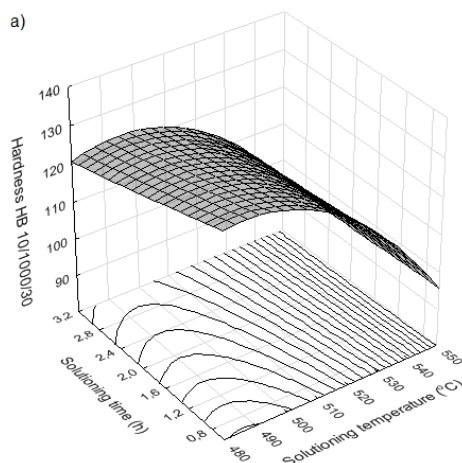


Fig. 8. Effect of temperature and time of: a) solutioning (for $t_A = 175$ °C and $\tau_A = 5$ hours), b) ageing (for $t_S = 510$ °C and $\tau_S = 1,5$ hour) on the HB 10/1000/30 hardness of the AlSi9Cu3(Fe) alloy

4. CONCLUSION

The performed T6 heat treatment of the investigated AlSi9Cu3(Fe) alloy modified with strontium consisted in heating of the alloy at a temperature near the solidus, cooling in cold water (20 °C), and subsequent artificial ageing with cooling in air, which resulted in a change of its mechanical properties, comparing to the alloy without the heat treatment. A selection of the suitable temperature and time of the solutioning and ageing treatments is a condition of increased mechanical properties. In the case of the investigated alloy, an increase of the temperature and time of the ageing has an effect on a drop of the tensile strength R_m and the hardness HB, causing a simultaneous growth of the elongation A_5 . The use of the ATD method enabled an initial determination of temperature and duration ranges of the solutioning and ageing treatments of the investigated alloy.

Selection of the temperature and time of the solutioning and ageing treatments on the basis of the performed investigations was completed with a determination of their ranges, enabling obtainment of improved mechanical properties, i.e. for:

a) the tensile strength R_m and the hardness HB 10/1000/30:

- solutioning temperature - 485 ÷ 510 °C,
- solutioning time - 0,5 ÷ 1,5 hour,
- ageing temperature - 175 °C
- ageing time - 2 ÷ 5 hours.

b) the elongation A_5 :

- solutioning temperature - 485 ÷ 500 °C,
- solutioning time - 3 hour,
- ageing temperature - 320 °C
- ageing time - 5 ÷ 8 hours.

As confirmed in laboratory conditions, temperature ranges of the solutioning and ageing treatments can constitute an optimal solution both from the point of view of a possibility of obtainment of maximal improvement of mechanical properties, and from the economy point of view, i.e. limitation of costs due to the necessity of implementation of long-lasting heat treatment.

5. REFERENCES

- [1] B. M. Closset, J. E. Gruzelski: *The Treatment of Liquid Aluminium-Silicon Alloys*, American Foundrymen's Society, ISBN 087-4331-218, Illinois, 1990
- [2] S. G. Shabestari, F. Shahri: *Influence of modification, solidification conditions and heat treatment on the microstructure and mechanical properties of A356 aluminum alloy*, Journal of Materials Science, Vol. 39, No. 6, (2004) 2023-2032, ISSN 1573-4803
- [3] S. Hegde, K. N. Prabhu: *Modification of eutectic silicon in Al-Si alloys*, Journal of Materials Science, Vol. 43, No. 9, (2008) 3009-3027, ISSN 1573-4803

- [4] L. Liu, M. A. Samuel, F. H. Samuel, S. G. Shabestari, F. Shahri, S. Valtierra, H. W. Doty: *Effect of solution heat treatment and additives on the microstructure of Al-Si (A413.1) automotive alloys*, Journal of Materials Science, Vol. 38, No. 22, (2003) 4507-4522, ISSN 1573-4803
- [5] Z. Poniewierski: *Crystallization, structure and properties of silumins*, WNT, ISBN zz, Warszawa, 1989
- [6] J. G. Kaufman, E. L. Rooy: *Aluminum Alloy Castings: Properties, Processes And Applications*, ASM International, ISBN 087-1708-035, Ohio, 2004
- [7] L. Wang, S. Shivkumar: *Strontium modification of aluminium alloy castings in the expendable pattern casting process*, Journal of Materials Science, Vol. 30, No. 6, (1995) 1584-1594, ISSN 1573-4803
- [8] P. Wasilewski: *Silumins - modification and its impact on structure and properties*, PAN Solidification of Metals and Alloys, ISSN 0208-9386, Katowice, 1993
- [9] A. K. Dahle, K. Nogita, S. D. McDonald, C. Dinnis, L. Lu: *Eutectic modification and microstructure development in Al-Si alloys*, Materials Science and Engineering A, Vol. 413-414, (2005) 243-248, ISSN 0921-5093
- [10] S. Farahany, A. Ourdjini, M. H. Idris: *The usage of computer-aided cooling curve thermal analysis to optimize eutectic refiner and modifier in Al-Si alloys*, Journal of Thermal Analysis and Calorimetry, Vol. 109, No. 1, (2012) 105-111, ISSN 1572-8943
- [11] D. Emadi, L. V. Whiting, S. Nafisi, R. Ghomashchi: *Applications of thermal analysis in quality control of solidification processes*, Journal of Thermal Analysis and Calorimetry, Vol. 81, No. 1, (2005) 235-242, ISSN 1572-8943
- [12] S.-W. Chen, S.-C. Jeng: *Determination of the solidification curves of commercial aluminum alloys*, Metallurgical and Materials Transactions A, Vol. 27, No. 9, (1996) 2722-2726, ISSN 1543-1940
- [13] X. Chen, H. Geng, Y. Li: *Study on the eutectic modification level of Al-7Si Alloy by computer aided recognition of thermal analysis cooling curves*, Materials Science and Engineering A, Vol. 419, No. 1-2, (2006) 283-289, ISSN 0921-5093
- [14] F. Bińczyk, J. Śleziona, J. Cwajna, S. Roskosz: *ATD and DSC analysis of nickel superalloys*, Archives of Foundry Engineering, Vol. 8, No. 3, (2008) 5-8, ISSN 1897-3310
- [15] M. Stawarz, J. Szajnar, C. Wójtowicz: *TDA method for evaluation of the mechanical properties in nodular cast iron of sort EN-GJS-400-15*, Archives of Foundry, Vol. 4, (2004) 468-475, ISSN 1642-530
- [16] V. S. Zolotarevsky, N. A. Belov, M. V. Glazoff: *Casting Aluminum Alloys*, Elsevier, ISBN 008-0550-231, Oxford, 2010
- [17] E. Sjölander, S. Seifeddine: *The heat treatment of AlSiCuMg casting alloys*, Journal of Materials Processing Technology, Vol. 210, No. 10, (2010) 1249-1259, ISSN: 0924-0136
- [18] Z. Górny: *Cast alloys of non-ferrous metals*, WNT, ISBN 832-0412-706, Warszawa, 1992
- [19] P. Y. Zhu, Q. Y. Liu and T. X. Hou: *Spheroidization of Eutectic Silicon in Al-Si Alloys*, AFS Transactions, Vol. 93, (1985) 609-614, ISSN 978-087-1703
- [20] J. Pezda: *Effect of T6 heat treatment on mechanical properties and microstructure of EN AB-42000 alloy modified with strontium*, Archives of Foundry Engineering, Vol. 11, No. 2, (2011) 169-174, ISSN 1897-3310
- [21] M. A. Moustafa, F. H. Samuel, H. W. Doty: *Effect of solution heat treatment and additives on the hardness, tensile properties and fracture behaviour of Al-Si (A413.1) automotive alloys*, Journal of Materials Science, Vol. 38, No. 22, (2003) 4523-4534, ISSN 1573-4803
- [22] J. Pezda: *The effect of the T6 heat treatment on hardness and microstructure of the EN AC-AlSi12CuNiMg alloy*, Metalurgija, Vol. 54, No.1, (2014) 63-66, ISSN 0543-5846
- [23] W. Reif, S. Yua, J. Dutkiewicz, R. Ciach, J. Król: *Pre-ageing of AlSiCuMg alloys in relation to structure and mechanical properties*, Materials & Design, Vol. 18, No. 4/6, (1997) 253-256, ISSN 0261-3069

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STUDY OF GX7CrNiMoCuNb18-18 STEEL HARDNESS BY USING SOLUTION ANNEALING HEAT TREATMENT

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Key words: GX7CrNiMoCuNb18-18 steel, Hardening, Annealing Solution.

Abstract: Mechanical properties of steels are affected the performed heat treatment. In this study was investigated the hardness of GX7CrNiMoCuNb18-18 (1.4585) steel after solution annealing heat treatment at different times. The results showed that after increasing solution annealing time decreases the hardness of 1.4585 steel.



Mohammad KUWAITI

1. INTRODUCTION

GX7CrNiMoCuNb18-18 steel from a group of austenitic stainless steels is accounted. This alloy retains its strength at high temperatures to about 800 °C. The resistance against conditions acute stress, heat and corrosion in this temperature, mainly used in military industries, especially in manufacturing rocket engines [1]. In this steel, delta ferrite from the remains ferrite becomes sigma phase during transformation and affects the ability of forging. Due to be slow of mentioned transformation, with rapid cooling of steel from solidification temperature to 500 °C can avoid the formation of this phase. MC carbides in alloys containing carbide forming elements such as titanium, niobium and hafnium are being formed during solidification. MC carbides are accumulated as particles in the spaces between the dendrites. In case steel be containing nitrogen, these carbides are solved after being surrounded by matrix phase during homogeneous heat treatment at high temperatures [2,3,4]. These carbides are formed together austenite and other carbides. M23C6 carbides are created from Cr metal. This phase occurs with the morphology of the various at a temperature of 950 °C during cooling and in case there is enough time deposited with various morphologies and in different regions [3,4]. M6C, M23C6, MC carbides precipitates at grain boundaries and the grain boundary strength increases and in case deposits infield, the field strength increases. Also with dissolution of other alloying elements can prevent from the creation of other phases. In austenitic stainless steels, by starting solidification and forming austenite, ferrite elements return into melt than austenite elements. Ferrite elements concentration in the melt is causing favorable conditions for the formation of ferrite and peritectic reaction become eutectic and peritectic. At the eutectic reaction deposits ferrite and austenite simultaneous from molten and are causing eutectic structures in dendrite space [5]. The presence of elements that diffusion rate has significant in austenite, the homogeneous time to reduce. For example, aluminum and titanium penetrates considerably faster than molybdenum in austenite so the segregation of elements has less risk than molybdenum segregation [6,7]. Austenitic stainless steels are particularly susceptible to the formation of harmful and destructive phases according Schaeffler diagram as Sigma, Chi and ... that are in various stages of production, in solidification stage and hot forming (forging and rolling) are formed. Solution annealing heat treatment of stainless steels in addition to supersaturated field is causing dissolution of these phases and will prevent the loss of mechanical properties. On GX7CrNiMoCuNb18-18 steel is performed the solution annealing at a temperature of 1200-1250 °C. When the steel is composed of two different phases in the equilibrium state on the phase diagram, Whereas in the range is cooled quickly so that there is a saturation phase of elements, these phases are susceptible to deposition. In austenitic stainless steels due to be single-phase and In lack of two-phase transformation at room temperature, aging treatment is rarely performed. In GX7CrNiMoCuNb18-18 steel has been reported aging treatment, in the temperature range of optimal 750-740 °C. In this study has been discussed solution annealing cycle of 1.4585 steel.

2. METHOD OF RESEARCH

GX7CrNiMoCuNb18-18 steel was used according to specified chemical composition in table 1, as raw material.

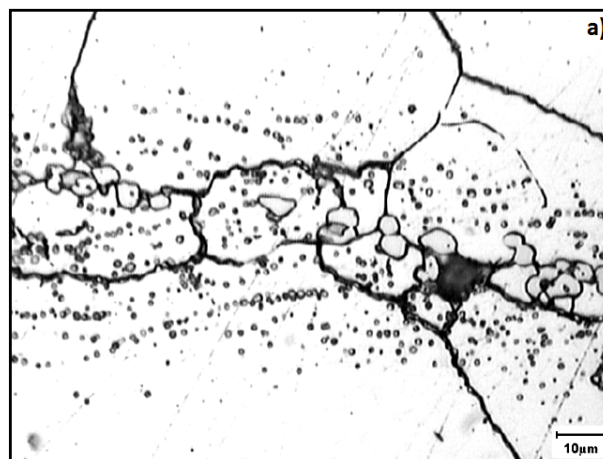
Table 1. Chemical composition of the 1.4585 steel [8]

%C	%Ni	%S	%P	%Cr	%Si
0.08	25	0.03	0.045	20	1.25

1.4585 steel was placed in according solution annealing cycle at 1220 °C and at 60, 120 and 180 minutes. Samples hardness was performed in accordance ASTM E 18 standard and by using Zwick 25. Samples metallography was done in accordance ASTM E45 standard and by using Olympus MPG.

3. RESULTS AND DISCUSSION

The solution annealing is performed in austenitic stainless steels usually, in order to dissolve the harmful and unwanted phases and also supersaturated austenitic matrix elements of chromium and nickel elements in the alloy composition, due to of the high alloy of steels and penetration rate of low in austenite matrix, in high temperatures is done. Figure 1 shows 1.4585 steel microstructure after solution annealing heat treatment cycle, duration of 60, 120 and 180 minutes.



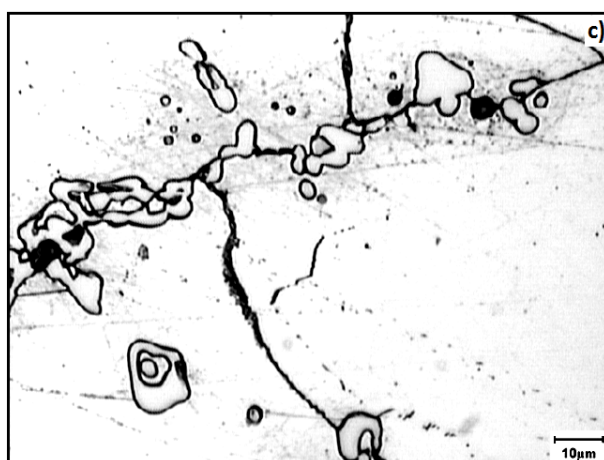
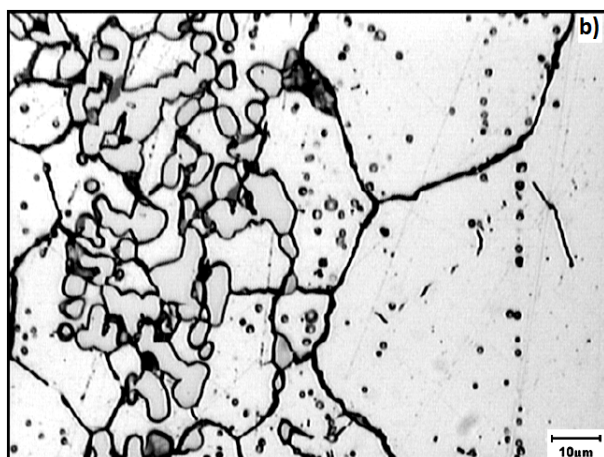


Figure 1. Microscopic images of 1.4585 steel after solution annealing heat treatment at temperature 1200 C ° a) 60, b) 120 c) 180 min.

From figure 1 is clear that with increasing annealing time, the microstructure is the more coarse-grained but most boundary carbides are solved and improved microstructure. Table 2 shows the results of the microstructure and hardness of the samples.

Table 2. Hardness and microstructure, samples after the solution annealing treatment

	Microstructure	Hardness (HB)	Sample
Solution Annealing 1200°C-	Austenite+Carbide	197	Surface
	Austenite+Carbide	180	1/2R

60Min + W.Q.	de		
	Austenite+Carbide	183	Center
Solution Annealing 1200°C- 120Min + W.Q.	Austenite+Carbide	178	Surface
	Austenite+Carbide	178	1/2R
	Austenite+Carbide	165	Center
Solution Annealing 1200°C- 180Min + W.Q.	Austenite+Carbide	180	Surface
	Austenite+Carbide	173	1/2R
	Austenite+Carbide	171	Center

As is clear from table 2, microscopic microstructure does not show and hardness phase changes and hardness changes are poor. What is the logic, decreasing hardness in the ingot center is with increasing temperature. It should be noted that the size of the structure (grain size and precipitates) from the center to the ingot surface becomes smaller, while the phase distribution do not show significant change.

4. REFERENCES

- [1] M., Hillert, "Eutectic and peritectic solidification", *Proceeding of solidification and casting of metals*, 18-21,1977, p. 81-84.
- [2] S., Hertzman, "A study of equilibria in the Fe-Cr-Ni-Mo-C-N system at 1273 K", *Met. Trans.*, Vol. 18A, 1987, p. 1767-1778.
- [3] K.R., Mazyka, "Physical metallurgy and effects of process variable on the microstructure of wrought super alloys", *Proceeding of Optimazation of processing, properties and service performance through microstructural control*, 1987, p. 526-546.
- [4] D., Ridder and R., Koch, "Forging and processing of high temperature alloys", *Micron* 78, 1978, p. 547-563.
- [5] J., Suchy, "Kinetics of the formation of segregations in steel ingots", *Proceeding of solidification technology in foundry and cast house*, 15-17, 1980, p. 22-28.
- [6] D.T., Llewellyn, "Boron in steels", *Ironmaking & steelmaking*, Vol. 20, 1993, p. 357-362.
- [7] S.D., Ridder and et.al., "Study state segregation and heat flow in EAR", *Met. Trans.*, Vol. 9B, 1978, p. 415-425.
- [8] C.W., Wegst, *Stahlschlüssel*, western, Germany 1989.

FOUNDRIES OF THE KOLUBARA DISTRICT (VALJEVO) IN SERBIA DURING THE TRANSITION PERIOD

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Key words: metallurgy, foundries, foundry sites, the process of ownership transformation foundries

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Abstract: This paper gives an overview of the companies in the field of casting during the period of the sanctions and the transition when the need for businesses in the area had a very specific form in the Kolubara District of Serbia. We also pointed out some characteristics of today's work in this area. Methodology for assessing the sites of these companies is also given and it is concluded that this method of presentation is at the fundamental level.

1. INTRODUCTION

Small workshops in the field of metallurgy were not a mass phenomenon in the former Yugoslavia. Needs of the population and the economy were mainly satisfied by industrial production within the country itself or import. During the time of the former country's breakup a great number of disorders and abnormalities happen in almost all spheres of life and activities of people as well as in the area of needs, trade, and production in the field of metallurgy.

Since Serbia was under sanctions, and therefore there was no exchange of goods with the outside world as well as with the parts of the former country, there was an interruption in the supply of certain products and the spare parts for various machines and devices that already existed here. Also, a lot of workers who worked in large companies (which were production-oriented to meet the needs of former Yugoslavia) lost their jobs because the market was reduced.

Naturally, in such a situation small businesses which were able to satisfy mainly needs of the market demand for lacking things and employ workers who lost their jobs, were established. This led to the opening of a relative big number of workshops in the area of metallurgy. However some major foundries had problems with placement and production volume, and there was also a change in the product range. Changes in the product range and specialization and focusing on certain products happened in the new-founded companies, too, but these are natural processes and they are, also, interesting to observe.

This paper analyzes the companies in this field within one region (the Kolubara region, based in Valjevo) in Serbia, which currently exist.

2. FOUNDRIES IN THE KOLUBARA DISTRICT (VALJEVO) IN SERBIA

In the Kolubara District at this moment (state of 31.12.2012/01.01.2013) seven foundries work. Two foundries are in the category of large companies (over 100 employees) one is a part of one medium enterprise (casting now is not the main activity), and the others are in the category of small enterprises (workshops).

It is interesting that only two companies have the internet site: one big, and one small foundry.

Looking narrowly, it can be said that only two foundries have a website and these sites will be presented in a separate chapter.

As far as their business is concerned, on the basis of reports of respective state audit institutions [6], all seven companies operated mainly positively in 2011, and in 2012 six of them operated

positively and one (in the category of small foundries) operated negatively and now is in bankruptcy.

If we look at the ownership structure of these companies it can be seen that all small enterprises are private ones, and the large one (Foundry LJIG) has completed the process of ownership transformation (now operating as a limited company). The other large enterprise that operated within the defense industry "Krušik" in Valjevo is currently (the first half of 2013) in the process of transformation (privatization).

If we look at the production programme of these companies we can see that all small companies are mostly oriented to providing services to the public - casting variety of items for the interior and exterior of a household, restaurants and businesses in general (such as lighting posts, benches, ... all in small batches and with certain requirements (it could also be something that is usually less expensive):

- ✓ small series of individual pieces of bronze, brass, aluminum
- ✓ individual castings for the tombstones (non-ferrous metal)
- ✓ castings of inscriptions, letters, numbers (for various purposes).

This programme makes 38% of activity of the company "Krušik Precision Casting" which is in the ownership transformation. In addition to this programme which is common for small foundries, beside two small foundries, two large ones also cast the spare parts from iron and steel for the industrial needs - in the first place for the repair of machinery and equipment (such as gears, pulleys, ...) which also includes machine processing.

Foundry Ljig is mainly engaged in the programme it has had since its founding - casting of iron manhole lids primarily for street water drains, water supply systems, sewages and telephone manholes and it has regular customers.

Foundry "Krušik Precision Casting" from Mionica (which entered the ownership transformation) has 62% of its standard programme on the website <http://www.krusik-precizniliv.com> and it was and still is a programme that was developed within the metal complex of metal industry.

3. ABOUT FOUNDRY SITES AND THEIR ASSESSMENT

Bearing in mind that these companies are usually specific and deal with the satisfaction of the needs of the local population (typical for small businesses), they almost have no need for advertising and presentation that exist in the Internet network.

Similarly, "Foundry Ljig" AD (whose owner is now based in Belgrade) has a standard programme and no need for presentation on the Internet, probably because they do not plan to expand the product range and programme.

Following the idea of evaluating the use of computers in a tourist hotel companies [1] and the evaluations of websites in [2] and [3] we are here proposing the evaluation of the companies' websites (there are two of them) from this area as follows:

O_1 – the evaluation of how informative site is which implies:

- assessment of information about products and services,
- assessment of information about the delivery deadlines (which can be expected),
- assessment of information about prices,
- assessment of possibility of visitors' assessment

O_2 – assessment of the site's opening speed

We suggest that the evaluation should be done using the tool "Stopwatch" from Numion web portal which is at: <http://www.numion.com/stopwatch/index.html>

Here the time from the moment of the page's opening until the moment when the procedure of opening finishes is measured.

We work with different browsers as well as a computer on which this page had not been opened before.

If the opening time lasts longer than 4 seconds, we consider this unsatisfactory time and the score will be less than 0.5;

If the time of opening is between one and four seconds the mark ranges from 0.5 to 0.8 and this is considered as normal time.

If the opening time lasts less than one second the mark ranges from 0.8 to 1, and this is considered as excellent time.

O_3 – assessment of the technology of site's creation which includes its compatibility with different web browsers

O_4 – assessment of site's design, which also includes the categories of attractiveness (which is not the same for all visitors and there is no universal objectivism in this matter)

O_5 – assessment of multilingual support

O_6 – assessment of the site's regular updates and innovations

O_7 – assessment from site visitors (not mandatory).

Each score is formed in the range of $0 \leq O_i \leq 1$

Which implies that the value 0 is inapplicable value and 1 is for the best possible value.

On the basis of these assessments the general assessment of the site is formed

$$O = \sum_{i=1}^7 r_i O_i$$

where r_i is the relative weight coefficient $0 \leq r_i \leq 1$ provided that the requirement is $\sum r_i = 1$

$$\sum_{i=1}^7 r_i = 1$$

(This implies that $r_j = 0$ for assessment O_j , which is for the given case unimportant and that the size of the coefficient corresponds to the importance of assessment).

It is obvious that $0 \leq O \leq 1$ which further implies that

$$0 \leq O \leq 0,25$$

mark for the poor sites

$$0,25 \leq O \leq 0,40$$

mark is low, but the site is satisfying

$$0,40 \leq O \leq 0,60$$

mark for satisfying sites

$$0,60 \leq O \leq 0,75$$

mark for good sites

$$0,75 \leq O \leq 0,90$$

is mark for excellent sites

$$0,90 \leq O \leq 1,0$$

is mark for exceptional sites.

Example 1:

1. Web site <http://www.krusik-precizniliv.com> „Krušik precision casting“ Mionica (Figure 1) [5].

$$\begin{aligned} O_1 &= 0,40; \\ O_2 &= 0,70; \\ O_3 &= 0,60; \\ O_4 &= 0,40; \\ O_5 &= 0; \\ O_6 &= 0,10; \\ O_7 &= 0 \end{aligned}$$

with the coefficient

$$\begin{aligned} r_1 &= 0,50; \\ r_2 &= 0,20; \\ r_3 &= 0,10; \\ r_4 &= 0,10; \\ r_5 &= 0,050; \\ r_6 &= 0,050; \\ r_7 &= 0; \end{aligned}$$

$$O = 0,4 \times 0,5 + 0,7 \times 0,2 + 0,6 \times 0,1 + 0,4 \times 0,1 + 0,05 + 0,1 \times 0,05 + 0 = 0,445$$

Which means that this site belongs to the group of satisfying sites.

The very fact that the site does not have data on 38% of its activities significantly reduces its assessment and marks. There is no assessment by the visitors so mark is 0 and also the relative importance is 0.



Figure 1: Web site <http://www.krusik-precizniliv.com> „Krušik precision casting“ Mionica

Example 2:

1. Web site <http://www.lom.rs/> Foundry „Lom“ Valjevo (Figure 2) [4].

$$\begin{aligned} O_1 &= 0,30; \\ O_2 &= 0,40; \\ O_3 &= 0,10; \\ O_4 &= 0,20; \\ O_5 &= 0; \\ O_6 &= 0; \\ O_7 &= 0 \end{aligned}$$

with coefficient

$$\begin{aligned} r_1 &= 0,50; \\ r_2 &= 0,20; \\ r_3 &= 0,10; \\ r_4 &= 0,10; \\ r_5 &= 0,050; \\ r_6 &= 0,050; \\ r_7 &= 0; \end{aligned}$$

$$O = 0,26$$

So this site is hardly in the category of satisfactory sites, since except for the pictures of some products there are no other data. This one can be considered as amateur work.



Figure 2: Web site <http://www.lom.rs/> Foundry „Lom“ Valjevo

4. CONCLUSION

It is characteristic that the companies in the field of metal casting, founded during the time of transition (which is not yet completed), and sanctions against Serbia (which is finished) can be divided into three groups:

- Enterprises which improve and advance in this area
- Companies that change their activity so the casting stops being their business or becomes an occasional and very minor activity.
- Companies that cease existing (usually the owner retires and the heirs put out companies).

One out of two previously known large companies in this area continues to do the same job but on a reduced scale and the other reduced its core business. However the latter infiltrated the uncovered part of the Kolubara District market whose founders were small companies, and probably contributed to the closure of many of them because it had the technology and equipment which worked better comparing to those ones.

Of all the companies involved in metal casting only two have websites and according to here presented methodology of assessment of their presentations, they are not at a high level – they could be much better.

However, this sector of the economy has fully met the needs of the population in this area and has made the quality of people's lives be at the higher level, and they continue doing so.

5. REFERENCES

- [1] Miodrag Žižović, Verka Jovanović: Proposal of evaluation methodology for computer applications in tourism -Hotel Facilities Units (10) Proceedings of International scientific conference, UNITECH'10, Gabrovo, Bulgaria, 2010, III- 171- III-174.
- [2] Rami Muhtaseb, Kleanthi Lakiotaki and Nikolaos Matsasinis, Applying a Multicriteria Satisfaction Analysis Approach Based on User Preferences to Rank Usability Attributes in E-tourism Websites, Journal of Theoretical and Applied Commerce Research (Electronic version) Vol 7 /ISSUE3/december2012/ 28-48
- [3] S.Alkan.(2010, December). Which factor is most important for the success of a website? Das Content Management Portal.[Online] Available:
http://www.contentmanager.de/magazin/welcher_factor_ist_fuer_den_orfolg_einer_website_am_wichtig.html
- [4] <http://www.lom.rs/>
- [5] <http://www.krusik-precizniliv.com>
- [6] <http://www.apr.gov.rs>

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THE IMPACT OF DIFFERENT MATERIALS ON RING DEFORMATION OF HOT-WATER PUMP

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Key words: different materials, high-temperature, temperature distribution, thermal-solid coupling, ring gap,



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Abstract: In order to study the different materials impact on ring deformation of high-temperature process pump, TEG200-400 type hot-water circulating pump was taken as an example, based on the software ANSYS Workbench analyzed with thermal-solid coupling. At the same temperature, the temperature distribution, stress and strain distribution of the hot-water pump of the different materials, and the deformations of the volute ring and the impeller ring had been obtained. Based on the MATLAB software to process data, and obtained the size of the ring gap of the hot-water pump of different materials. These results can provide a certain basis for the choice of materials for the design of high-temperature process pump.

1 INTRODUCTION

The solid material generally has the characteristics of the thermal expansion and contraction. At the high temperature, since the object to thermal strain, its volume will change. During the running process of the hot-water pump, the media's high temperature has an important impact on the structure of the pump, and this often leads to the thermal abrasion of the rings, the deformation of the impeller and the sealing surface, and other issues, impacts on the safety and reliability of hot-water pumps. During the design process, because there is not enough experience and technical means, generally selected larger ring gap, resulting in the pump volume loss increases and the efficiency decreases. However, if selected relatively small ring gap, due to the combined effects of the temperature and mechanical loads, may leads to the thermal deformation, and even results in the rotor parts jammed, so the pump may fail to run.

By the analysis of thermal-solid coupling can guide the structure of the pump design, reasonable selection of the ring clearance, thereby improving the safety and reliability of the pump, for similar pumps ring gap to provide a reference design methodology.

2 CALCULATION

2.1 Calculation model

The hot-water pump was composed of the pump body, volute ring, impeller ring, impeller, pump cover, seal, bracket, et al. Based on the software Pro/E, and used of hybrid technology to generate the 3D solid model, shown in Fig.1. TEG200-400's performance is: Flow is 316 m³/h, head is 50 m, pump inlet pressure is 4.1 MPa, outlet pressure of 4.6 MPa, working temperature is 250 °C, rotation speed is 1480 r/min, power of 90 kw. AT the preliminary design process, to select the radial clearance between the ring of the impeller and the volute of 0.6 mm.

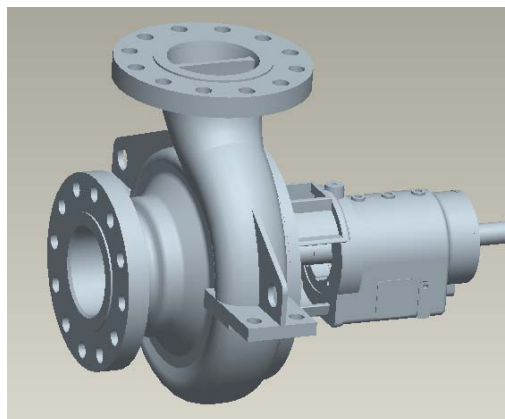


Fig.1 Structure model

2.2 Boundary Conditions

In accordance with the provisions of API610 that for the horizontal pump, applied to the pump nozzle with twice nozzle load. Considering the influence of the nozzle load and the deformation, applied to the outlet flange with one double load. The load data is shown in Tab.1. Applied external loads coordinate diagram is shown in Fig.2. The transfer surface of the component is set to bonded contacts, ignoring the impact and deformation of the bolt. Pump with central support, applied to the pump support with Fixed constraints. Bracket with foot support, applied to the foot support with Fixed constraints.

Tab.1 The load on the top and the side

location	F/N			M/N • m		
	F _x	F _y	F _z	M _x	M _y	M _z
top	3780	3110	4890	3530	1760	2580
side	3780	4890	3110	3530	1760	2580

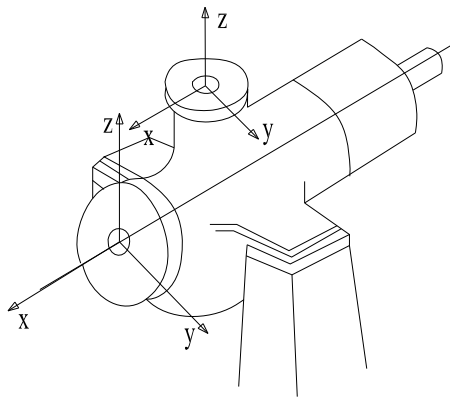


Fig.2 Load applying coordinate

At 250°C, the water vapor pressure is 3.977Mpa, in this paper, pump inlet pressure is 4.1MPa, pump head is 0.5MPa, so apply to the surface of the pump body with the maximum pressure is 4.6MPa. Applied the temperature loads to the contact surface between the pump cover, impeller, ring with the liquid. Applied the convection heat treatment to the surface exposed to the air. The calculate data of the temperature is passed to the static structural, to obtain the deformation of the ring, pump body, bracket and other components. Assumed the rotor parts are stationary, in order to avoid occlusion and abrasion during the operation.

2.3 Material selection

For most materials, the material characteristics may change as the temperature changes accordingly of the material. The structures include: pump body, volute ring, impeller ring, impeller, pump cover, seal, bracket, et al. who withstand the combined effects of temperature and mechanical loads, the characteristics of directly affect the stress distribution include: elastic modulus, linear expansion coefficient and thermal conductivities and so on.

The pump cover material selected 1Cr13, the impeller and shaft selected 2Cr13, the ring selected 3Cr13, the bracket selected ZG230-450, the pump body selected ZG00Cr18Ni10, 1Cr13, ZG230-450. Various materials properties at 190°C is shown in Table 2.

Tab.2 The physical properties of a variety of materials at 190°C

Material	P g/cm ³	E GPa	α 10 ⁻⁶ K ⁻¹	λ w/(m·°C)
1Cr13	7.75	205.42	10.95	25.94
2Cr13	7.75	207.73	10.95	23.28
3Cr13	7.76	209.2	10.95	25.46
ZG230-450	7.8	197	12.8	51.1
ZG00Cr18Ni10	7.85	192.08	16.05	18.71

3 THE ANALYSIS OF STRESS

The stress distribution of the pump cover and pump body of the different programs is shown in Fig.3. It can be seen, the maximum stress points of the pump body appear at the cusp location of the changed cross-section of the center-support legs position (from the motor). Due to the combined effects of the thermal stress and support, is prone to appear stress concentration.

The maximum stress of the first pump cover occurs at the connected location between the pump cover and bracket, indicating that the program is impacted by the bracket supported. The maximum stress of the other programs occurs at the connected location between the pump cover and the pump body.

As can be seen from the figure, the maximum stress of the pump body and the pump cover did not exceed the yield strength of the material. Strength meets to the design requirements.

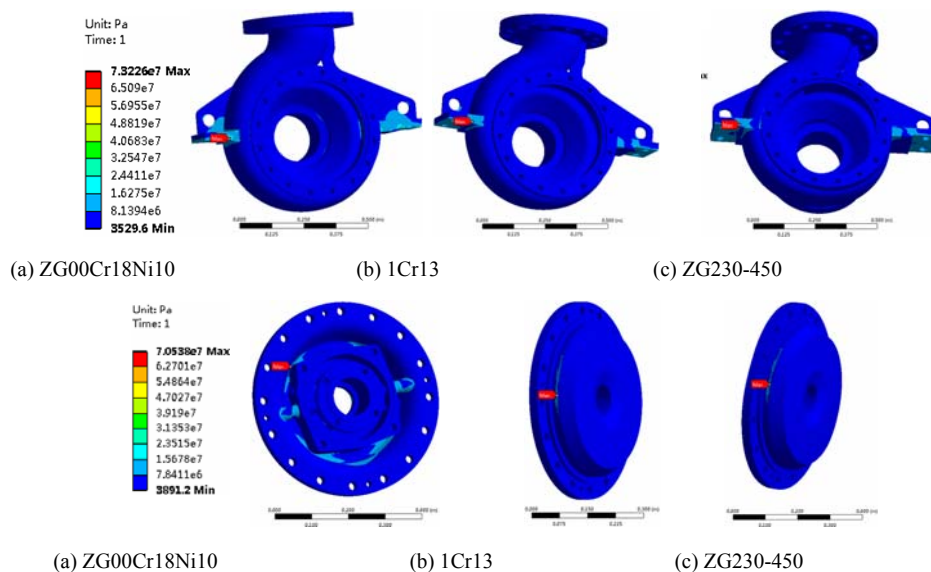


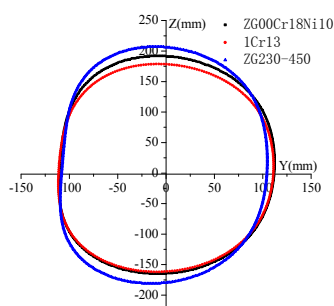
Fig.3 Stress distribution

4 THE RING DEFORMATION ANALYSIS

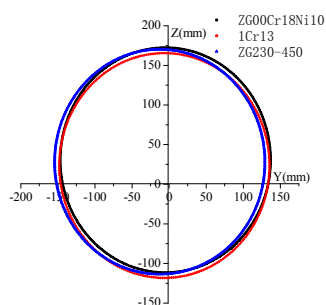
Based on the software ANSYS Workbench analyzed with thermal-solid coupling, obtained the deformation of the volute ring and impeller ring of the three programs. Selected $X=165\text{mm}$, the ring deformation tendency in the Y-Z plane, as shown in Fig.4.

From the Fig.4 (a), the material of pump body is selected ZG230-450, the volute ring deformation increased in the Z direction, decreased in the Y direction.

From the Fig.4 (b), the impeller ring deformation tendency is the center of the impeller ring deviation to the second quadrant. The ring deformation tendency which pump body material is ZG230-450 is the largest in the second quadrant.



(a) Volute ring



(b) Impeller ring

Fig.4 Ring deformation

5 DATA PROCESSING

Selected $X=140\text{mm}$, $X=145\text{mm}$, $X=155\text{mm}$, $X=160\text{mm}$, $X=160\text{mm}$ section, based on the MATLAB software simulating of the discrete data, obtained the radius of the being deformed ring. According to the results, it can judge the difference between the

volute ring and the impeller ring. The ring gap is shown in Tab.3.

Tab.3 The value of ring gap

	ZG00Cr18Ni10	1Cr13	ZG230-450
Minimum (mm)	0.23	0.20	0.14
Maximum (mm)	1.2	1.1	1.3

6 CONCLUSION

In this paper, based on the software Workbench analyzed with thermal-solid coupling, studied the ring deformation of the hot-water pump with different material. We can see that, the material ZG230-450 is greater impact on the ring deformation. And it is greater impact on the volute ring deformation. From the value of ring gap, we can see the material ZG00Cr18Ni10 will be the best selection.

7 REFERENCES

- [1] Wang Xufei, Liu Jurong. FEM thermal-solid coupling analysis of heat pipe with insulation layer[J]. Journal of Shaanxi University of Technology (Natural Science Edition), 2011, 27 (2):5-10. (in Chinese)
- [2] Chen Hongsheng. A finite element analysis on thermal-soild coupling analysis of friction plate[J]. Food & Machinery, 2011,27(1): 81-83. (in Chinese)
- [3] Zhao Xinyuan, Liu Jiquan. Thermal-structure Coupling Analysis of Engine Cylinder Head[J]. Mechanical Engineering & Automation, 2011, 166(3):67-69. (in Chinese)
- [4] Duccio Bonaiuti, Mehrdad Zangeneh, Reima Aartojarvi, et al. Parametric design of a waterjet pump by means of inverse design, CFD calculations and experimental analyses[J]. Journal of Fluids Engineering, 2010, 132 (3): 031104.
- [5] R. W. Westra, L.Broersma, K. van Anel, et al. PIV Measurements and CFD Computations of Secondary Flow in a Centrifugal Pump Impeller[J]. Journal of Fluids Engineering, 2010, 132 (6): 061104.
- [6] Cao Weidong, Gao Yi, Wang Xiulan, et al. Optimization design of submersible pump rotor system for coal mine based on ANSYS[J]. Journal of Drainage and Irrigation Machinery Engineering, 2012,30(2):157-161.(in Chinese)
- [7] H Schmucker, F Flemming, S Coulson. Two-way coupled fluid structure interaction simulation of a propeller turbine[C]//Proceedings of the 25th IAHR on Hydraulic Machinery and systems, 2010.
- [8] Yang Huidong, Walter Zulehner. Numerical simulation of fluid-structure interaction problems on hybrid meshes with algebraic multi-grid methods[J]. Journal of Computational and Applied Mathematics, 2011, 235(18): 5367-5379.
- [9] Liao Ridong, Zuo Zhengxing, Zou Wensheng. The Effect of Temperature Field on Stress Distribution of Cylinder Head[J]. Transactions of CSICE, 2001, 19(3): 253-257. (in Chinese)
- [10] Lucius A, Brenner G. Unsteady CFD simulations of a pump in part load conditions using scale-adaptive simulation[J]. International Journal of Heat and Fluid Flow, 2010,31(6): 1113-1118.

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STRENGTH ANALYSIS OF STAINLESS STEEL STAMPING MULTISTAGE PUMP BASED ON FLUID-STRUCTURE INTERACTION

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Key words: Stainless steel, stamping pump, strength analysis, fluid-structure interactionPh. D. eng.
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Abstract: In this paper, in order to explore the reliability of the impeller structure for stainless steel stamping multistage pump, based on the ANSYS Workbench, the final-stage impeller strength of the multistage pump was calculated by using unidirectional fluid-solid interaction method. After calculating the stamping impellers with different blade thickness by using the finite element method, the influence of inertial force and flow field pressure loads on equivalent stress and deformation of the impeller were found out. Results indicate that the maximum stress and deformation caused by fluid pressure load are much larger than those caused by inertial force, while slightly smaller than their composite, which means that the pressure load caused by high-pressure fluid plays a dominating role in distribution of stress and deformation of impeller. With the increase of flow rate, the maximum stress of the impeller gradually increased, while the maximum deformation of the impeller first decreased then increased, and achieving the minimum value at the rated flow point.

1. INTRODUCTION

Multistage pump are specially equipped for groundwater extraction in rural areas, factories, mines, water companies, geothermal development and oil fields [1-2]. Most multistage pumps in the past were manufactured by casting process. Conventional casting pump are made by some complex manufacturing processes such as pattern making and machining. These processes will consume lots of power and material and emit a huge amount of toxic gas. Also in the mass production process of small pump, the dimensional accuracy and surface roughness can not be guaranteed due to the limitation of casting process. Stainless steel stamping multistage pump are produced by cutting through steel, stamping, drawing, welding and other advanced technologies. All flow components are made through mechanical molds so that the shape and dimensional accuracy is easy to be guaranteed and the hydraulic performance of pump is stable. Therefore, stainless steel stamping pump are gradually replacing casting pump and becomes a mainstream product [3-5].

Impeller is the key component of stainless steel multistage centrifugal pump, whose blade thickness determined by the steel plate can reach 0.5 mm. The blade thickness is one of the main parameters on pump design, which makes the traditional design method of casting pump is not fully applicable to stainless steel pump. Although thin blade causes energy-saving effects, it may also influence the reliability of impeller structure. Hence, it has a great realistic significance to study the stress and deformation on impeller with different blade thicknesses. Based on ANSYS Workbench, this paper studies the final stage impeller of stainless steel multistage pump with FSI and implements finite element calculation on impeller. As a reasonable value of blade thickness, 1.5 mm is selected at last.

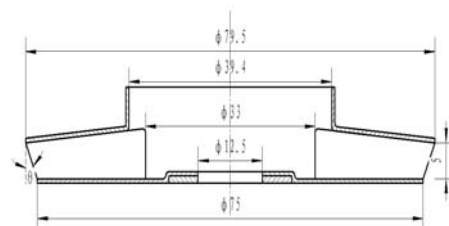
2. ESTABLISHING MODEL

2.1 Impeller model

This paper selects 100XQJ stamping well pump, and the basic design parameters are as follows: $Q=8\text{m}^3/\text{h}$, single-stage head $H=4.5\text{m}$, rotation speed $n=2850\text{r}/\text{min}$ and the total head $H=72\text{m}$.

In view of the structural condition that the outer diameter of well pump is limited by well diameter, Lu Weigang studied a design method of well pump—the impeller maximal diameter design method, which expands the front cover of impeller to the edge of pump wall and makes the impeller diameter achieve maximum value while well diameter is invariable [6]. The impeller is in coordination with the return guide vane, which can shorten the axial length of well pump to the minimum.

In the design of ordinary pump, the impeller diameter is calculated based on the requirements of pump performance, but the impeller maximal diameter design method only provides rated flow at the maximum efficiency point and won't provide rated single-stage head, which hopes that the single-stage head is as high as possible, thereby reducing the series and costs of well pump. In this case the front cover diameter of impeller is 79.5mm. It is equal to the diameter of the pump spigot. The clearance is guaranteed by tolerance and the outlet of impeller is skewed, which is shown in Fig. 1. After determining the front cover diameter of impeller, the other structural parameters of impeller can be designed. Details can be seen in document [7-8].



(a) 2-D picture

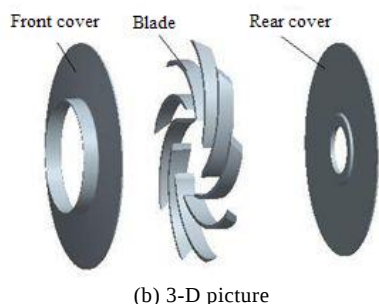
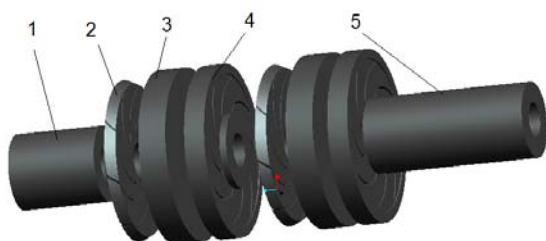


Fig. 1. Impeller

2.2 Computational domain

Compared with single stage pump, the structure of multistage pump is more complex. The flow in the first impeller inlet of multistage pump is usually irrotational while rotational in the other impeller inlet. Due to that the flow after the first stage impeller are similar, two-stage pump model is selected and it consists of inlet section, two-stage impeller water, two-stage chamber water, two-stage reverse diffuser water and outlet section. It is generally assembled after establishing solid model respectively in Pro/E, which is shown in Fig. 2.



1. Inlet; 2. Impeller; 3. Pump chamber; 4. Reverse diffuser; 5. Outlet

Fig. 2. Pump water model

2.3 Element Model of Impeller

The finite element analysis of the impeller in this paper is based on ANSYS Workbench and the impeller is made of stainless steel 0Cr18Ni9, whose basic property is listed as follows. Elasticity modulus $E=193000\text{MPa}$, Density $\rho=7930\text{ kg/m}^3$, yielding strength $\sigma_s=207\text{MPa}$, Poisson ratio $\mu=0.37$.

3. EFFECTS OF IMPELLER LOADS

3.1 Effects of Impeller Loads on Stress

Loads on stainless steel impeller consist of inertial force load caused by impeller rotation speed and fluid pressure load when pump is working. In order to compare the influence of the two loads on impeller, this study calculates respectively inertial force load, fluid pressure load, and both loads at design flow rate on stress and deformation of impeller. Table 1 means the stress distribution of impellers whose blade thicknesses are 0.5mm, 1.5mm, and 2.5mm. The table indicates stress distributions on three impellers are similar. The maximum stress by fluid pressure load is much greater than those brought by inertial force load, while slightly smaller than those brought by both of them, which means that the load brought by high-pressure fluid plays a dominating role in stress distribution. Affected by three different loads, stress on impeller distributes in circumference and it is apparently larger at the inlet of blade. Besides, when the radius is the same, the stress at intersection between impeller and cover is obviously larger. With the increase of blade thickness, the maximum stress caused by inertial force load gradually increases, while the maximum stress of fluid pressure load decreases. That's because thicker blade brings heavier impeller and larger stress caused by inertial force. Moreover, thicker blade increases the area of intersection between blade and cover, which makes impeller steady and reduces the maximum stress caused by fluid pressure. If the blade thickness is 0.5 mm, the maximum stress caused by both of the two loads is 277.29 MPa which exceeds the stainless steel's yield strength $\sigma_s = 207\text{ MPa}$; if it is 1.5 mm and 2.5 mm, the maximum stress are respectively 78.16 MPa and 50.69 MPa. But the over-thick blade not only increases the cost of impeller, but also reduces the performance of pump.

3.2 Effects of Impeller Loads on Stress

Table 2 shows the deformation distribution of impellers whose blade thicknesses are 0.5mm, 1.5mm, and 2.5mm. The table indicates deformation distributions on three different impellers are similar. The maximum deformation caused by fluid pressure load is much greater than those caused by inertial force load and slightly smaller than those caused by both of them, which is similar to stress distribution illustrated above. When the thickness is 0.5 mm, the deformation caused by inertial force load increases gradually along the flow direction from inlet to outlet and at the outlet of front shroud it reaches the maximum value, while the deformation by fluid pressure load gets the highest at the blade inlet because equivalent stress here is too large and blade is too thin. Maximum deformation caused by three loads gradually decreases with the increase of blade thickness, but the position where maximum deformation appears transfers from blade inlet to outlet of front shroud. In addition, due to relatively high rigidity of cylindrical interface between the impeller and shaft, deformation in this position is always small for all load cases.

Table 3. Stress distribution for impellers with different thicknesses

Blade thickness	Inertia load	Fluid load	Combination of both loads
0.5 mm	1.1901 Max 1.0593 0.92854 0.79778 0.66701 0.53624 0.40548 0.27471 0.14394 0.013174 Min [MPa]	276.5 Max 245.8 215.1 184.4 153.7 123 92.305 61.606 30.906 0.20687 Min [MPa]	277.29 Max 246.5 215.71 184.92 154.14 123.35 92.563 61.775 30.988 0.20095 Min [MPa]
1.5 mm	1.8947 Max 1.6849 1.4752 1.2654 1.0556 0.84588 0.63612 0.42636 0.2166 0.0068444 Min [MPa]	77.814 Max 69.191 60.568 51.946 43.323 34.7 26.077 17.454 8.8313 0.20839 Min [MPa]	78.161 Max 69.508 60.856 52.203 43.551 34.898 26.246 17.593 8.9409 0.28843 Min [MPa]

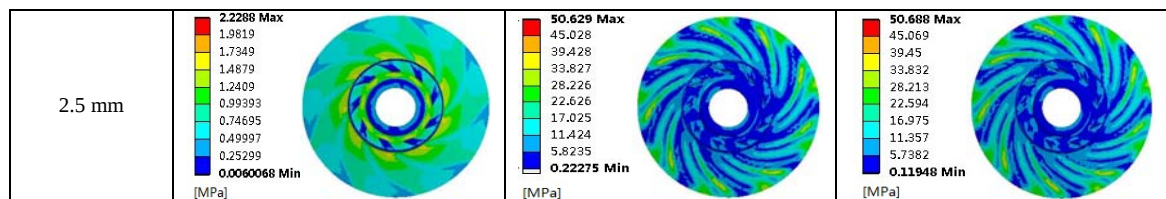


Table 4. Deformation distribution for impellers with different thicknesses

Blade thickness	Inertia load	Fluid load	Combination of both loads
0.5 mm	0.00038926 Max 0.00034601 0.00030276 0.00025951 0.00021626 0.00017301 0.00012975 8.6503e-5 4.3251e-5 0 Min	0.10153 Max 0.090246 0.078965 0.067684 0.056404 0.045123 0.033842 0.022561 0.011281 0 Min	0.10192 Max 0.0906 0.079275 0.06795 0.056625 0.0453 0.033975 0.02265 0.011325 0 Min
1.5 mm	0.00020903 Max 0.00018581 0.00016258 0.00013935 0.00011613 9.2903e-5 6.9677e-5 4.6451e-5 2.3226e-5 0 Min	0.020854 Max 0.018537 0.01622 0.013903 0.011586 0.0092687 0.0069515 0.0046343 0.0023172 0 Min	0.021049 Max 0.01871 0.016371 0.014032 0.011604 0.009355 0.0070162 0.0046775 0.0023887 0 Min
2.5 mm	0.00018573 Max 0.0001651 0.00014446 0.00012382 0.00010318 8.2548e-5 6.1911e-5 4.1274e-5 2.0637e-5 0 Min	0.017303 Max 0.015381 0.013458 0.011536 0.009613 0.0076904 0.0057678 0.0038452 0.0019226 0 Min	0.017287 Max 0.015366 0.013445 0.011524 0.0096037 0.0076829 0.0057622 0.0038415 0.0019207 0 Min

4. IMPELLER STRENGTH CHECK

The calculations of stress and deformation at different flow rate are implemented to check the strength of stainless steel impeller with blade thickness of 1.5 mm. Due to that the distribution laws of stress and deformation are similar at different flow rate, the maximum deformation and stress at different flow rate only should be obtained, which is shown in Fig. 3. The figure indicates that the maximum stress increases with the augment of flow rate. Maximum stress on impeller is 75.57 MPa when the flow rate is 3.2 m³/h, and when it is 14 m³/h, maximum stress reaches 89.07 MPa. With the increase of flow rate, maximum deformation decreases first and reaches 0.021 mm at the design flow rate, and then increases.

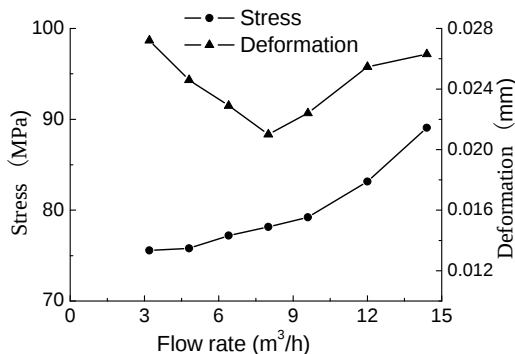


Fig. 3. Maximum stress and deformation of impeller at different flow rate

In the end, impeller strength checking is processed. According to the material properties, it is known that the yield strength of stainless steel $\sigma_s = 207$ MPa. The relationship among safety coefficient n ,

yielding strength σ_s and maximum stress $[\sigma]$ satisfies the following equation:

$$n = \sigma_s / \sigma \quad (1)$$

According to formula (1), the safety factors of impeller at different flow rate are calculated and displayed in Table 3. Generally, the safety coefficient n should be more than 2. It can be seen in Table 3 that the minimum safety factor is 2.234 when flow rate is 14.4 m³/h, which exceeds the range of safety factor but close to the critical value. So the thickness of blade has better be more than 1.5 mm to ensure the strength of stainless steel impeller.

Table 3. Safety coefficient at different flow rate

Q (m ³ /h)	Safety coefficient
3.2	2.739
4.8	2.731
6.4	2.681
8	2.648
9.6	2.613
12	2.489
14.4	2.234

7. CONCLUSION

In this paper, unidirectional fluid structure interaction is used to calculate the final stage impeller of stainless steel multistage centrifugal pump. Through the finite element calculation of the impeller with five different blade thicknesses, distribution laws of stress and deformation caused by inertial force load and fluid pressure load are found. With the increase of blade thickness, the maximum stress caused by inertial force load gradually increases,

while the maximum stress of fluid pressure load decreases. Moreover, maximum deformation caused by three loads gradually decreases with the increase of blade thickness, but the position where maximum deformation appears transfers from blade inlet to outlet of front shroud. With comprehensive consideration of pump performance and strength, the blade thickness of 1.5 mm is selected at last.

8. REFERENCES

- [1] Shi Weidong, Wang Hongliang and Yu Xuejun. Development And Prospect Of Deep Well Pump In China, *Drainage and Irrigation Machinery*, Vol. 27, No. 1, pp. 64-68, 2009.
- [2] C. L. Yao, C. H. Wang, K. Liu, and L. Ding, "Characters and current developments of stamping and welding centrifugal pump," *Manufacturing Automation*, vol. 28, no. 12, pp. 214-215, December 2006.
- [3] Wang Yang, Wang Hongyu, Xu Xiaomin and Zhang Xiang. Finite element computation for impeller of stamping and welding centrifugal pump [J]. *Drainage and Irrigation Machinery*, 2011, 29(2): 109-113.
- [4] Wang Yang, Wang Hongyu, Zhang Xiang and Xu Xiaomin. Strength analysis on the stamping and welding impeller in centrifugal pump based on fluid-structure interaction theorem [J]. *Transactions of the CSAE*, 2011, 27(3): 131-136.
- [5] C. L. Yao, C. H. Wang, K. Liu, and L. Ding, "Characters and current developments of stamping and welding centrifugal pump," *Manufacturing Automation*, vol. 28, no. 12, pp. 214-215, December 2006.
- [6] Lu Weigang, Zhang Qihua, Shi Weidong. Impeller diameter maximum approach on deep well pump [J]. *Drainage and Irrigation Machinery*, 2006, 24(5): 1-7.
- [7] C. Wang: *Optimization design and internal flow field research on low specific speed agricultural centrifugal pump*, INFORMATION, vol.16, no. 5, (May. 2013), page numbers (3211-3228), ISSN 1343-4500.
- [8] D. Zhang: *Unsteady flow analysis and experimental investigation of axial-flow pump*, Journal of Hydrodynamics, Ser.B, vol.22, no. 1 (Jan. 2010), page numbers (35-44) ISSN 1001-6058.
- [8] W. Shi: *Numerical and experimental investigation on high efficiency axial-flow pump*, Chinese Journal of Mechanical Engineering, vol.23, no. 1, (Jan. 2010), page numbers (38-44), ISSN 1000-9345.

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IMPROVEMENT OF CENTERLINE SEGREGATION IN CONTINUOUSLY CAST BILLETS OF HIGH CARBON STEEL BY COMBINATION OF INTENSE SECONDARY COOLING AND F-EMS

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Key words: centerline segregation, intense secondary cooling, F-EMS, high carbon steel, continuously cast billet

Abstract: In order to comprehensively investigate the effects of intense secondary cooling and F-EMS on the improvement of centerline segregation in continuously cast billet of high carbon steel, the numerical simulations of temperature field, electromagnetic field and fluid flow field and plant trials were performed in present study. The numerical models were validated by the strand surface temperature measured by infrared camera ThermalCAMTM, shell thickness measured by nail-shooting method and the magnetic flux density measured with Teslameter CT-3, respectively. The liquid pool thickness of strand, the magnetic flux density and liquid flow in the liquid pool at the location of F-EMS were calculated by the numerical simulation model to theoretically determine the suitable casting parameters and stirring parameters. Moreover, plant trials were further carried out to optimize casting parameters and stirring parameters to improve the centerline segregation in continuously cast billets. The results show that the centerline segregation in continuously cast billets of 70# steel can be significantly improved by combination of intense secondary cooling and F-EMS, and the suggested specific secondary cooling water, casting speed, and current density and frequency of F-EMS stirrer located at 8.2m from the meniscus are 1.0L/kg, 1.80m/min, 360~380A, 6Hz, respectively.

1 INTRODUCTION

During the solidification of continuous casting steel, the elements of steel with smaller solubility in solid phase than in liquid phase are rejected ahead of the solidification interface and enriched in the remaining liquid. The enriched liquid is gradually pushed into the center of the strand by solidification interface and finally solidified, resulting in a significant concentration peak of alloy elements in the center of the strand.^[1, 2] The uneven distribution of alloy elements across the centerline axis is termed centerline segregation, and usually occurs in continuously cast billets of high carbon steel.

The significant centerline segregation has a detrimental effect on the quality of final product and puts limits on the castability of specific steel grades. Therefore, it is obviously of great economic importance to take suitable countermeasures to control the centerline segregation efficiently. As a consequence, lots of attempts have been made to solve this industrial problem and many useful techniques have been proposed^[3-5], such as electromagnetic stirring (EMS)^[6-12], mechanical soft reduction (MSR)^[13-15], thermal soft reduction (TSR)^[16, 17], intensive secondary cooling^[18-21], etc. EMS is classified into in-mold stirring (M-EMS), in-strand stirring (S-EMS) and final stirring (F-EMS) according to the position of EMS, and has the function of breaking the columnar dendrites, promoting the equiaxed dendritic growth and homogenizing the molten steel in the liquid pool of strand. MSR is usually applied at the final solidification of strand to compensate the solidification shrinkage and squeeze out the solute-enriched liquid by mechanical force of supporting rollers, therefore the improvement of centerline segregation is achieved. TSR is also an effective technique that hard cooling is applied at the liquid pool end to decrease the difference in cooling rates between the center and surface of strand at the end of the liquid pool and reduce the volume contraction of the strand center. Moreover, intensive secondary cooling has been developed at the secondary cooling zone at high flow rates or high water pressure to achieve the fine columnar solidification structures and decrease centerline segregation. Among these various techniques, EMS is widely used in continuously cast billets of high carbon steel. TSR and intensive secondary cooling are also adopted in continuously cast billets, but much attention should be paid to balance the improvement of centerline segregation and occurrence of both surface and inner crack in strand. Nevertheless, to the knowledge of author, MSR is rarely used in continuously cast billets.

In present work, investigation of the centerline segregation in continuously cast billets of high carbon steel by combination of intense secondary cooling and F-EMS was carried out. Firstly, numerical models for temperature field, electromagnetic field and fluid flow field of continuously cast billets were developed and validated by combination of surface temperature measurement, shell thickness measurement and magnetic flux density measurement. Secondly, the effects of secondary cooling patterns and F-EMS stirring parameters on the solidification of continuously cast billets of high carbon steel were theoretically analyzed by the developed numerical models. Thirdly, plant trials were carried out to investigate the effects of intense secondary cooling and F-EMS on the centerline segregation in continuously cast billets of high carbon steel. Finally, the optimum intense secondary cooling pattern and F-EMS stirring parameters were proposed to achieve the significant improvement of centerline segregation in continuously cast billets of high carbon steel.

2 PLANT TRIAL DETAILS

2.1 Plant trial condition

The investigation was carried out on a ten-strand bow-type billet caster with a radius of 10m and section size of 160 × 160 mm², as shown in **Fig. 1**. The mold height was 900 mm, and the secondary cooling zone with a total length of 6.359 m was divided into four zones: one water cooling zone and three air-mist cooling zones. The distance from the exit of the fourth cooling zone to the torch cutting position was 27.814 m, which was regarded as the radiation cooling zone. The electromagnetic stirrer in the lower region of the strand (called F-EMS) with a length of 800mm was located at 8.2m from the meniscus, and the stirring mode of F-EMS in the billet caster was rotative.

In order to exert the metallurgical effect of F-EMS prefixed at 8.2m from the meniscus, plant trials were conducted to explore the optimum casting parameters (secondary cooling intensity and casting speed) and stirring parameters for aim steel grade in present study. 70# steel was adopted and its chemical composition was listed in **Table 1**. In order to investigate the effect of secondary cooling pattern on the centerline segregation, weak and intense secondary cooling, the specific water flow rates of which were 0.46 and 1.0 L/kg respectively, were applied on billet caster. Moreover, the tests of F-EMS modes were also conducted to examine the effect of F-EMS stirring parameters on the centerline segregation.

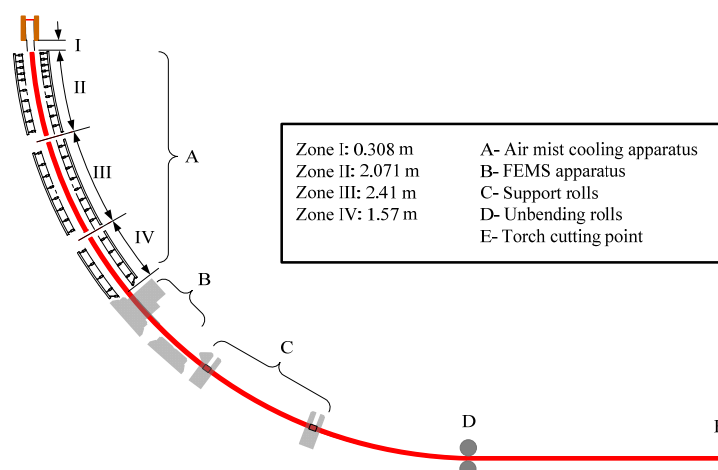


Fig. 1 The schematic diagram of the billet continuous caster

Table 1 The chemical compositions of 70# steel, wt%

Steel	C	Si	Mn	P	S
70#	0.70	0.20	0.57	0.016	0.004

2.2 Surface temperature and shell profile measurement test

The surface temperature and solid shell profiles were investigated by infrared camera ThermalCAM™ and nail-shooting method, respectively. Fig. 2 shows the schematic diagram of strand surface temperature measurement by infrared camera ThermalCAM™. The infrared camera ThermalCAM™, which was connected with a portable computer, was placed near the measurement point and recorded the thermal history of the billet surface. Fig. 3 shows the shooting gun and nails for the nail-shooting

test. It should be mentioned here that because of the melting point of nail lower than that of test steel, the nails shot into the strand are hard to melt in liquid pool of strand. A significant gap between the liquid core and the nail will be formed during the solidification of continuously cast billets due to the solidification shrinkage of the molten steel, and therefore the length of discontinuous gap along the nail shot into the strand revealed the thickness of liquid core in the strand.

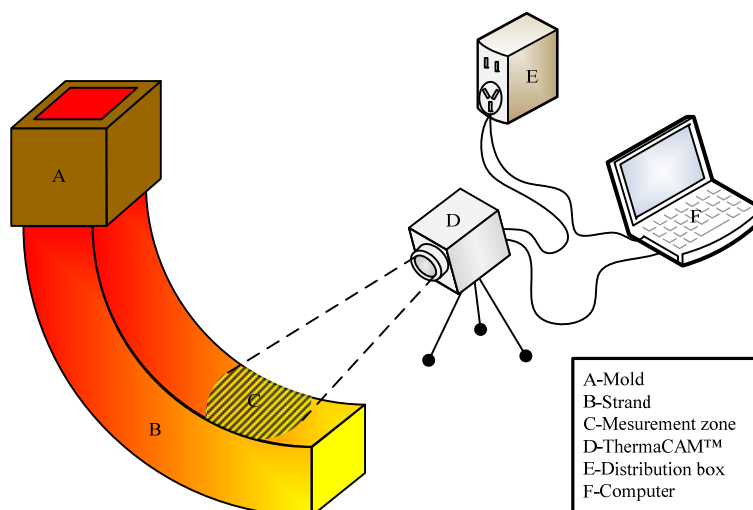


Fig. 2 Schematic diagram of surface temperature measurement of continuously cast billet

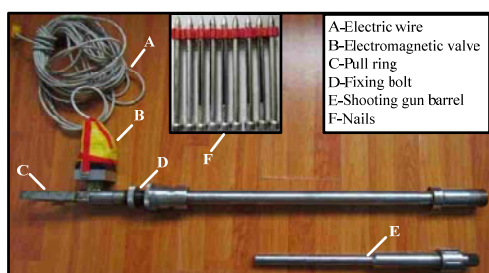


Fig. 3 Shooting gun and nails

2.3 Segregation analysis test

In order to investigate the effect of the secondary cooling intensity and F-EMS on the centerline segregation, slices with 30mm

thickness were taken from the continuously cast billet perpendicular to the casting directions to perform macrosegregation analysis for each plant trial condition, as shown in Fig. 4 (a). In order to eliminate effect of non-uniformity of structure in the strand centre on the transversal sample and provide more unambiguous data on segregation, several transversal samples are taken and the quantitative evaluation of carbon concentration was made by the analysis results of drilling samples, which were collected at 1/4, 1/2 and 3/8 length in diagonal lines of billet slice with drill of 5mm diameter, as shown in Fig. 4 (c). It should be mentioned here that because the geometrical centre was not always coincide with the metallurgical centre, the drilling position of center point must be chosen carefully to meet the metallurgical centre in order to represent the actual segregation at the centre. Therefore, the centerline segregation ratio was expressed as a ratio of the carbon concentration at the metallurgical centre to the average carbon concentration of total analysis points and given as follows:

$$\bar{C} = 9C_s / \sum_{i=1}^9 C_i \quad (1)$$

where C_i is carbon concentration at the drilling point i .

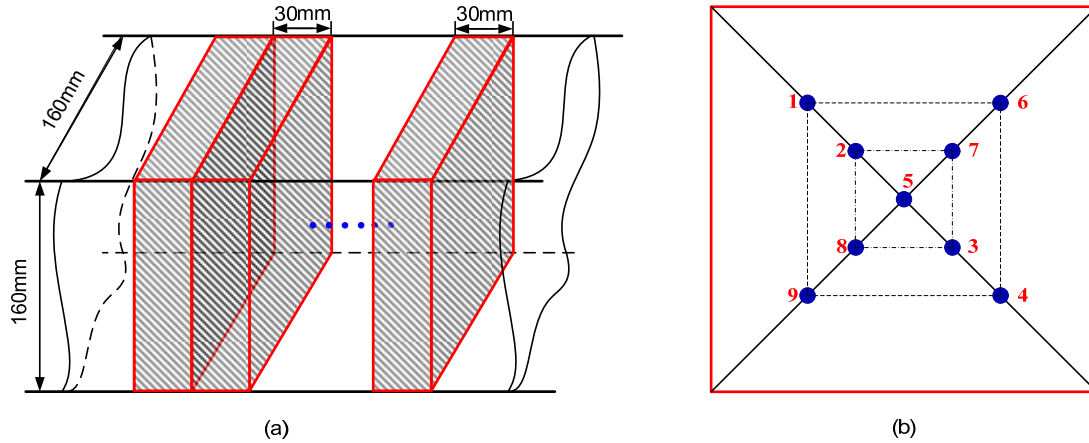


Fig. 4 Schematic diagrams of (a) sampling and (b) drilling in the continuous casting billet

3 MATHEMATICAL MODEL DESCRIPTION

3.1 Temperature field model

In order to provide more comprehensive information for the effect of secondary cooling intensity on the temperature field of strand, a numerical model of temperature field was developed here for the continuously cast billet. The governing equation for heat transfer during the continuous casting steel is given as follows:

$$\rho c \frac{\partial T}{\partial t} = \lambda \nabla^2 T + S_0 \quad (2)$$

where T is the temperature, °C; t is the time, s; ρ is the density, kg/m³; c is the specific heat capacity, J/(kg·°C); λ is the heat conductivity, W/(m·°C); and S_0 is the internal heat source, W/m³.

The initial temperature for numerical simulation is assumed to be the casting temperature, which is uniformly distributed in the modeling domain and determined by continuous measurement of temperature in the tundish.

Owing to the axisymmetry of billet, only 1/4 cross section is chosen as calculation domain. The heat flux along the symmetric axis is set to be zero. The boundaries of the outer sides depend on position of moving slice and are described as follows.

(1) Mold cooling zone

In mold cooling zone, the heat flux is loaded on the outer sides according to Savage and Pritchard^[22], which is expressed as follow

$$q = 2.688 - B\sqrt{t} \quad \text{MW/m}^2 \quad (3)$$

where B is a coefficient depending on the mold cooling conditions.

(2) Secondary cooling zone

In the secondary cooling zone, the heat of strand is mainly extracted by the spraying water with convection. The convection coefficient depending on the flow rate and temperature of secondary cooling water is estimated using Nozaki's formula^[23].

$$h_w = 1570W^{0.55} (1 - 0.0075T_w) / \alpha \quad \text{W/(m}^2 \cdot \text{°C)} \quad (4)$$

where, W is the water flux, L/(m²·s); T_w is the cooling water temperature, °C; α is a modified parameter depending on the cast machine.

(3) Radiation cooling zone

In the radiation cooling zone, the radiation heat from strand surfaces to the ambient is governed by the Stefan-Boltzmann law, expressed as follow.

$$q_{\text{rad}} = \sigma \varepsilon (T_{\text{surf}}^4 - T_{\text{amb}}^4) \quad (5)$$

where q_{rad} is the radiation heat flux, W/m²; σ is Stefan-Boltzmann constant, 5.70×10^{-8} W/(m²·K⁴); ε is steel emissivity 0.95; T_{surf} and T_{amb} are respectively the surface temperature of the strand and the ambient temperature, K.

In order to predict the thermal history of continuously cast billet more reliable, the thermophysical properties of steel should be chosen carefully. Here, a microsegregation model, developed by authors in previous work^[24] with considering the effect of the δ/γ phase transformation and non-metallic inclusion precipitation on the interdendritic solute segregation during the solidification of steel, was adopted to calculate the temperature dependent thermophysical properties of steel combining with the empirical equations of thermophysical properties of steel proposed by Harste^[25].

3.2 Electromagnetic field model

The F-EMS installed at the final solidification stage of continuously casting billet is to generate magnetic field, resulting in the induction electric current in the molten steel. The flow motion of molten steel in the liquid pool is driven by the Lorentz force induced by the interaction of induced electric current in the molten steel and the magnetic field. Finally, the macrosegregation and porosity are improved by the flow motion of molten steel at the final solidification of stand.^[26] The electromagnetic field can be expressed by the Maxwell's equation.

$$\text{Faraday's Law:} \quad \nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \quad (6)$$

$$\text{Ampere's Law:} \quad \nabla \times \mathbf{B} = \mu \mathbf{J} \quad (7)$$

$$\text{Magnetic flux density:} \quad \nabla \cdot \mathbf{B} = 0 \quad (8)$$

where $\mathbf{E}$ is the electric field, V/m; $\mathbf{B}$ is the magnetic flux density, T; $\mathbf{J}$ is the current density, A/m²; t is the time, s; and μ is the magnetic permeability, H/m.

The electric current density is governed by Ohm's Law for the moving molten steel in the liquid pool:

$$\mathbf{J} = \sigma (\mathbf{E} + \mathbf{U} \times \mathbf{B}) \quad (9)$$

where σ is the electro conductivity, S/m; and $\mathbf{U}$ is the fluid velocity vector, m/s. Owing to the very low values of the Magnetic Reynolds number, the effect of the fluid motion on the Lorentz force field can be neglected by omitting the convection term $\mathbf{U} \times \mathbf{B}$ in Ohm's law.

Once the current distribution and the vector potential are known, the magnetic field is readily calculated and the Lorentz forced termed $\mathbf{F}$ in the molten steel is given as follows:

$$\mathbf{F} = \mathbf{J} \times \mathbf{B} \quad (10)$$

3.3 Fluid flow field model

The fluid flow field of the liquid core in the continuously cast billets was expressed by mass conservation formulation and momentum conservation formulation. Owing to the much larger viscosity coefficient of the solidifying shell than that of molten steel, the solidifying shell was not considered and only single liquid phase

was considered in the whole physical model in order to simply the physical model and save the computation time.

The single-phase continuity equation for incompressible flow is described as follows:

$$\frac{\partial}{\partial x_i}(\rho \mathbf{U}_i \mathbf{U}_j) = \frac{\partial}{\partial x_i} \left[(\mu + \mu_t) \left(\frac{\partial \mathbf{U}_i}{\partial x_j} + \frac{\partial \mathbf{U}_j}{\partial x_i} \right) \right] - \frac{\partial P}{\partial x_i} + \mathbf{F}_i \quad (12)$$

where μ is the laminar viscosity, Pa·s; and μ_t is the laminar viscosity, Pa·s. The turbulent viscosity is expressed as $\mu_t = \rho C_\mu (k^2/\epsilon)$; $C_\mu = 0.09$.

The no-slip boundary condition at the solid/liquid interface and free surface boundary condition both at the inlet and outlet of F-EMS are assumed in present study.

$$\nabla \cdot \mathbf{U} = 0 \quad (11)$$

The single-phase momentum equation for incompressible flow with a $k-\epsilon$ turbulence model is described as follows:

3.2 Model validation

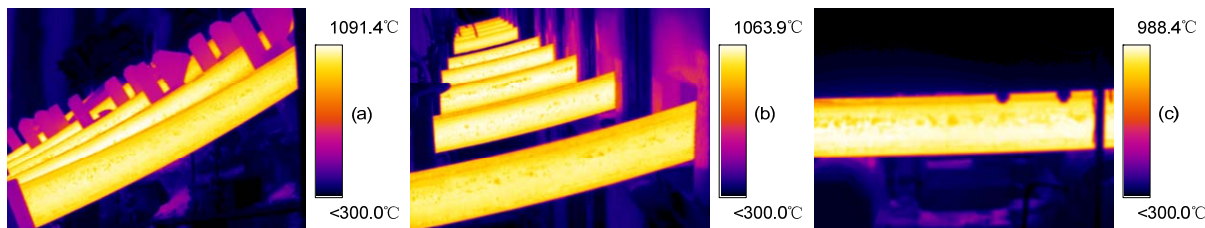


Fig. 5 Snapshot of measured temperature distribution of continuous casting billets of 70# steel (a) F-EMS exit, (b) unbending entrance, (c) horizontal position

The surface temperature measurement tests were carried out on the continuously cast billets of 70# steel under the condition of weak secondary cooling of 0.46L/kg and casting speed of 1.8 m/min. **Fig. 5** shows the snapshot of measured temperature distribution of continuously cast billets near FEMS exit, unbending entrance and horizontal position, respectively. It can be seen that the surface temperature of strand is revealed by the infrared camera ThermalCAM™ and the surface temperature decreased with the distance far away from the meniscus. However, owing to the non-uniform scales on the strand surface, the snapshot of temperature field of strand surface can't represent the real temperature field of whole strand surface. Therefore, the recording time of each test point under steady casting state should not be less than 5 minutes, and the

maximum measured temperature appeared at the discontinuous position of scales on the strand surface is regarded as the authentic temperature of billet surface. **Fig. 6** shows the real-time measured temperature of the side face center at the position of 11.112m, 14.792m and 16.092 m from the meniscus, respectively. It is clearly noted that the measured temperature of billet surface fluctuates drastically due to the effect of scales on the strand surface and the maximum temperature appears intermittently when the scales on the strand surface disconnect. The maximum temperatures at the position of 11.112m, 14.792m and 16.092 m from the meniscus are respectively 1046 °C, 1025 °C and 998 °C, which are regarded as the authentic surface temperature of strand.

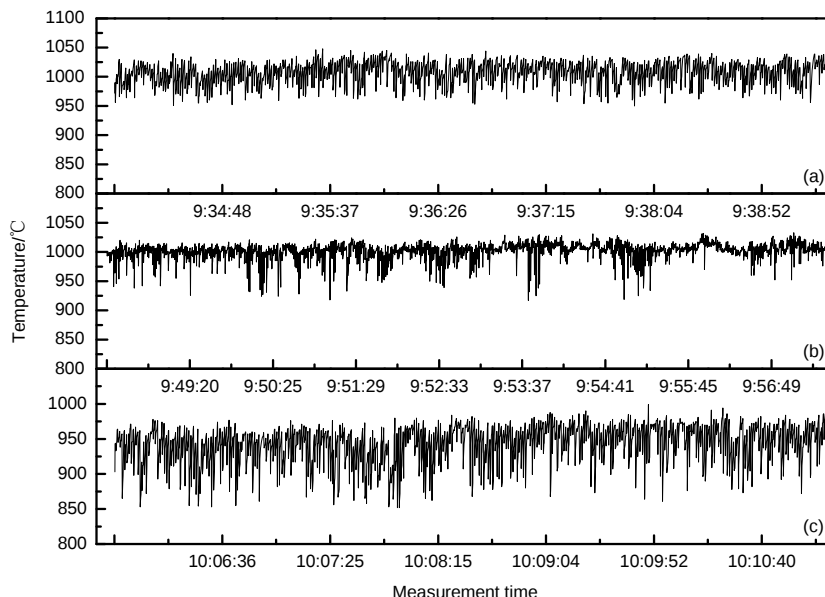


Fig. 6 Measured surface temperature of continuous casting billets of 70# steel, (a) 11.112 m, (b) 14.792 m, and (c) 16.092 m from the meniscus

Meanwhile, The nail-shooting tests were also carried out on the continuously cast billets of 70# steel under the condition of hard secondary cooling of 1.0L/kg and various casting speeds of 1.9 m/min, 1.99m/min and 2.05m/min. The 100mm-length nails containing FeS were shot into the strand at the position, where

11.786m is away from the meniscus. **Fig. 7** shows the macroetched nail-shooting samples. It can be found that the thickness of solidified shell is approximately 67.0 mm, 64.0 mm and 62.0 mm corresponding to the casting speed of 1.9 m/min, 1.99m/min and 2.05m/min, respectively.

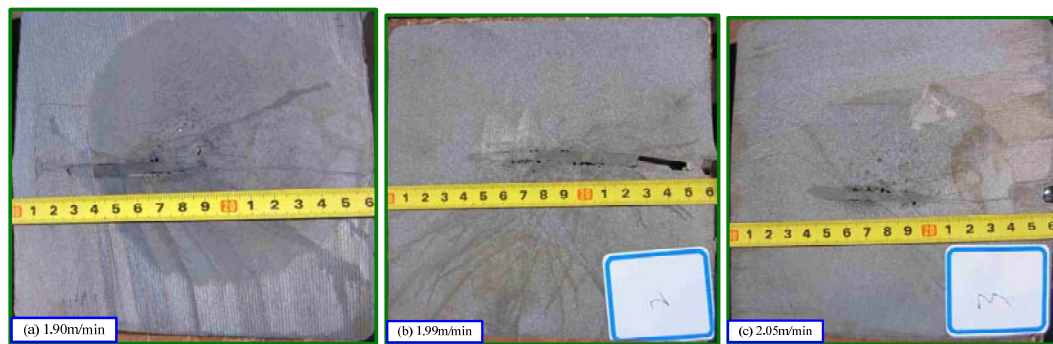


Fig. 7 Macroetched nail-shooting samples at casting speed of (a) 1.90 m·min⁻¹, (b) 1.99 m·min⁻¹ and (c) 2.05 m·min⁻¹

Fig. 8(a) shows the comparison between the calculated surface center temperature and measured temperature by the infrared camera ThermalCAMTM. It shows a good agreement between the measured and calculated values. The maximum absolute error of surface temperature is 1.0%, which means the prediction of surface

temperature by numerical model is reliable. A good agreement between the experimentally measured and predicted shell thickness is also gained in Fig. 8(b). Therefore, the numerical model of temperature field is capable of predicting the surface temperature and solidified shell thickness of continuously cast billets.

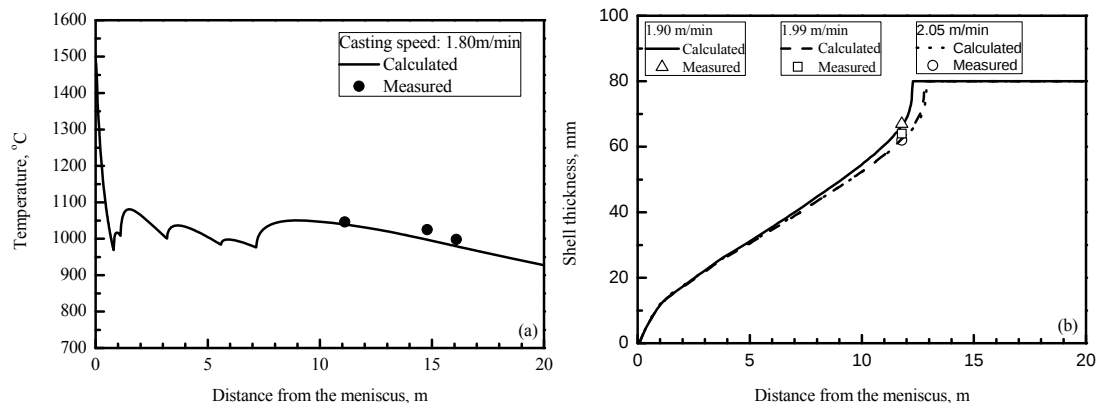


Fig. 8 Comparison between the calculated and measured results of (a) Surface center temperature and (b) Shell thickness of 70# steel

In addition, in order to validate the electromagnetic field model, the magnetic flux density at the center of F-EMS stirrer was measured using the Teslometer CT-3. Fig. 9 shows the comparison between the calculated and the measured magnetic flux density at the center of F-EMS stirrer with no-load and frequency of 6Hz. It shows a good agreement between the calculated and the measured magnetic flux density, and can be concluded that the electromagnetic field model can be applied to predict the magnetic flux density at inner of F-EMS stirrer.

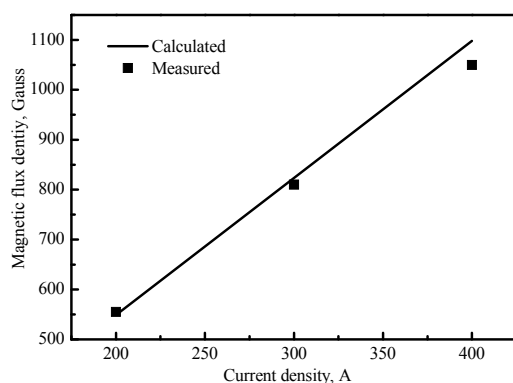


Fig.9 Comparison between the calculated and measured magnetic flux density in stirrer center

4 RESULTS AND DISCUSSION

4.1 Effect of secondary cooling intensity

Plant trials were undertaken to investigate the effect of secondary cooling intensity on the centerline segregation of continuously cast billets. Two secondary cooling modes, which were weak secondary cooling mode of 0.46L/kg and intense secondary cooling mode of 1.0L/kg respectively, were applied in continuously

cast billet of 70# steel at casting speed of 1.80 m/min. The F-EMS stirrer was fixed at 8.2m away from the meniscus with current of 340A and frequency of 6A.

Fig. 10 shows the solidification progress of continuously cast billet of 70# steel with different secondary cooling intensities. The rectangle filled with oblique lines marks the position of F-EMS stirrer. It is evident that increasing the secondary cooling intensity from 0.46L/kg to 1.0L/kg causes the length of mushy zone decrease from 3.66m to 3.42m, resulting in the decrease of solidification time. For the weak secondary cooling mode, the corresponding liquid core thicknesses both at the inlet and outlet of F-EMS are 69.8 mm and 62.5 mm, respectively. However, for the intense secondary cooling mode, the corresponding liquid core thickness both at the inlet and outlet of F-EMS are 63.9 mm and 55.0 mm, respectively. Another interesting feature should be mentioned that for the weak secondary cooling mode, there is completely liquid in the strand centre at the inlet of F-EMS. Consequently, it might be hard to achieve the metallurgical effect of F-EMS.

Fig.11 shows the effect of secondary cooling intensity on the segregation ratio of carbon. It can be seen clearly that for the weak secondary cooling mode, the centerline segregation ratios of carbon are respectively 1.26, 1.27 and 1.33 for different superheats of 25°C, 23°C and 29°C. Nevertheless, when the intense secondary cooling mode is applied, the centerline segregation ratios of carbon are respectively 1.13, 1.16 and 1.19 for different superheats of 21°C, 25°C and 28°C. It is also evident that increasing the secondary cooling intensity, the average centerline segregation ratio of carbon decreases from 1.29 to 1.16. That may be because with the increase of secondary cooling intensity, the length of mushy zone and solidification time decreases, with the consequence of much finer columnar solidification structures and decreased segregation levels, which is also demonstrated by other metallurgical researchers^[3, 18-20].

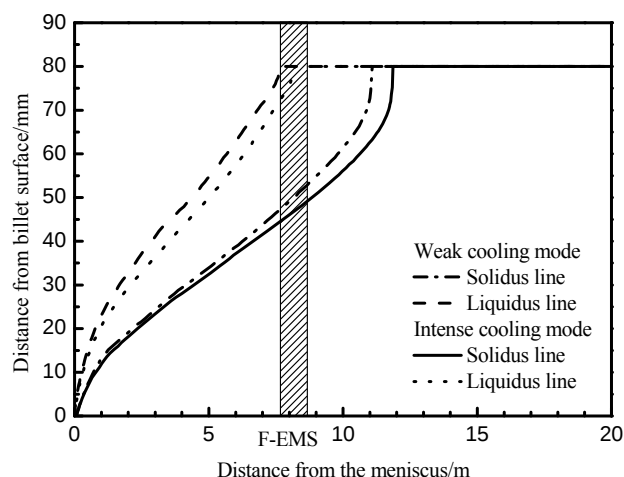


Fig. 10 Effect of secondary cooling intensity on solidification of continuously cast billet of 70# steel

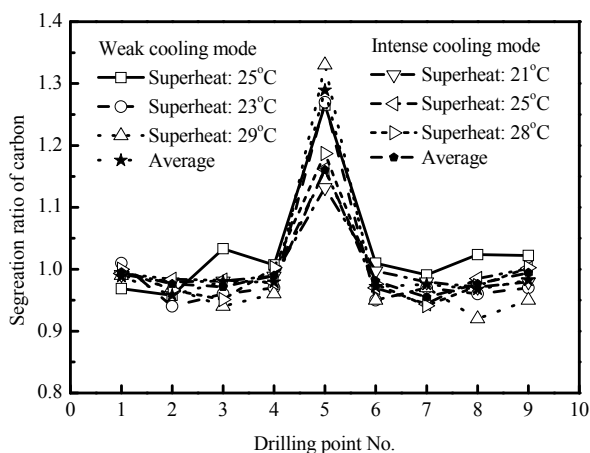


Fig. 11 Effect of secondary cooling intense on the segregation ratio of carbon

4.2 Effect of casting speed

In order to determine the optimum casting speed for the continuously cast billet of 70# steel with application of F-EMS, numerical simulation of heat transfer during the solidification of continuously cast billet was carried out to predict the liquid pool thickness at the F-EMS and experimental investigation on the solute soundness of continuously cast billet was also conducted for different casting speeds. The current and frequent of F-EMS were 350A and 5.8Hz, respectively. In addition, the secondary cooling intensity of 1.0L/kg was applied.

Fig. 12 shows the calculated liquid pool thickness at the position of F-EMS for different casting speeds. It can be seen that with the increase of casting speed from 1.6m/min to 2.0m/min, the liquid pool thickness at the inlet of F-EMS increases from 52.48mm to 72.32mm, and the liquid pool thickness at the outlet of F-EMS increases from 40.80mm to 64.96mm. Correspondingly, the liquid pool thickness difference between the inlet and outlet of F-EMS decreases from 11.68mm to 7.36mm with the increase of casting speed from 1.6m/min to 2.0m/min, resulting in the effect zone of F-EMS decreasing significantly. It should be mentioned that when the casting speed is greater than 1.80m/min, there is completely liquid in the strand centre at the inlet of F-EMS, which locates too high in the casting machine and can't achieve the desired metallurgical effect.

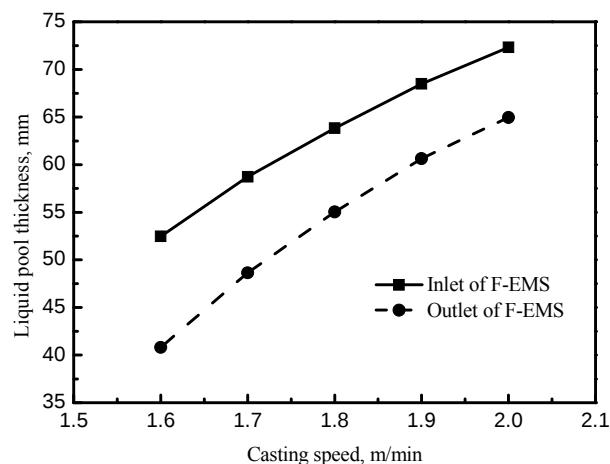


Fig. 12 Effect of casting speed on liquid pool thickness at the position of F-EMS

Fig. 13 shows the effect of casting speed on the centerline segregation ratio of carbon. It is interesting to see that there is a minimum centerline segregation ratio of carbon, when the casting speed is 1.80m/min. When the casting speed is larger than 1.80m/min, the centerline segregation ratio of carbon shows the clear trend of increase. That may be because the location of the F-EMS stirrer is too high in the machine resulting in completely liquid existed in strand center for the high casting speed, and the operation of F-EMS stirrer can't have a metallurgical effect. Correspondingly, when the casting speed is lower than 1.80m/min, the centerline segregation ratio of carbon also increases. That may be because the location of the F-EMS stirrer is too low in the machine, resulting in high fraction of solid existed in strand center for the lower casting speed, and the operation of F-EMS stirrer can't also exert the best metallurgical effect on improvement of centerline segregation. It should be mentioned that when the casting speed is 1.80m/min, the calculated liquid pool thicknesses both at the inlet and outlet of F-EMS stirrer are respectively 55.04mm and 63.84mm, and the calculated liquid pool thickness at the position of F-EMS stirrer shows good agreement with the previously experimental study performed by Oh and Chang,^[9] who proposed that the optimum liquid core thickness at F-EMS stirrer for the continuously cast billet of 0.72wt% carbon steel was 55.0 mm. Consequently, it can be concluded that the present location of F-EMS is suitable for the billet of 70# steel casted by 1.8m/min in order to improve the centerline segregation significantly.

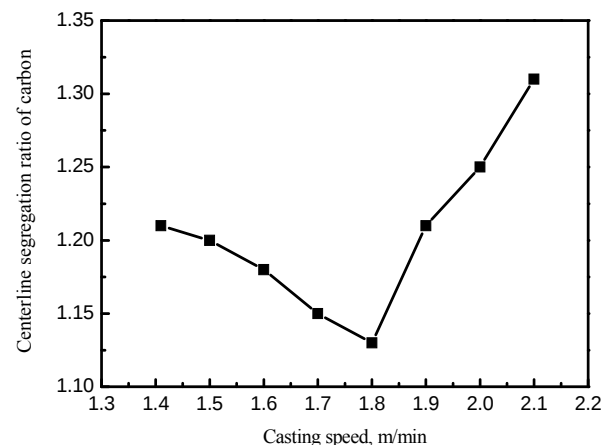


Fig. 13 Effect of casting speed on centerline segregation ratio of carbon

4.3 Effect of stirring parameters of F-EMS

In order to exert the metallurgical effect of F-EMS on the improvement of centerline segregation of continuously cast billet, numerical simulation and experimental investigation were carried to determine the optimum stirring parameters of F-EMS. It should be mentioned that the casting speed of 1.8m/min and secondary cooling

intensity of 1.0 L/kg, which were determined in the above sections, were used in the continuously cast billets of 70# steel with application of F-EMS located at 8.2m away from the meniscus in the following research works.

Fig. 14 shows the calculated magnetic flux density distribution along the axis of F-EMS stirrer with the frequency of 6Hz. It can be found that the magnetic flux densities of different current densities run parallel to each other, and the highest magnetic flux density is in the center of F-EMS stirrer. The magnetic flux density decreases along the axis of F-EMS stirrer away from the center and the lowest magnetic flux densities are both at the inlet and outlet of F-EMS stirrer. With the increase of current, the highest magnetic flux density increases. It can be quantitatively determined that the highest magnetic flux densities are respectively 933Gs, 988Gs, 1042Gs and 1097Gs for the current of 340A, 360A, 380A and 400A.

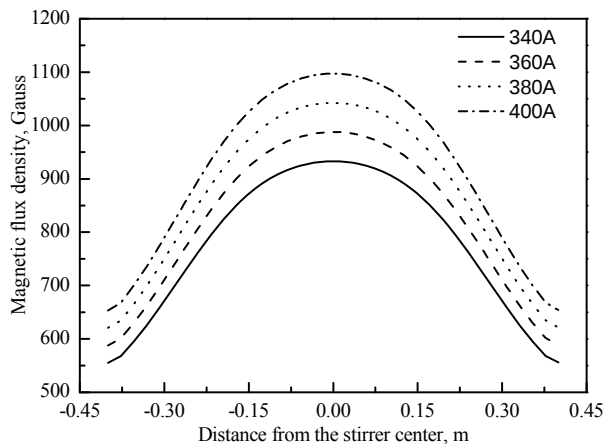


Fig. 14 Magnetic flux density distribution along the axis of stirrer

Fig. 15 shows the calculated tangential velocity distribution along the diameter direction in the center of F-EMS stirrer with the frequency of 6Hz. It can be seen that the tangential velocity increases firstly with the increase of distance from the stirrer center along the diameter direction and gradually reaches the highest tangential velocity at the front of solid/liquid interface. Later, the tangential

velocity approaches to zero at the solidified shell. For same frequency, the highest tangential velocity increases with the increase of current. It can be quantitatively determined that the highest tangential velocities along the diameter direction in the center of F-EMS stirrer with the frequency of 6Hz are respectively 0.137m/s, 0.152m/s, 0.165m/s and 0.180m/s for the current of 340A, 360A, 380A and 400A.

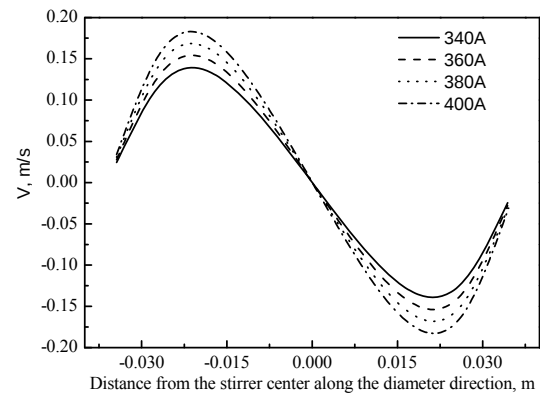


Fig. 15 Tangential velocity distribution along the diameter direction in the center of stirrer

According to the study carried by Mizukami *et al.*^[8], the stirring velocity of 0.10~0.12m/s induced by F-EMS stirrer is enough to the segregation free cast. Therefore, based on the calculation results, the present F-EMS stirrer operated on the current of 340~400A and frequency of 6Hz can create enough stirring velocity to improve the centerline segregation of continuously cast billet, but which operation parameter of F-EMS is optimum to greatly enhance the solute soundness in continuously cast billet, plant trials are conducted in casting shop and the experimental scheme of F-EMS is listed in Table 2.

Table 2 The experimental scheme of final electromagnetic stirring

Steel Grade	Casting speed (m/min)	Current density (A)	F-EMS Frequency (Hz)	Stirring Pattern
70#	1.8	340	6	continuous
70#	1.8	360	6	continuous
70#	1.8	380	6	continuous
70#	1.8	400	6	continuous

Fig. 16 shows the effect of current density on the centerline segregation ratio of carbon. It can be seen that when the current density increases from 340A to 360A, the centerline segregation ratio of carbon decreases significantly from 1.16 to 1.08. That may be because that with the increase of current density, the Lorentz force and stirring velocity of molten steel increases, resulting in solute soundness of continuously cast billet. When the current density increases from 360A to 380A, the improvement of centerline segregation becomes slightly, and the centerline segregation ratio of carbon decreases from 1.08 to 1.06. That may be because the Lorentz force induced by F-EMS stirrer is enough to create flow motion of molten steel to make the solute-enriched molten steel uniform in the strand core, and the increase of current density is not beneficial for decreasing centerline segregation significantly, when the current density is in the range of 360~380A. However, there is an obvious trend that the centerline segregation of carbon increases with the increase of current density, when the current density is larger than 380A. It is obvious to note that the centerline segregation ratio of carbon reaches as high as 1.24, when the current density is 400A. That may be because that when the current density is larger than 380A, the stirring velocity of molten steel induced by F-EMS stirrer is excessive for mixing the solute-enriched molten steel with the surrounding depleted zone. Consequently, the rejected solute at the solid/liquid interface is washed away and accumulated in the center of strand, resulting in significant centerline segregation.

From the above plant trial results, it is considered that the suitable parameters of F-EMS stirrer are the current density of 360~380A and the frequency of 6Hz in order to improve the centerline segregation in continuously cast billet of 70# steel.

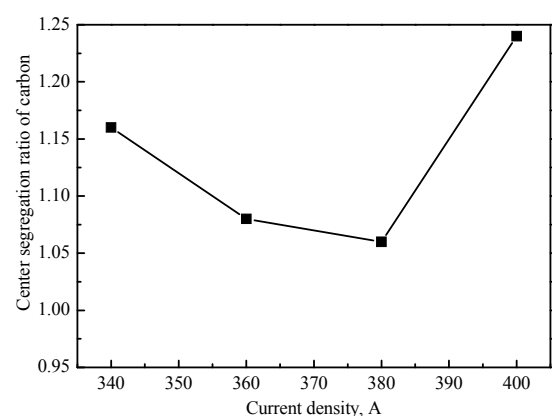


Fig. 16 Variation of centerline segregation ratio of carbon with current density

5 CONCLUSIONS

The effects of combination of intense secondary cooling and

F-EMS on the improvement of centerline segregation of continuously cast billets were investigated by the numerical simulation and plant trials. The results are concluded as follows:

(1) The intense secondary cooling with specific water of 1.0L/kg can improve the centerline segregation in continuously cast billet of 70# steel.

(2) In order to exert the metallurgic effect of F-EMS stirrer located at 8.2 m from the meniscus, the optimum casting speed should be maintained at 1.80 m/min, and the suitable parameters of F-EMS stirrer are the current density of 360~380A and the frequency of 6Hz in order to improve the centerline segregation in continuously cast billet of 70# steel.

(3) The centerline segregation in continuously cast billet of 70# steel is significantly improved by combination of intense secondary cooling and F-EMS.

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REFERENCES

- [1] Flemings M C. Our Understanding of Macroseggregation: Past and Present [J]. *ISIJ International*, 2000, 40(9): 833.
- [2] El-Bealy M O. Spray Cooling Pattern and Microthermomechanical Rigidity Criterion for Improving Inner Quality in Continuously Cast Steel Slabs [J]. *Ironmaking and Steelmaking*, 2013, 40(3): 167.
- [3] Ludlow V, Normanton A, Anderson A, et al. Strategy to Minimise Central Segregation in High Carbon Steel Grades during Billet Casting [J]. *Ironmaking and Steelmaking*, 2005, 32(1): 68.
- [4] Scholes A, et al. Segregation in Continuous Casting [J]. *Ironmaking and Steelmaking*, 2005, 32(2): 101.
- [5] Sediako D, Sediako O, Lin K J. Some Aspects of Thermal Analysis and Technology Upgrading in Steel Continuous Casting [J]. *Canadian Metallurgical Quarterly*, 1999, 38(5): 377.
- [6] Yu H Q, Zhu M Y. Three-Dimensional Magnetohydrodynamic Calculation for Coupling Multiphase Flow in Round Billet Continuous Casting Mold with Electromagnetic Stirring [J]. *IEEE Transactions on Magnetics*, 2010, 46(1): 82.
- [7] Ayata K, Mori T, Fujimoto T, et al. Improvement of Macroseggregation in Continuously Cast Bloom and Billet by Electromagnetic Stirring [J]. *Transactions ISIJ*, 1984, 24(11): 931.
- [8] Mizukami H, Komatsu M, Kitagawa T, et al. Effect of Electromagnetic Stirring at the Final Stage of Solidification of Continuously Cast Strand [J]. *Tesu-to-Hagné*, 70(2): 194 (in Japanese).
- [9] Oh K S, Chang Y W. Macroseggregation Behavior in Continuously Cast High Carbon Steel Blooms and Billets at the Final Stage of Solidification in Combination Stirring [J]. *ISIJ International*, 1995, 35(7): 866.
- [10] Li J C, Wang B F, Ma Y L, et al. Effect of Complex Electromagnetic Stirring on Inner Quality of High Carbon Steel Bloom [J]. *Materials Science and Engineering A*, 2006, 425(1-2): 201.
- [11] Bode O, Schwerdtfeger K, Geck H G, et al. Influence of Casting Parameters on Void Volume and Centre Segregation in Continuously Cast 100Cr6 Blooms [J]. *Ironmaking and Steelmaking*, 2008, 35(2): 137.
- [12] Su W, Jiang D B, Luo S, Zhu M Y. Numerical Simulation for Optimization of F-EMS in Billet Continuous Casting [J]. *Journal of Northeastern University (Natural Science)*, in press (in Chinese).
- [13] Luo S, Zhu M Y, Ji C, et al. Characteristics of Solute Segregation in Continuous Casting Bloom With Dynamic Soft Reduction and Determination of Soft Reduction Zone [J]. *Ironmaking and Steelmaking*, 2010, 37(2): 140.
- [14] Bleck W, Wang W, Bülte R. Influence of Soft Reduction on Internal Quality of High Carbon Steel Billets [J]. *Steel Research International*, 2006, 77(7): 485.
- [15] Oh K S. Development of Soft Reduction Technology for the Bloom Caster at POHANG Works of POSCO [C] // *Steelmaking Conference Proceedings*. Tennessee: Iron and Steel Society, 1995: 301.
- [16] Sivesson P, Raihle C M, Kontinen J. Thermal Soft Reduction in Continuously Cast Slabs [J]. *Materials Science and Engineering A*, 1993, 173(1-2): 299.
- [17] Sivesson P, Hallén G, Widell B. Improvement of Inner Quality of Continuously Cast Billets Using Electromagnetic Stirring and Thermal Soft Reduction [J]. *Ironmaking and Steelmaking*, 1998, 25(3): 239.
- [18] Ray A K, Bhor P K, Basu D S, et al. Improvement in Internal Quality of Boiler Plates at Bhilai Steel Plant [J]. *Ironmaking and Steelmaking*, 2000, 27(3): 189.
- [19] Feng J, Chen W Q. Effect of High Secondary Cooling Intensity on Solidification Structure and Center Carbon Segregation of High Carbon Steel Billet [J]. *Special Steel*, 2006, 27(4): 42 (in Chinese).
- [20] Leblanc J P R, Limoges J. Production of High Quality Billets [J]. *Revue de Metallurgie CIT*, 1997, 94(3): 359.
- [21] Su W, Wang W L, Luo S, et al. The Heat Transfer and Central Segregation of Continuous Casting High Carbon Steel Billet [J]. *Journal of Iron and Steel Research International*, 2013, in press.
- [22] Savage J, Pritchard W H. The Problem of Rupture of the Billet in the Continuous Casting of Steel [J]. *Journal Iron and Steel Institute*, 1954, 178: 269.
- [23] Nozaki T, Matsuno J, Murata K, et al. Secondary Cooling Pattern for the Prevention of Surface Cracks of Continuous Casting Slab [J]. *Tetsu-to-Hagane*, 1976, 62(12): 1503 (in Japanese).
- [24] Luo S, Zhu M Y, Ji C, et al. Solute Microsegregation Model for Continuous Casting Process of Steel [J]. *Iron and Steel*, 2010, 45(6): 31 (in Chinese).
- [25] Harste K. Investigation of the Shrinkage and the Origin of Mechanical Tension during Solidification and Successive Cooling of Cylindrical Bars of Fe-C alloys [D]. Clausthal: Technical University of Clausthal, 1989.
- [26] Das S K. Process Modelling of Electromagnetic Stirring and Segregation during Continuous Casting of High Carbon Steel [J]. *Metals Materials and Processes*, 1995, 7(3): 191.

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STUDY OF GX7NiCrMoCuNb41-20 STEEL MORPHOLOGY AFTER TEEMING AND FORGING OPERATIONS

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Key words: GX7NiCrMoCuNb41-20 steel, Morphology, Forging, Teeming.



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Abstract: The morphology of steels is usually changed after teeming and forging. In this study was discussed the microstructure of GX7NiCrMoCuNb41-20 (1.4559) steel after teeming and forging treatment. The results showed that after teeming in surface structure and center, continuous lattice of carbide in grain boundary is deposited carbides when the after forging, ingot center microstructure is completely different.

1. INTRODUCTION

GX7NiCrMoCuNb 41-20 steel from a group of austenitic stainless steels is accounted. This alloy retains its strength at high temperatures to about 800 °C. The resistance against conditions acute stress, heat and corrosion in this temperature, mainly used in military industries, especially in manufacturing rocket engines [1]. In this steel, delta ferrite from the remains ferrite becomes sigma phase during transformation and affects the ability of forging. Due to be slow of mentioned transformation, with rapid cooling of steel from solidification temperature to 500 °C can avoid the formation of this phase [2]. MC carbides in alloys containing carbide forming elements such as titanium, niobium and hafnium are being formed during solidification. MC carbides are accumulated as particles in the spaces between the dendrites. In case steel be containing nitrogen, these carbides are solved after being surrounded by matrix phase during homogeneous heat treatment at high temperatures [3,4,5]. These carbides are formed together austenite and other carbides. M23C6 carbides are created from Cr metal. This phase occurs with the morphology of the various at a temperature of 950 °C during cooling and in case there is enough time deposited with various morphologies and in different regions [4,5]. M6C, M23C6, MC carbides precipitates at grain boundaries and the grain boundary strength increases and in case deposits infield, the field strength increases. Also with dissolution of other alloying elements can prevent from the creation of other phases. In austenitic stainless steels, by starting solidification and forming austenite, ferrite elements return into melt than austenite elements. Ferrite elements concentration in the melt is causing favorable conditions for the formation of ferrite and peritectic reaction become eutectic and peritectic. At the eutectic reaction deposits ferrite and austenite simultaneous from molten and are causing eutectic structures in dendrite space [6]. In this study was discussed the morphology of 1.4559 steel after melting and forging operations.

2. METHOD OF RESEARCH

GX7NiCrMoCuNb 41-20 steel was used according to specified chemical composition in table 1, as raw material.

Table 2. Chemical composition of the 1.4559 steel [7]

%C	%Ni	%S	%P	%Cr	%Si
0.08	41	0.001	0.001	20	<1

Two samples of the 1.4559 steel by melting in EAF furnace and secondary metallurgy of VD, VOD and then pouring in specified mold and another sample, forging by GFM four hammer device of LX 20 model were performed under treatment. The microstructure of

samples was investigated by using Olympus MPG optical microscopy according to ASTM E45 standard.

3. RESULTS AND DISCUSSION

Surface structure and center of re-melting ingot of 1.4559 steel is shown in figure 1.

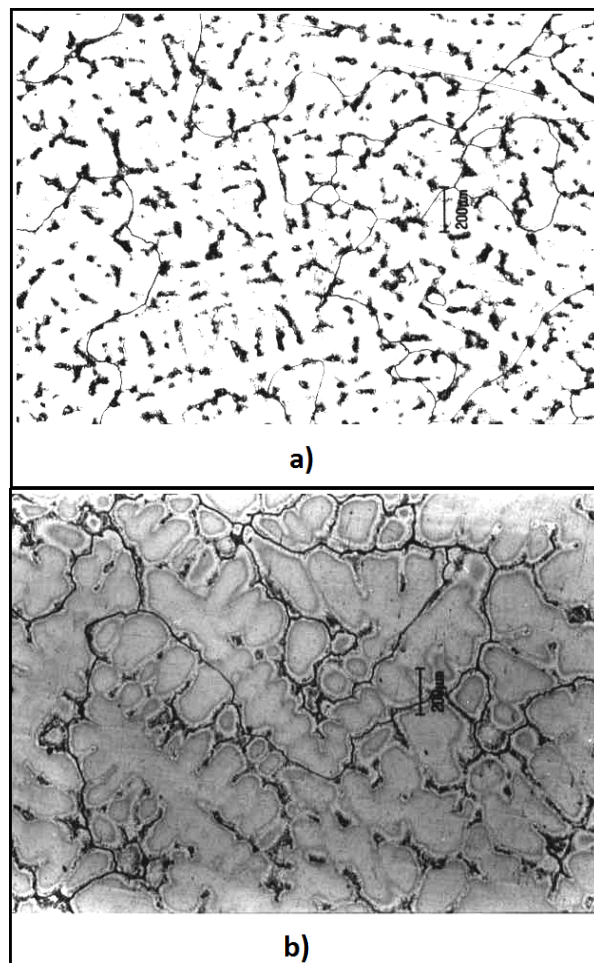


Figure 1. The structure of re-melted ingot in a) surface and b) center, with a magnification of 50X

In figure 2 with a magnification higher shows that carbo-nitrides have been deposited in the spaces between the dendrites.

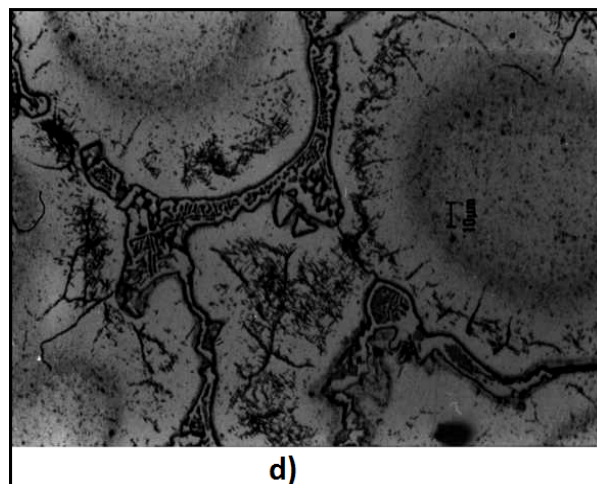
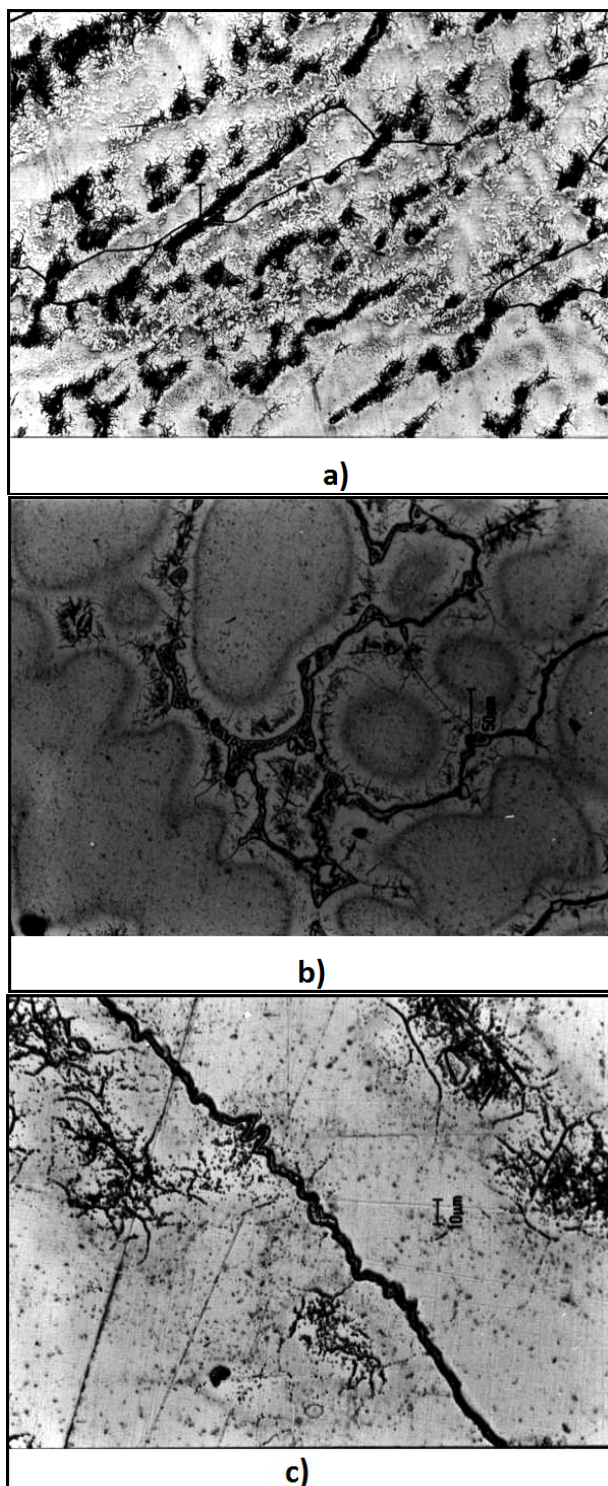


Figure 2. The microstructures of the figure (1) in magnification of 500X a, b) surface ingot c, d) center ingot

This phase is seen mainly in resistant alloys and rich in chromium element, however, other elements such as molybdenum are solved. In surface structure, in boundaries is observed continuous lattice from carbides [3,5,8]. Figures 2 (c) and 2 (d) shows the structure of the central ingot that is different. In the spaces between the dendritic is seen phase composed of two components (the source of carbide and austenite) that the result is eutectic transformation. This phase is called eutectic carbides and with the morphology of bone-form is detectable. These eutectic carbides are much coarser and are surrounded by fine deposits of carbo-nitrides.

4. REFERENCES

- [1] M., Hillert, "Eutectic and peritectic solidification", *Proceeding of solidification and casting of metals*, 18-21, 1977, p. 81-84.
- [2] G., Kraues, "Steels heat treatment and processing principles", ASM International materials park, OHIO, 1990.
- [3] S., Hertzman, "A study of equilibria in the Fe-Cr-Ni-Mo-C-N system at 1273 K", *Met. Trans.*, Vol. 18A, 1987, p. 1767-1778.
- [4] K.R., Mazyka, "Physical metallurgy and effects of process variable on the microstructure of wrought super alloys", *Proceeding of Optimazation of processing, properties and service performance through microstructural control*, 1987, p. 526-546.
- [5] D., Ridder and R., Koch, "Forging and processing of high temperature alloys", *Micron* 78, 1978, p. 547-563.
- [6] J., Suchy, "Kinetics of the formation of segregations in steel ingots", *Proceeding of solidification technology in foundry and cast house*, 15-17, 1980, p. 22-28.
- [7] C.W., Wegst, *Stahlschlüssel*, western, Germany 1989.
- [8] D.T., Llewellyn, "Boron in steels", *Ironmaking & steelmaking*, Vol. 20, 1993, p. 357-362.

RESEARCH ON RECRUITING SIMULATIONS AND CAREER CENTER SERVICES IN VIRTUAL ENVIRONMENTS

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Abstract: The paper is focused on technologies used for student online learning on recruiting process, within career advising services. The results of this research show positive effect of virtual environments in preparation for active job seeking, especially job interviews. Different games, simulations and other online services presented in the paper are developed to help potential and current job seekers to improve their employability. The mentioned tools improved overall quality of career counselling services, providing a realistic experience. The results of the paper show potential benefits of cooperation between career centres and companies that provide preparation modules for recruitment and selection, in the terms of candidate job prospects and employer branding. Disadvantages of the virtual environment conditions, in this sense, could be overcome by relevant additional services of career centers.

1. INTRODUCTION

Information technology (IT) provides unlimited availabilities of different kinds of services. Related to career centres, IT is widely used for online learning, e-counselling services, improved visibility of the projects and services etc [1]. Furthermore, IT has become an icon in a world of different educational systems [2], due to its ability to create three important scientific and practical, humane conditions: communication, interaction, and collaboration [3].

In the period of recession, ratio available jobs – candidates is getting worsened. That is why active job seeking becomes one of the core activities of career centres today.

On the other hand, companies need to attract talents and recognize them among number of job seekers. Virtual environments improve effectiveness of demand and supply matching process, in which way they help companies, career centres and job seekers to achieve their targets.

This paper analyses specific virtual solutions used for improvement of recruitment process, especially focused on job seeking preparation activities. Bearing in mind transformation of labour market and diminishing “job for life” concept [4], virtual environments become even more interesting for a much broader use in this sense.

2. BACKGROUND AND MOTIVATION

Finding talented individuals to recruit has always been one of the most difficult and challenging tasks [5]. Services can be very expensive and time consuming. The Internet and e-Business applications emerged as an attractive option to match job seekers with employment opportunities worldwide. Internet as a viable and reliable tool for recruiting provides the medium for conducting the recruitment and selection process in an online environment. Technology provides innovative learning methods and reduces the obstacles of traditional classrooms. It is possible that a lecturer and its students do not share a same classroom, or the same space at the same time, and still to participate in the same course. This approach to learning, for example, has become widely accepted and started its development when it became clear that lecturers were not the only medium in the knowledge transfer process [6].

IT enables utilizing human resource recruiting for: placement online advertisements and related promotion of corporate career opportunities (in the form of recruiting web sites are examples of such an approach), thousands of resumes research available, research on data about companies, processes and transactions.

There are various forms of the above-mentioned processes represented as the online activity. Many organizations use virtual

(globally dispersed or distributed) teams to accomplish an organizational task. All of the behaviours and communication of virtual team workers [7] enabled companies and applicants to reach one another faster and easier, which resulted in significant challenges for Human Resource departments [8]. An asynchronous (“anytime”) learning network, which uses the Internet to deliver courses, provides new challenges for teaching and learning, with an emphasis on collaborative student-student and student-teacher interaction [9]. On the other hand, IT provides synchronous communication, especially in the area of distance learning systems [10], mostly supported by different multimedia components.

Today's communication technologies enable recruitment and counselling activities, which are used to be in a face-to-face environment, to be held remotely through the use of Internet. The effective deployment of communication services compared to traditional face-to face interviews requires an integrated hardware and software environment. A good example of how multimedia communications are managed in the environment and how they can be used to assist the interviews is presented in the work of Kiddell et al. [11]. There is a variety of technologies used for counselling, either in synchronous and asynchronous communication. Each technology, including telephone, email, online chat, instant messaging, and video conferencing [13] has its own advantages [12] and can be used in the counselling process. With the development of virtual environments [14] it is even easier to transfer all the mentioned activities online. That is possible because in virtual environment people are “being there together” [15].

Qualitative role changes and work with virtual professors is explained in the work of Coppola et al. [9]. The authors captured role changes enacted by instructors in asynchronous learning network settings. Those roles are: cognitive, affective, and managerial. The cognitive role shifts to one of deeper cognitive complexity. The affective role requires faculty to find new tools to express emotion, yet they find the relationship with students more intimate. The managerial role requires greater attention to detail, more structure, and additional student monitoring.

A holistic e-recruiting system architecture supported by information system has been presented in the work of Lee [16]. Increased attention is focused on the development of virtual worlds and on the opportunities that they offer to companies and universities [17]. A first approach how virtual worlds can be integrated in a company's recruiting strategy is explained in the work of Laumer et al. [18]. Virtual environment can be used as an interesting and innovative platform for all the steps of a recruiting process (employer branding, candidate attraction, applicant tracking, pre- and final selection).

Taking all into consideration, our attention is focused on how to use modern technology to help students and university staff in career counselling, which is one of the most important issues in higher education [19]. Beyond the traditional graphical user interfaces, virtual and immersive environments, like Second Life [20], become emerged. With the introduction of virtual environments and the increasing number of online games, the new type of "e-recruiting" emerged in the form of online games to be applied for jobs [21]. This chapter provides an overview of solutions that help students as well as teachers in all the recruiting problems using modern communication technologies, applications and solutions. Based on these approaches we will address the following research questions in an organizational setting: How can an online application (in the form of online game or 3D environment) be used for supporting the recruiting process, in its broadest sense?

3. REVIEW OF EXISTING SOLUTIONS

Much attention is directed to carry out corporate activities on the Internet. When it comes to recruiting and counselling, the emergence of new functions and transfer of the old ones are shown by the examples provided in this chapter.

Much attention is directed to carry out corporate activities on the Internet. When it comes to recruiting and counselling, the emergence of new functions and transfer of the old ones are shown in the examples provided in this chapter.

Online interviews serve as a tool for allowing recruiters to gather a structured interview and to assess cultural fit, while at the same time stream the interview process can be found in [the work of Georgios et al. 5]. Online interviews cannot replace the traditional face-to-face interviews, but can provide in hiring managers with interviewing challenges. The most important thing is that online interviews provide companies with cost savings as well as with time savings which would be crucial factors, especially in recession periods for the economies. Some researches suggest that an online hiring process costs about one-twentieth as much as to hire the same person through ads or some other traditional means [22]. Online recruiting is crucial for people seeking for jobs today, especially for younger population of university graduates worldwide. Furthermore, the whole cycle of seeking, processing, and hiring candidates could be substantially spread up with the means of online recruiting. A research of 50 Fortune 500 companies revealed that an average company could cut about six days off its hiring cycle of 43 days by posting job ads online instead of doing it through other traditional printed media (like newspapers or magazines), another four days by collecting online instead of offline applications, and more than one whole week by processing job applications electronically [22]. Today, there would be really hard to find a serious and successful U.S. company that does not use online hiring and recruiting procedures as its commonly used option.

Integrated e-assessments is a virtual world as a part of the selection phase of recruitment process that can be completed online by jobseekers and can support connection between candidates' skills and given job requirements presented [23]. Also, in the context of personnel selection, e-assessment refers to self-assessments as a component of realistic job previews [19]. Thereby a realistic job preview is the provision of both favourable and unfavourable job-related information to job candidates [20] in order to provide them with more realistic perceptions of a job seeking process. In combination with self-assessment, the provided information aids the applicants in self-selecting in accordance with the desired job [21]. As self-assessment is also developed to help a participant to appraise himself and test his qualification for a specific job profile, e-assessment is just used to select a small group of adequate candidates out of a bunch of candidates.

In the paper of Ginanjar and Zebua [25] virtual game that shows working activities like in the real office have been presented. It enables the participants to experience to feel real-life work in the office. The goal is to help the players (participants, students) to understand that the situation in the real office is not easy as they could think (player has to answer the questions like in the real interview and to accomplish various difficult real-life office situations). Successfully finished level enables more jobs. At the end, all participants experienced possible situations in which they were going to be, they learnt how to organize the time efficiently to finish the job as well as how to speak with the managers in their further sessions.

One more example in the form of virtual job interview that helps students to face a new stage careers as soon as they graduate is explained in the work of Chang et al. [24]. The most important part regarding students' inexperienced job activities is related to college career counselling programs. The role reversal strategy can encourage and help students organize their thinking skills, and have the empathy ability to make a right response. In this paper, the role reversal strategy is conducted as a virtual job interview in Second Life environment. The reversal activity in Second Life, as a part of gaining interview experiences performed in this way, improves students' interview skills. In this game students played interviewers as well as interviewees and thus anticipated in creating possible questions and had ready answers. In the paper is also explained how it is possible to accomplish the transferability from the counselling in reality to the Internet.

Jobseekers with an attractive environment for finding jobs have been described in the work of Georgios et al. [5]. It is an online interview for screening candidate as an integrated electronic job marketplace. How to eliminate paperwork, to create a resume, to use Internet as a tool for recruitment and selection, to improve time to hire, to reduce turnover and similar difficulties were the main challenges addressed in the work of Georgios et al. [5]. Besides describing development and progress of a solution, at the end of the paper the authors concluded how online recruiting can become cost-effective and time-consuming activity in the organisation [26].

4. ADVANTAGES AND DISADVANTAGES

Advantages and disadvantages of online and virtual environments used for recruiting simulation and career counselling as practical activities could be summarized in the following manner.

Advantages:

- Creating virtual environments enables experiencing real-life situations to those who cannot instruct or learn in a real environment;
- Breaking time and space limitations, enabling students to be involved in mutual actions and solving tasks collaboratively – instant access to candidates worldwide;
- Learning-by-doing motivates the participants' presentations and collaboration;
- Cost-effective for organizations, educational institutions as well as for participants;
- Targeted approach to candidates – enables companies to search for specialties and experts in different fields;
- Virtual human resource structure enables companies to be active "24x7" in its virtual environment while searching for candidates, and quite similarly, enables candidates to seek for jobs in the same manner.

Disadvantages:

- Lack of peer contact and interaction some participants create wrong picture about real-life recruiting processes. Some of them find it scary, and frustrating;
- Students working alone face a great loss of concentration and the lack of interaction with peers, which is valuable for frequent dialogues based on actual subjects;
- Absence of flexible and available tutorial support provides lack of motivation and confidence in the used system;

Online "real-life" situations that are not covered with its creator, students, and a sufficient information system, could have a negative influence on the processing and adopting system of the candidates, even if the candidates are familiar with the given subject. For example, product ads as a source of information for an applicant, could be helpful in reaching and orienting candidates [26].

5. CONCLUSION

Virtual environments became very popular among recruiters and career counsellors. Such environments support cost effective strategies and results. Even more, virtual environments are especially interesting to students, already adapted to different ways of online learning [27].

One of the biggest challenges put in front of the job seekers is related to face-to-face contact with interviewers. Online recruiting simulations overcome this barrier in considerable extent, providing opportunities for practicing and pre-assessment tools. Different solutions presented in this paper show increasing popularity of virtual simulations in the process of preparation for job seeking. Interesting

feature of e-recruiting architecture is that it is highly usable for companies, universities and career centers [22].

Bearing in mind both advantages and disadvantages of the recruiting simulations in virtual environments, it can be concluded that all of the mentioned could be of a great help to career advisors in preparing number of students for effective job seeking. On the other side, analysed technologies and applications are helpful to the students preparing themselves for the real world of job market.

Providing platforms for virtual learning and simulations, help companies create their distinctive position in the minds of future job candidates, which is an important part of employer branding. Cisco is one of the companies that is very active in online recruiting, building strong relationships with universities through its "university programs" as a source of recruiting competitive young graduates [28]. Positioning themselves as responsible and reliable corporate partners, companies could improve their reputation and prospects of attracting talents in the recruitment process. This could be also a strong foundation for building motivation of corporations to invest in e-recruiting solutions, suitable for practice in a classroom environment.

8. REFERENCES

- [1] **Savković, M., Gavrilović J.** (2012), Elektronski servisi kao podrška radu univerzitetskog karijernog centra, International Scientific Conference Infotech 2012, available at: <http://www.infotech.rs.ba/zbornik/2012/radovi.html>
- [2] **Selwyn, N.** (2007), The use of computer technology in university teaching and learning: a critical perspective. *Journal of Computer Assisted Learning*, 23(2), 83–94
- [3] **Harasim, L., Hiltz, S. R., Teles, L., Turoff, M.** (1995), *Learning Networks, A Field Guide to Teaching and Learning Online*. Cambridge MA. The MIT Press
- [4] **Linda, A., Graham B.**, The Counselling Approach to Career Guidance, Routledge, London, 1996, page 128
- [5] **Georgios A. Dafoulas, G.A., Athanasios N. Nikolaou, and Mike Turega.** 2003. E-Services in the Internet Job Market. In Proceedings of the 36th Annual Hawaii International Conference on System Sciences (HICSS'03) - Track 3 - Volume 3 (HICSS '03), Vol. 3. IEEE Computer Society, Washington, DC, USA, 75.2-.[6] **Stanković, J., Gavrilović, J.,** (2013) "A Solution (One Solution) for the Distance Learning System Mode Adapted for Students of Economics, Sinergija International Symposium
- [7] **Daphne M. Dekker.** 2007. Effective Versus Ineffective Communication Behaviors in Virtual Teams. In Proceedings of the 40th Annual Hawaii International Conference on System Sciences (HICSS '07). IEEE Computer Society, Washington, DC, USA, 41-. DOI=10.1109/HICSS.2007.195
- [8] **Dafoulas, G.A., Pateli, A.G., and Turega, M.,** (2002), Business-to-Employee Cooperation Support through Online Job Interviews. In Proceedings of the 13th International Workshop on Database and Expert Systems Applications (DEXA '02). IEEE Computer Society, Washington, DC, USA, 286-292.
- [9] **Coppola, N.W, Hiltz S.R, and Rotter, N.G.** (2002), Becoming a Virtual Professor: Pedagogical Roles and Asynchronous Learning Networks. *J. Manage. Inf. Syst.* 18, 4 (March 2002), 169-189.
- [10] **Littlefield, J.,** (2013) Synchronous Distance Learning vs. Asynchronous Distance Learning, <http://distancelearn.about.com/od/choosingaschool/p/LearningTypes.htm>, visited on 17 May 2013
- [11] **Kiddell, M., Chen, M., Osborne, D. J., Slater, F. W., and McCulloch, M.** (1999) TRIUMF - A System for Remote Multimedia Interviewing. In Proceedings of the 1999 IEEE International Conference on Multimedia Computing and Systems - Volume 02 (ICMCS '99), Vol. 2. IEEE Computer Society, Washington, DC, USA, 715-. DOI=10.1109/MMCS.1999.778572
- [12] **R.K. Elleven and J. Allen,** "Applying technology to online counseling: Suggestions for the beginning e-therapist," *Journal of Instructional Psychology*, vol. 31, no. 3, pp. 223-226.
- [13] **Y.M. Lei,** "Issues on real-time individual counseling in cyberspace," *Student Guidance*, vol. 56, pp.100-109.
- [14] **Kelly, J.W, Beall, A.C., and Loomis, J.M.** (2004), Perception of Shared Visual Space: Establishing Common Ground in Real and Virtual Environments. *Presence: Teleoper. Virtual Environ.* 13, 4 (August 2004), 442-450. DOI=10.1162/1054746041944786
- [15] **Schroeder, R.** (2006) Being There and the Future of Connected Presence, *Presence: Journal of Teleoperators and Virtual Environments*, 15(4): 438-454.] Exchanging experiences in real time and learning together, in Schroeder, R. (2008) Defining Virtual Worlds and Virtual Environments: *Journal of Virtual Worlds Research*, Vol.1. No.1 ISSN: 1941-8477
- [16] **Lee.** 2007. An architecture for a next-generation holistic e-recruiting system. *Commun. ACM* 50, 7 (July 2007), 81-85. DOI=10.1145/1272516.1272518 <http://doi.acm.org/10.1145/1272516.1272518>
- [17] **Bray, D.A., Konsynski, B. R.** (2007) Draft Version: Final Version to appear in The DATA BASE for Advances in Information Systems, Special Issue on Virtual Worlds, Vol. 38, No. 4, available at http://www.researchgate.net/publication/220627407_Virtual_worlds_multidisciplinary_research_opportunities/file/d912f50929de40b80f.pdf
- [18] **Laumer, S., Eckhardt, A., and Weitzel, T.** (2008), "Recruiting IT Professionals in a Virtual World", In: Proceedings of the 12th Pacific Asia Conference on Information Systems (PACIS 2008); Suzhou, China
- [19] **Caligiuri, P.M., and Phillips, J.M.** (2003), "An application of self-assessment realistic job previews to expatriate assignments", *The International Journal of Human Resource Management*, Vol. 14, No. 7, pp. 1102-1116.
- [20] **Rynes, S.L.** (1991), Recruitment, "Job Choice, and Post-Hire Consequences", in: M.D. Dunnette, and L.M. Hough (eds), *Handbook of Industrial and Organizational Psychology*, Consulting Psychologists Press, Palo Alto, CA
- [21] **Phillips, J.M.** (1998), "Effects of Realistic Job Previews on Multiple Organizational Outcomes: A Meta-Analysis", *Academy of Management Journal*, Vol. 41, No. 6, pp. 673-690.
- [22] **Capelli, P.** (2001) Making The Most of On-Line Recruiting: Harvard Business Review, March 2001, <http://hbr.org/2001/03/making-the-most-of-on-line-recruiting/ar/1>, visited on 18 May 2013
- [23] **Bartram, D.** (2006), "Testing on the Internet: Issues, Challenges and Opportunities in the field of Occupational Assessments", in: D. Bartram, and R.K. Hambleton (eds), *Computer-Based Testing and the Internet: Issues and Advances*, John Wiley & Sons, Ltd., Chichester, England
- [24] **Chang, B., Lee, J., Chen, Y., Yu, F.** (2012), Applying Role Reversal Strategy to Conduct the Virtual Job Interview: A Practice in Second Life Immersive Environment. In Proceedings of the 2012 IEEE Fourth International Conference On Digital Game And Intelligent Toy Enhanced Learning (DIGTEL '12). IEEE Computer Society, Washington, DC, USA, 177-181. DOI=10.1109/DIGTEL.2012.51
- [25] **Ginanjar, R., Zebua, C.S.M.** (2011), Virtual Office Life Desktop Game Application. In Proceedings of the 2011 First International Conference on Informatics and Computational Intelligence (ICI '11). IEEE Computer Society, Washington, DC, USA, 83-87. DOI=10.1109/ICI.2011.24 <http://dx.doi.org/10.1109/ICI.2011.24>
- [26] **Webinars on Talent Management**, available at: <http://talentmgt.com/events/view/virtualizing-hr-leveraging-virtual-environments-for-recruiting-benefits-and-more>
- [27] **Colaric, S., Johanssen, D.H.,** (2001) Information equals knowledge, searching equals learning, and hyperlink is good instruction, myths about learning from the World Wide Web. *Computers in School*, 17 (3-4), 159-169
- [28] **CISCO** website, <http://www.cisco.com/web/about/ac40/univ/index.html#~acc~overview>, visited on 18 May 2013

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CORROSION BEHAVIOR OF NiFe_2O_4 -10NiO BASED CERMET INERT ANODE SURFACE FOR ALUMINUM ELECTROLYSIS

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Key words: dense layer; corrosion behavior; cermet inert anode; aluminum electrolysis

Abstract: The cup-shaped cermet inert anode for aluminum electrolysis, composed of 20Ni-Cu(90 NiFe_2O_4 -10NiO), was prepared and the operation performances were investigated in a lab-scale electrolysis cell with the electrolyte CR2.3 and Al_2O_3 concentration of 7.43% (mass fraction). The results indicate that the NiO phase on the surface of the cermet anode after electrolysis for 10 h to 40 h was gradually dismembered and engulfed by the NiFe_2O_4 phase, and the NiO- NiFe_2O_4 phase reacted with the Al_2O_3 dissolving in flux. Moreover, aluminates such as NiAl_2O_4 and FeAl_2O_4 were formed on the surface of the cermet, and preferential corrosion of the Fe element was found. Thus, a dense layer containing a NiFe_2O_4 - NiAl_2O_4 - FeAl_2O_4 spinel phase was formed, originating from the reaction of Al_2O_3 dissolved in the electrolyte with NiO or FeO and the annexation of NiFe_2O_4 toward NiO.

1 INTRODUCTION

NiFe_2O_4 -10NiO based cermets, which show good resistivity against corrosion in molten cryolite, are one of the most promising materials as inert anode for aluminum electrolysis.^[1-3]

The phenomenon of the dense layer NiFe_2O_4 - NiAl_2O_4 - FeAl_2O_4 on the surface of NiFe_2O_4 -10NiO based cermet inert anodes for aluminum electrolysis has been examined in recent years. Lorentsen^[4] and Olsen^[5] reported a dense layer about 50 μm thick after 50 h of electrolysis, and suggested its formation resulted mainly from the formation of aluminates such as NiAl_2O_4 and FeAl_2O_4 . However, the corrosion behavior of the dense layer in molten cryolite was not investigated.

In this study, the corrosion behavior of a dense layer of NiFe_2O_4 - NiAl_2O_4 - FeAl_2O_4 on the surface of a NiFe_2O_4 -10NiO based cermet inert anode for aluminum electrolysis was investigated. The operation performance of a cup-shaped cermet inert anode was evaluated in a lab-scale electrolysis cell.

2 EXPERIMENT

2.1 Preparation of the sample

The raw materials of NiO (99%, Jinchuan, China) and Fe_2O_3 (99%, Qidong, China) were all reagent grade. NiFe_2O_4 -10NiO based cermet samples were prepared using an isostatic pressing-sintering process.^[6-8] Appropriate amounts of Fe_2O_3 and NiO were ball milled in distilled water and stainless steel milling media for 2 h. The mixture was dried for 12 h at 90°C and then calcined at 1,200°C for 4 h in air. Metal Ni-Cu powder was added to the calcined powder and the mixture was once again ball milled. Finally, the mixture was uniaxially pressed into cylindrical blocks (about 20 mm in diameter and 40 mm thick) at 200 Mpa and sintered at 1,300°C for 4 h in a nitrogen atmosphere with an original oxygen partial pressure of 100

ppm to achieve the desired cermet samples.

2.2 Electrolysis operation

The electrolyte was employed from Na_3AlF_6 (99%, Shanghai, China), AlF_3 (98%, Shanghai, China), CaF_2 (98.5%, Tianjing, China) and Al_2O_3 (98%, Tianjing, China). The composition was 5% CaF_2 , 7.43% Al_2O_3 and balanced by cryolite (CR=2.3). All compositions were dried at 120°C for 48 h to remove the water before use. Sixty grams of metal aluminum were placed in the bottom of the cell as the cathode. The cell with the inert anode was heated to the required temperature (960°C) and kept for 2 h before the anode was immersed. The immersion depth of the anode was 20 mm. A 3 cm distance was placed between the anode and cathode, the electrolysis temperature is 960°C and the current density of 1.0 A/cm² was adjusted based on the bottom area of the anode. Al_2O_3 was added at 15 min intervals based on the electrolytic consumption rate of 80% cathode current efficiency.

2.3 Characterization

After electrolysis, the anode was sectioned, polished and analyzed with XRD and SEM/EDS. The phase composition of the electrolyte and cermet were identified by X-ray diffraction analysis using a Philips PW1390 X-ray diffractometer with Cu-K α radiation. The microstructure was analyzed with a JSM25600LV scanning electron microscope and JXP26A metallographic microscope.

3 RESULTS AND DISCUSSION

After electrolysis for 10 h, a white layer about 2 mm thick formed on the surface of the anode. The X-ray diffraction in Fig. 1 shows that the layer was electrolyte Na_3AlF_6 and $\text{Na}_5\text{Al}_3\text{F}_{14}$, adhering to the anode surface.

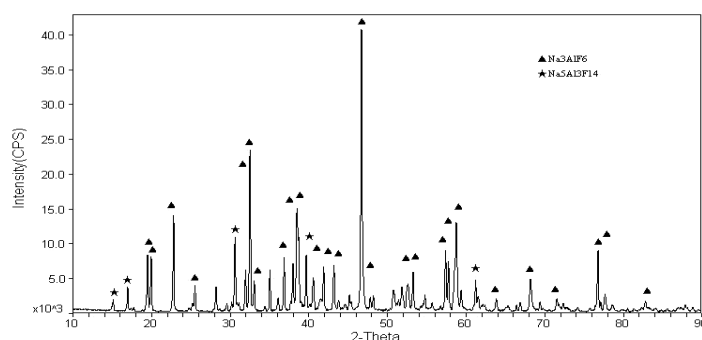
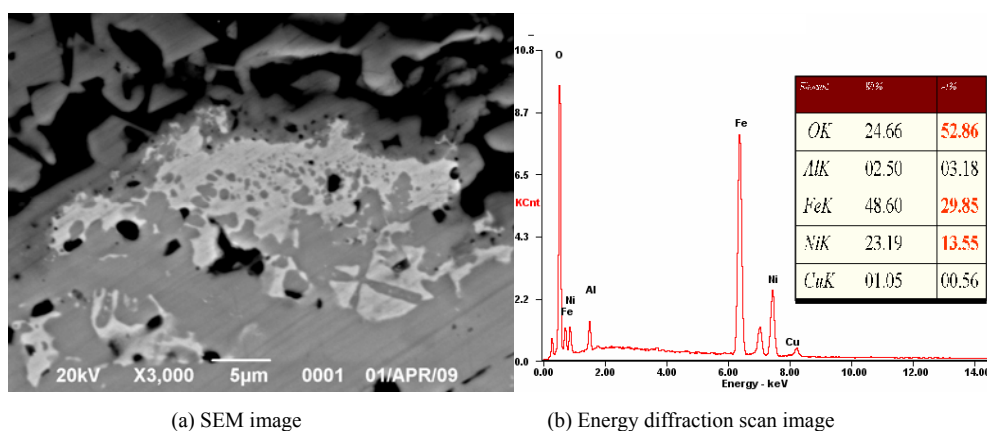


Fig. 1 XRD Patterns of the electrolyte on the (NiFe_2O_4 -10NiO)-17(Cu-20Ni) cermet surface after electrolysis for 10 h

Fig. 2 shows the metallographic image of the cross-section of the anode sample surface after 10 h of electrolysis. Some cross-morphological precipitates appeared inside the NiO grains. Fig. 3 shows the microstructure of the anode surface after electrolysis for 40 h. The NiO- NiFe_2O_4 phase interfaces are very legible. After electrolysis, the NiO phase was gradually dismembered and engulfed by the NiFe_2O_4 phase, and the NiO- NiFe_2O_4 phase interfaces became indistinct. In addition, the original cross precipitates developed to granular morphology, and some spherical pores also formed inside the NiO. The NiFe_2O_4 grains in contact with the electrolyte flux became fragmented. The energy diffraction scan revealed that this dense layer contained the Al element and not the Na and F elements found on the (NiFe_2O_4 -10NiO)-17(Cu-20Ni) cermet surface. These results suggest that the shrink and disappearance of NiO is related to the action of the NiFe_2O_4 phase and the Al_2O_3 dissolving in flux.



Fig. 2 Metallographic image of the (NiFe₂O₄-10NiO)-17(Cu-20Ni) cermet surface after electrolysis for 10 h



(a) SEM image

(b) Energy diffraction scan image

Fig. 3 SEM and energy diffraction scan image of the NiO phase for the (NiFe₂O₄-10NiO)-17(Cu-20Ni) cermet after electrolysis for 40 h

Table 1 Element contents in the dense layer in different areas of the (NiFe₂O₄-10NiO)-17(Cu-20Ni) cermet after electrolysis

Zone	Element content (%)				Fe/Ni atomic ratio
	O	Al	Fe	Ni	
Zone A in Fig. 4	54.20	0.97	30.38	14.45	2.10
Zone B in Fig. 4	53.53	0.62	31.24	14.61	2.14
Zone C in Fig. 4	52.73	0.34	32.09	14.84	2.16

Fig. 4 shows SEM images of the (NiFe₂O₄-10NiO)-17(Cu-20Ni) cermet surface after electrolysis for 24 h in the molten salt electrolyte. A dense metal-depleted layer existed on the surface of the cermet. Table 1 presents the EDX analysis results. Aside from the compositional elements in the as-sintered sample, the Al element appeared in the dense layer of the electrolyzed sample. The Al content was rather high in the surface area but became lower in the inner part. Moreover, compared with the Fe/Ni atomic ratio of the (NiFe₂O₄-10NiO)-17(Cu-20Ni) cermet (2.55), the Fe/Ni atomic ratio in the surface area was lower. This suggests that some aluminates formed on the surface of the cermet and that the preferential corrosion of the Fe element was found.

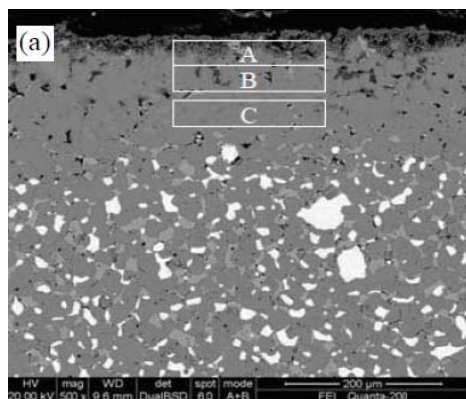


Fig. 4 SEM images of the (NiFe₂O₄-10NiO)-17(Cu-20Ni) cermet after electrolysis for 24 h

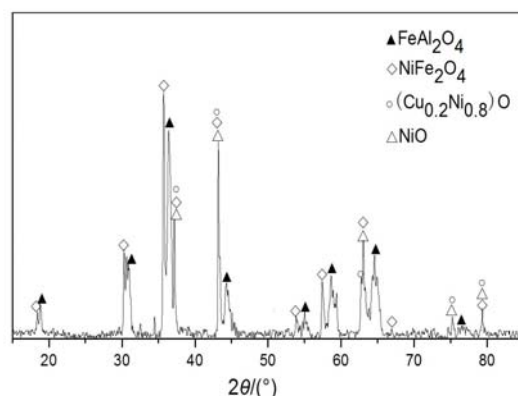


Fig. 5 X-ray diffractogram of the dense layer on the surface of the (NiFe₂O₄-10NiO)-17(Cu-20Ni) cermet after electrolysis for 40 h

Fig. 5 shows an X-ray diffractogram of the dense layer on the surface of the (NiFe₂O₄-10NiO)-17(Cu-20Ni) cermet after electrolysis for 40 h. The FeAl₂O₄ phase formed on the surface of the cermet inert anode.^[9] Furthermore, the structures of the NiAl₂O₄ and FeAl₂O₄ spinel phases were similar. Thus, the component of the dense layer produced on the surface of the anode was NiFe₂O₄-NiAl₂O₄-FeAl₂O₄. Fig. 6 shows the X-ray diffraction pattern of the dense layer and indicates a typical cubic spinel structure. Combining the EDX and X-ray diffraction results, we conclude that the dense layer contained the NiFe₂O₄-NiAl₂O₄-FeAl₂O₄ spinel phase.

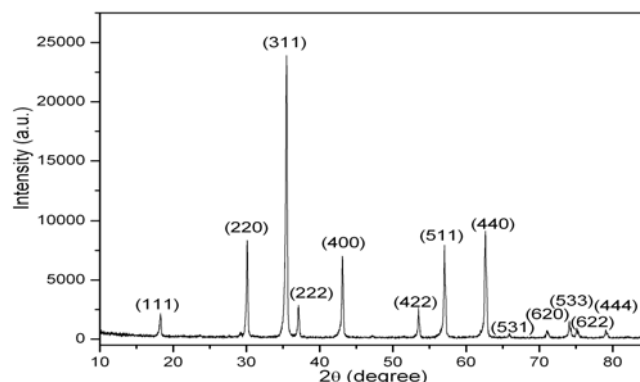


Fig. 6 X-ray diffractogram of the dense layer on the surface of the $(\text{NiFe}_2\text{O}_4\text{-}10\text{NiO})\text{-}17(\text{Cu-}20\text{Ni})$ cermet after electrolysis for 40 h

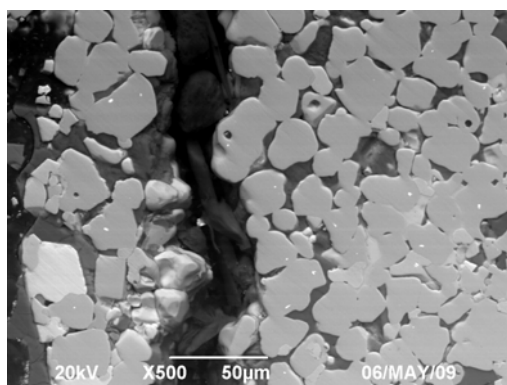


Fig. 7 SEM image of the $(\text{NiFe}_2\text{O}_4\text{-}10\text{NiO})\text{-}17(\text{Cu-}20\text{Ni})$ cermet after electrolysis for 240 h

Fig. 7 shows the SEM image of a cross-section of the anode sample sintered in nitrogen after 240 h of electrolysis. A fracture layer with a thickness of about 50 μm appeared on the surface of the anode. This phenomenon may be related to the internal stress of the dense layer in the high temperature and molten salt electrolyte. Therefore, the suitable thickness of the dense spinel ceramic layer should be investigated in further work according to the control of experimental conditions such as electrolysis temperature, Al_2O_3 concentration and current density.

4 CONCLUSION

During electrolysis, the NiO phase on the surface of a cermet anode after electrolysis for 10 h to 40 h was gradually dismembered and engulfed by the NiFe_2O_4 phase, and the $\text{NiO-NiFe}_2\text{O}_4$ phase reacted with the Al_2O_3 dissolving in flux. Some aluminates such as NiAl_2O_4 and FeAl_2O_4 formed on the surface of the cermet inert anode, and preferential corrosion of the Fe element was found. Thus, a dense layer containing the $\text{NiFe}_2\text{O}_4\text{-NiAl}_2\text{O}_4\text{-FeAl}_2\text{O}_4$ spinel phase was formed. However, after 240 h of electrolysis, a fracture layer about 50 μm thick appeared on the surface of the anode. Therefore, the suitable thickness of a dense spinel ceramic layer should be investigated in further work.

Acknowledgements

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REFERENCES

- [1] S.P. Ray. TMS Light Metals (1986) 287.
- [2] J.D. Weyand, D.H. DeYoung, S.P. Ray, G.P. Tarcy, F.W. Baker. Inert anodes for aluminium smelting. Contract DE-FC07-80CS40158. Final Report, DOE/CS/40158-20 (1986).
- [3] D.R. Sadoway. JOM. 53 (2001) 34.
- [4] O.A. Lorentsen, J. Thonstad. TMS Light Metals (2002) 443.
- [5] E. Olsen, J. Thonstad, J. Appl. Electrochem. 29 (1999) 301.
- [6] N. Xie, W.Z. Shao, L. Zhen, L.C. Feng, J. Am. Ceram. Soc. 88 (2005) 2589.
- [7] R.A. Rapp, Y. Zhang. TMS Light Metals (2002) 463.
- [8] R.P. Pawlek. TMS Light Metals (2004) 283.
- [9] B. Liu, L. Zhang, K. Zhou, Z. Li, H. Wang. Solid State Sciences 13 (2011) 1483-1487.

STUDY OF ANNEALING AND AGING HEAT TREATMENT ON THE MECHANICAL PROPERTIES OF GX7NiCrMoCuNb25-20 STEEL

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Key words: GX7NiCrMoCuNb41-20 steel, Morphology, Forging, Teeming.



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Abstract: Undoubtedly heat treatment is affected on the stainless steels morphology and mechanical properties. In this study was discussed the effect of annealing and aging heat treatment cycles on GX7NiCrMoCuNb25-20 (1.4500) steel microstructure and mechanical properties. The results showed that decreasing of annealing temperatures and keeping of cycle time in specific heat treatment can be led to complex carbides precipitate in the microstructure of the 1.4370 steel and severely influences on the mechanical properties of this steel.

1. INTRODUCTION

GX7NiCrMoCuNb25-20 steel from a group of austenitic stainless steels is accounted. This alloy retains its strength at high temperatures to about 800 °C. The resistance against conditions acute stress, heat and corrosion in this temperature, mainly used in military industries, especially in manufacturing rocket engines [1]. The solidification process of steels, depending on the type of steel and alloy element's percentage are different. In binary diagrams of iron, with elements of austenite regain increasing such as iron, carbon, nitrogen, nickel and manganese often occur in peritectic reaction. In addition to mentioned elements, elements of the production of ferrite such as chromium, silicon and molybdenum exist in steel composition, which have may influence on peritectic reaction [2]. Mechanisms types of solidification of stainless steels, considering initial phase occurs during peritectic reaction and later phases are generated until the completion of solidification [2, 3]. In this steel, delta ferrite from the remains ferrite becomes sigma phase during transformation and affects the ability of forging. Due to be slow of mentioned transformation, with rapid cooling of steel from solidification temperature to 500 °C can avoid the formation of this phase [4]. MC carbides in alloys containing carbide forming elements such as titanium, niobium and hafnium are being formed during solidification. MC carbides are accumulated as particles in the spaces between the dendrites. In case steel be containing nitrogen, these carbides are solved after being surrounded by matrix phase during homogeneous heat treatment at high temperatures [3,4,5]. These carbides are formed together austenite and other carbides. M23C6 carbides are created from Cr metal. This phase occurs with the morphology of the various at a temperature of 950 °C during cooling and in case there is enough time deposited with various morphologies and in different regions [4,5]. M6C, M23C6, MC carbides precipitates at grain boundaries and the grain boundary strength increases and in case deposits infield, the field strength increases. Also with dissolution of other alloying elements can prevent from the creation of other phases. In austenitic stainless steels, by starting solidification and forming austenite, ferrite elements return into melt than austenite elements. Ferrite elements concentration in the melt is causing favorable conditions for the formation of ferrite and peritectic reaction become eutectic and peritectic. At the eutectic reaction deposits ferrite and austenite simultaneous from molten and are causing eutectic structures in dendrite space [6]. The presence of elements that diffusion rate has significant in austenite, the homogeneous time to reduce. For example, aluminum and titanium penetrates considerably faster than molybdenum in austenite so the segregation of elements has less risk than molybdenum segregation [7,8]. Austenitic stainless steels are particularly susceptible to the formation of harmful and destructive phases according Schaeffler diagram as Sigma, Chi and ... that are in various stages of production, in solidification stage and hot forming (forging and rolling) are formed. Solution annealing heat treatment of stainless steels in addition to supersaturated field is causing dissolution of these phases and will prevent the loss of mechanical

properties. On GX7NiCrMoCuNb25-20 steel is performed the solution annealing at a temperature of 1200-1250 °C. When the steel is composed of two different phases in the equilibrium state on the phase diagram, Whereas in the range is cooled quickly so that there is a saturation phase of elements, these phases are susceptible to deposition. In austenitic stainless steels due to be single-phase and In lack of two-phase transformation at room temperature, aging treatment is rarely performed. In GX7NiCrMoCuNb25-20 steel has been reported aging treatment, in the temperature range of optimal 750-740 °C. In this study, solution annealing and aging was done on the 1.4500 steel and the effects of these cycles on the mechanical properties and microstructure were investigated.

2. METHOD OF RESEARCH

GX7NiCrMoCuNb25-20 steel was used according to specified chemical composition in table 1, as raw material.

Table 1. Chemical composition of the 1.4500 steel [9]

%C	%Ni	%S	%P	%Cr	%Si
0.08	25	0.03	0.045	20	1.25

1.4500 steel samples were performed under identified heat treatment cycle annealing and aging. Tensile testing was done in accordance with DIN EN 10002 standard and by Zwick device. Impact test was done in accordance with DIN EN 10045 standard and by Zwick 52. Microstructures of samples was performed using ASTM E3 standard and Olympus MPG device.

3. RESULTS AND DISCUSSION

Figures 1 and 2 show cycles of annealing solution and aging on the samples of 1.4500 steel.

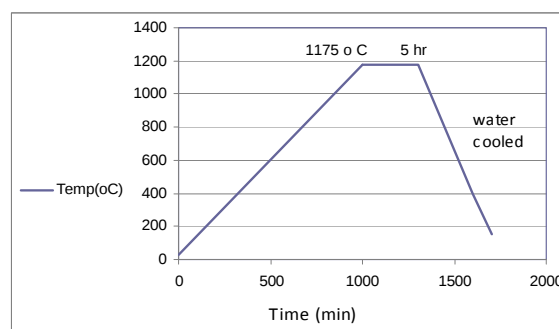


Figure 1. Solution annealing cycle for 1.4500 steel

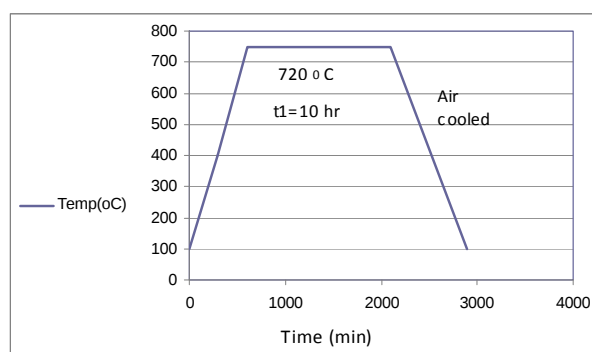


Figure 2. Aging cycle 1.4500 steel

Table 2 show test results of the mechanical properties of the 1.4500 steel.

Table 2. Tensile test on the 1.4500 steel after solution annealing and aging

Microstructure	Tensile				(HB) Hardness
	% Z	%A	UTS (N/mm ²)	Y.S (N/mm ²)	
Austen.+ Carbide	4	6	692	526	248

Is considerable despite the hardness of steel is suitable, But before reaching the ultimate strength, this steel is brittle and break and elongation percentage is very low, Therefore shows that in aging treatment have been formed the phase boundary again. Figure 3 shows microscopic images of the 1.4500 steel after aging.

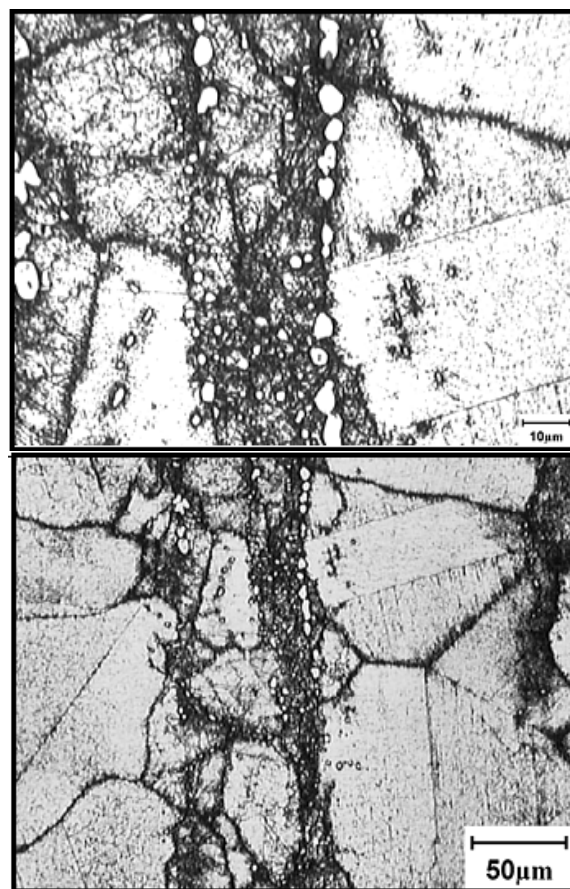
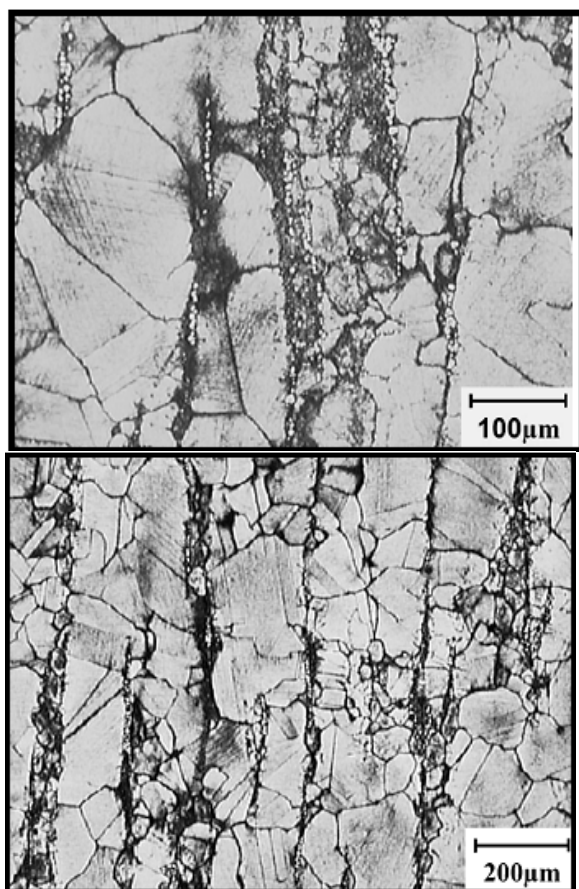


Figure 3. The morphology of 1.4500 steel after heat treatment cycles with different magnifications

Figure 3 is characterized by the decreasing the mechanical properties this steel formation of white precipitates is on grain boundary. Can be concluded that the white deposits are complex carbides. These deposits unsolved in the annealing cycle at low temperature or low storage time and for mechanical properties of the alloy are very destructive.

4. REFERENCES

- [1] M., Hillert, "Eutectic and peritectic solidification", *Proceeding of solidification and casting of metals*, 18-21,1977, p. 81-84.
- [2] G., Kraues, "Steels heat treatment and processing principles", *ASM International materials park, OHIO*, 1990.
- [3] S., Hertzman, "A study of equilibria in the Fe-Cr-Ni-Mo-C-N system at 1273 K", *Met. Trans., Vol. 18A*, 1987, p. 1767-1778.
- [4] K.R., Mazyka, "Physical metallurgy and effects of process variable on the microstructure of wrought super alloys", *Proceeding of Optimazation of processing, properties and service performance through microstructural control*, 1987, p. 526-546.
- [5] D., Ridder and R., Koch, "Forging and processing of high temperature alloys", *Micron 78*, 1978, p. 547-563.
- [6] J., Suchy, "Kinetics of the formation of segregations in steel ingots", *Proceeding of solidification technology in foundry and cast house*, 15-17, 1980, p. 22-28.
- [7] D.T., Llewellyn, "Boron in steels", *Ironmaking & steelmaking*, Vol. 20, 1993, p. 357-362.
- [8] S.D., Ridder and et.al., "Study state segregation and heat flow in EAR", *Met. Trans., Vol. 9B*, 1978, p. 415-425.
- [9] C.W., Wegst, *Stahlschlüssel*, western, Germany 1989.

HIGH TEMPERATURE MECHANICAL PROPERTIES OF 27CrMoTi STRUCTURAL STEEL

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Xiuqin TAN**Key words:** 27CrMoTi; structural steel; mechanical properties; high temperature.**Abstract:** The mechanical properties have an important role in structural steel design due to the rapid reduction on mechanical properties under high temperature conditions, such as yield strength and elastic modulus. Therefore, as a newly designed structural steel-27CrMoTi, there is a need to understand its mechanical property to establish a proper reheating schedule. In this article, tensile samples were tested by Gleeble 1500D for temperature in the range of 600 - 1100 °C. The test results show that there is a phase transformation during 600-800 °C at where yield strength, tensile strength and plasticity have a drastic change.Prof. Ph. D.
Liangying WEN

1. INTRODUCTION

27CrMoTi is a newly designed structural steel that is widely used for making petroleum pipes in recent years. There are several alloy elements such as Cr, Mo, Ti are added into steel that can improve corrosion resistance and enhance strength and can change microstructure, even physical and mechanical property^[1]. Because those changes have a closer relationship with expansion of steel under high temperature, the internal stress variation rules of steel are different with original pure steel. However, at present, we know little information about the changes that have influenced the establishment of reheating furnace temperature schedule. Hence, it is necessary to recognize the physical and mechanical properties of 27CrMoTi, so that we can supply a suitable reheating schedule for actual production.

There are double main factors that forming internal stress which causes defects occurred in reheating furnace^[2]: thermal stress arises directly from the different heating rates experienced by the surface and the interior of steel; transformation stress due to the volume changes which occur when austenite transforms to other phases. In terms of reheating furnace, the first one is controllable factor while the second one is not. Therefore, heating rate is a key parameter that has crucial influence on internal stress. Besides, heating rate also has matter with mechanical properties of material^[3]. That is to say, the mechanical properties of material decide the internal stress directly.

Thus far, some thermo-mechanical experiments over high temperature indicate that: When the temperature increases while the strain-rate kept constant, the overall level of the flow curve reduces correspondingly due to the growing work hardening^[4-5]; the stress level decreases with increasing deformation temperature and decreasing strain-rate^[6-14]. However, there are hardly any investigations about 27CrMoTi in number, which brings about some difficulties to design proper reheating schedule and thus leads to material internal stress during reheating process. In this article, some work has been done for obtaining accuracy mechanical parameters.

2. EXPERIMENTAL

The steel used for this investigation is nominal compositions of 27CrMoTi (0.9~1.00Cr, 0.25~0.35Mo, 0.05~0.15Ti, wt.%) which is a kind of low alloy and high strength ferrite steel contained Mo and Ni that improve ability of harden and tempering stability, and also contained Ti and Al, which reduce the plasticity and toughness of steel. The material is treated into a rod of size $\phi 10\text{mm} \times 120\text{mm}$ and both ends are threads. The mechanical property is tested by Gleeble 1500D that is often used to test mechanical properties of material by stretching or compression test^[15-19]. Since simulating a heating environment in reheating furnace, the temperature schedule in this investigation is showed like Fig. 1.

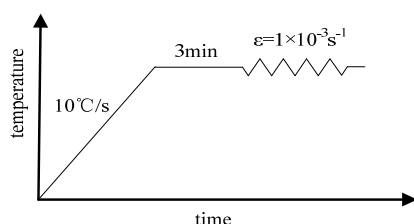


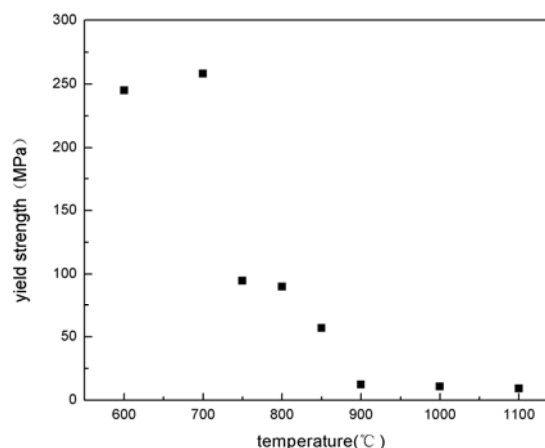
Fig. 1 Heating and deforming process for the tensile test

The experiment temperature arranges from 600°C to 1100°C (600°C/700°C/800°C/850°C/900°C/950°C/1000°C/1100°C) which covers the overall reheating furnace temperature region that makes the simulation is more accuracy. The rod heated to experiment temperature by the speed of 10°C/s. After keeping three minutes to unify the temperature distribution, the rod will be stretched to fracture in strain rate $\dot{\epsilon}$ is 10^{-3}s^{-1} . The computer system records strain, stress and stroke varying with time and temperature during the tensile experiment. When the fractured rod cooled to room temperature, measure its diameter and length to calculate the reduction of area and axial extension rate, which can stand for the plasticity of this material.

3. RESULTS AND DISCUSSION

3.1 Yield Strength

Metal material bends when loaded. If the deformation can recover by itself quickly after taking off load, we call this behavior elastic deformation. If the load is too big to recover so that the metal deformation preserves permanently, we call this behavior plastic deformation. Most kinds of metal experience elasticity, elasticity-plasticity (exist elastic and plastic deformation), plasticity stages chronologically as the load increased, respectively. When the load is heavy enough to step into a complete plastic stage, corresponding stress is called yield strength. Obviously, yield strength represents internal property of material. Fig. 2 shows the yield strength of 27CrMoTi structural steel.

Fig. 2 Yield strength as function of temperature at strain rate of 10^{-3}s^{-1}

As shown in Fig. 2, the yield strength decreases with the increasing temperature since higher temperatures provide longer time for energy accumulation and higher mobility at boundaries for the nucleation and growth of dynamic recrystallization grains and dislocation annihilation and thus reduce the yield strength level. Analogous rules have been reported^[20]. Especially, between 700°C~750°C, the yield strength of this material decreases drastically with the increase of temperature. It proves that a microstructure has some changes at this temperature range, which was caused by crystal phase transactions. When temperature reaches 900°C, yield strength will not vary with temperature.

3.2 Tensile Strength

Tensile strength (σ_b) is a capacity of resisting tension to avoid being broken, which was caused by the load before necking deformation. As shown in Fig. 3, the tensile strength decreases with the increase of temperature like the rule of yield strength vs. temperature. Similarly, when temperature is higher than 800°C, σ_b keeps stable that tensile stress does not vary with the temperature.

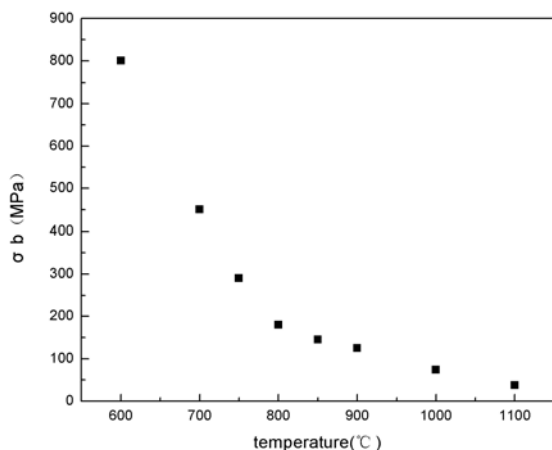


Fig. 3 Tensile strength as function of temperature at strain rate of 10^{-3} s^{-1}

3.3 Thermo-Plasticity

Thermo-plasticity is a capacity of deformation at high temperature before crack, that is to say, it is the maximal amount of deformation under the circumstance of keeping non-necking. Generally, thermo-plasticity is investigated by percentage reduction of area and axial prolonged rate, which can represent the plasticity of material. The bigger they are, the better the thermo-plasticity is. The thermo-plasticity of 27CrMoTi is showed as Fig. 4.

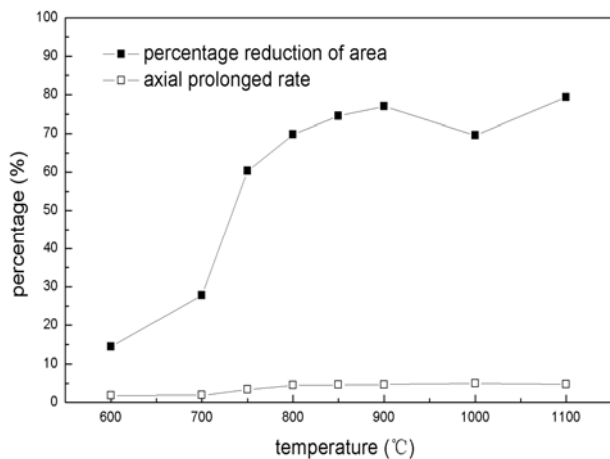


Fig. 4 Thermo-plasticity of 27CrMoTi at high temperature

As shown in Fig. 4, 27CrMoTi has a low temperature brittle zone from 600°C~750°C. When temperature is higher than 750°C, the material has fine plasticity that percentage reduction of area is more than 60%. 27CrMoTi contains much Mo element that can form hard carbides. The most common carbide is Mo_2C that is not stable in steel; in general, it dissolves at 500°C~600°C. This leads to less hard carbides in 27CrMoTi that make it is less possible to forming inhomogeneous carbides distribution. Therefore, the third brittle temperature range is narrow. Element Mo can shrink γ -phase through enhancing A_3 point. Coincidentally, Cr is also the element to decrease austenite phase region. However, when Cr content is lower than 7%, A_3 point descends with the increase of Cr content. Hence, the A_3 point of 27CrMoTi is higher than any other steels that lead austenite produces at higher temperature.

In order to observe plasticity of material well, SEM has been taken for investigating the fracture surface of sample. The sample tested at 1000°C has been chosen as representative from those whose test temperature above 750°C that have the approximate plasticity. As showed in Fig. 5, the fracture mode is dimple at 1000°C that first causes by plasticity deformation lead to the cracks formed on the

interface of second-phase and spread widely, and then there is internal necking among every second-phase that results in fracture at last. Meanwhile, Fig. 5 proofs that this material does have excellent plasticity at 1000°C.

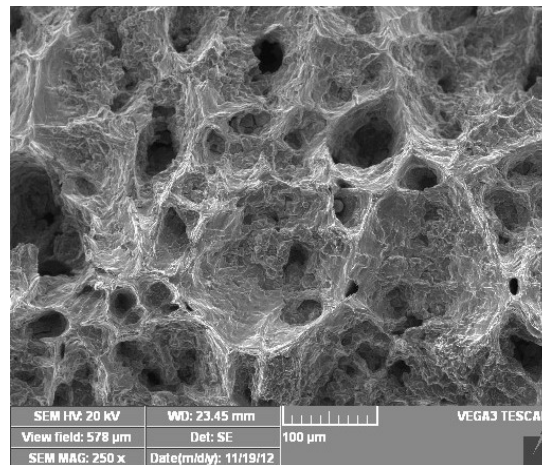


Fig.5 Fracture surface of sample tested at 1000°C

4. CONCLUSIONS

In this study, 27CrMoTi samples were stretched to fracture at eight temperature points by Gleeble 1500D and mechanical properties of 27CrMoTi were investigated. The main results obtained in this study are showed as following:

- (1) The yield strength of 27CrMoTi sample decreases with the increasing temperature at strain rate 0.001/s. 600°C-750°C, yield strength has a rapid drop.
- (2) The tensile strength has a similar variation to yield strength. We can predict that there is a phase transformation occurred around 600°C-800°C.
- (3) The percentage reduction of area reaches 60% when temperature above 750°C that means the material has a good plasticity.

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REFERENCES

- [1] Abdunnaser Fadel, Dragomir Glisic, Nenad Radovic and Djordje Drobniak. Influence of Cr, Mn and Mo Addition on Structure and Properties of V Microalloyed Medium Carbon Steels. J. Mater. Sci. Technol, Vol. 28 (2012), p1053.
- [2] R. W. K. Honeycombe. Steels Microstructure and Properties. Metallurgy and Materials Science Series: 1982.
- [3] CHEN Hongfu. Metallurgical Furnace Technology and Structure. Metallurgy Industry Press: 1986.
- [4] Y.C. Lin and Xiao-Min Chen. A critical review of experimental results and constitutive descriptions for metals and alloys in hot working. Materials and Design, Vol. 32(2011), p.1733.
- [5] M. Aghaie-Khafri and A. Zargaran. High temperature tensile behavior of a PH stainless steel. Materials Science and Engineering A, Vol. 527(2010), p4727.
- [6] Lin YC, Chen MS and Zhong J. Effects of deformation temperatures on stress/strain distribution and microstructure evolution of deformed 42CrMo steel. Mater Des, Vol. 30(2009), p. 908.
- [7] Lin YC, Chen MS and Zhang J. Prediction of 42CrMo steel flow stress at high temperature and strain rate. Mech Res Commun, Vol. 35(2008), p.142.
- [8] Nirosha Dolamune Kankanamge and Mahen Mahendran. Mechanical properties of cold-formed steels at elevated temperatures. Thin-Walled Structures, Vol. 49(2011), p.26.
- [9] Liu Xianbin, Zhang Zhigang, Tang Linzhi and Gong Shengkai. Influence of Temperature and Tensile Rate on Performance of NiAl-30Cr-4Mo Eutectic Alloy. Aerospace Material and technology, Vol. 6(2007), p.105.
- [10] Luo Haiwen and Zhao Pei. Calculation Model and Experimental Verification on True Strain and True Stress in Hot Tensile Test. JOURNAL OF IRON AND STEEL RESEARCH, Vol. 10(1999), p61.

- [11] Yung-Tang Chiu, Chih-Kuang Lin and Jiunn-Chi Wu. High-temperature tensile and creep properties of a ferritic stainless steel for interconnect in solid oxide fuel cell. Journal of Power Sources, Vol.196(2011), p.2005.
- [12] C.Garcia-Mateo, F.G.Caballero, T.Sourmail, M.Kuntz, J. Cornide, V. Smanio and R. Elvira. Tensile behaviour of a nanocrystalline bainitic steel containing 3 wt% silico. Materials Science and Engineering A, Vol. 549 (2012), p.185.
- [13] Jiao Deng, Y.C. Lin, Shui-Sheng Li, Jian Chen and Yi Ding. Hot tensile deformation and fracture behaviors of AZ31 magnesium alloy. Materials and Design, Vol. 49(2013), p.209.
- [14] L. Liu, J.B. Zhu, L. Li, J.C. Li and Q. Jiang. Microstructure and tensile properties of FeMnNiCuCoSnx high entropy alloys. Materials and Design, Vol. 44(2013), p.223.
- [15] SHI Ru-xing and LIU Zheng-dong. Hot Deformation Behavior of P92 Steel Used for Ultra-Super-Critical Power Plants [J]. JOURNAL OF IRON AND STEEL RESEARCH, INTERNATIONAL, Vol. 18(2011), p.53.
- [16] C.J.Bennett, S.B.Leen and E.J.Williams. A critical analysis of plastic flow behaviour in axisymmetric isothermal and Gleeble compression testing [J]. Computational Materials Science, Vol. 50(2010), p.125.

- [17] LI Long, DING Hua, DU Lin-xi, WEN Jing-lin, SONG Hong-mei and ZHANG Pi-jun. Influence of Mn Content and Hot Deformation on Transformation Behavior of C-Mn Steel. JOURNAL OF IRON AND STEEL RESEARCH, INTERNATIONAL, Vol. 15(2008), p.51.
- [18] Guoling Ji, Fuguo Li, Qinghua Li Huiqu Li and Zhi Li. Research on the dynamic recrystallization kinetics of Aermet 100 steel. Materials Science and Engineering A 2010; 527: 2350-6.
- [19] Rong-xia Chai, Cheng Guo and Li Yu. Two flowing stress models for hot deformation of XC45 steel at high temperature. Materials Science and Engineering A, Vol. 534(2012), p.101.
- [20] Ming Jiang, Xuefeng Yang, Shiyao Pa, Bruce W. Krakauer and Mingfang Zhu. Correlation between Microstructures and Yield Strength of a High Strength Enameling Steel. J. Mater. Sci. Technol, Vol. 28(2012), p.737.

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CONTRACTOR CHOICE OPTIMIZATION IN COMPLEX PROJECTS

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Abstract: One of the most important problems that arise in the realization of any project and especially complex projects is contractor choice optimization of all its activities. The term choice optimization presumes the selection of such contractors that will perform their activities, and thus the whole project, on schedule and at minimum cost. This paper analyzes these problems in detail and shows how they can be presented using models of combinatorial parametric optimization. Since the majority of algorithms for resolving these models is inconvenient for practical application, this paper recommends a modified PERT-COST algorithm for cost minimization of project realization based on its lead time.

1. INTRODUCTION

The majority of projects and particularly complex investment and other projects, consist of a large number of various business activities for which various contractors need to be hired. In order to successfully realize the project as a whole each of these activities needs to be completed within strict deadlines and at the lowest possible cost.

It is well known that the lead time of a project and its costs are two basic and crucial parameters or indicators of the successful realization of any project. They both depend on the lead time and the costs of each activity the project consists of [1], [2]. It is also known that the lead time of each activity, as well as its realization costs depend, for the most part, on the contractor, i.e. on the availability, equipment and efficiency of their capacity, then on the previous work experience in the realization of such or similar activities, and on a sequence of other factors specific for the realization of a particular activity [3].

This practically means that the optimization of project contractor choice is one of the most important problems that requires special attention in the realization of any project. By successfully solving this problem, i.e. optimizing the project contractor choice, optimal values of two most important parameters or indicators of the entire realization of a project are determined as well: optimal lead time of the project and corresponding minimum costs of its realization.

Since this is a particularly important and delicate problem, it is necessary to take a good look at all the relevant factors that underlie its solution. Thus, for example, when making a decision about the choice of contractor(s) who will work on the realization of a particular activity, it is necessary, beside the lead time and corresponding costs, to bear in mind the importance of that activity from the point of view of duration and completion of the entire project. It is obvious that, in this respect, the activities that have immediate impact on the deadline for the completion of the project and the activities whose deadlines can be altered within certain limits without making an impact on the deadline for the completion of the entire project cannot have the same importance. Hence, it is obvious that the problem of the optimization of the choice of the project contractor who will, following the lead time/cost criteria, provide the realization of the given project under the most favorable conditions a

very important and complex problem the solution of which is not in the least simple.

This paper considers the problem of the contractor choice optimization in complex projects, providing that there are multiple prospective contractors for each activity and that their respective lead time is known, as well as the corresponding costs related to the lead time, the goal being to determine for each possible project lead time minimum costs necessary for its completion. Thus, the decision-maker is given the possibility to choose the most convenient solution out of the sequence of solutions determined by the project lead time and the corresponding minimum costs of its realization.

Stated thus, the problem can be solved with a mathematical model which belongs to the class of combinatorial parametric optimization. However, since the algorithms for solving such models are very complex and unsuitable for practical application due to a large number of arithmetical operations, we will present a different and, from the arithmetical perspective a far simpler algorithm that makes it possible to solve the majority of practical problems.

2. PROBLEM DESCRIPTION AND SETTING THE MATHEMATICAL MODEL

We will look at the following problem that very often arises in practice:

For a given project which consists of several various activities tenders have been invited for contractors for each of the activities. All the conditions necessary for the realization of each individual activity have been defined in detail, as well as the conditions to be fulfilled by all the prospective contractors. In the tender, beside other required data and information, each prospective contractor should state detailed data on the lead time duration and corresponding costs needed for the completion of the given activity.

It is certain that for each activity there will be a different number of prospective contractors. All the uncompetitive bids that require longer lead times and larger costs for the realization of the given activity can immediately be eliminated. This way, for each activity the remaining prospective contractors can be shortlisted, the first being the one offering the shortest lead time and the highest costs, and then, following the criterion: shortest lead time / highest cost, the remaining prospective contractors. Thus, for each activity there is a shortlist where the first bidder requires the shortest lead

time and the highest costs, while the last requires the longest lead time and the lowest costs. All the other bidders are shortlisted between them following the above-mentioned criterion.

Such a shortlist represents a discrete function of activity costs that depend on its lead time. Unlike the well known function from the field of network planning and management, where it is assumed that the function, within the interval: the shortest or constrained and the longest or normal activity lead time, continuous and strictly falling and mostly linear, this function here is discrete and set with several pairs of data on lead times and corresponding realization costs for the given activity. If we set lead times data on the abscissa, and corresponding costs data on the ordinate, then this discrete function can be shown with as many points on the plane as there are prospective contractors, whereby there is no information on lead times or corresponding activity realization costs in between these points.

Since there are multiple different activity lead times, there will be multiple different lead times for the project consisting of these activities. For each possible project lead time there is a corresponding cost necessary for its realization. Our goal is to determine for each possible project lead time the corresponding minimum cost for its realization.[4]

After giving the description of the problem with explanations, the problem of contractor choice optimization in complex projects can, in brief, be formulated as follows:

For each possible lead time determine minimum cost required for its realization as well as the contractors for each activity, who will complete the project in given deadlines at corresponding minimum costs, providing that lead times and corresponding costs for each activity are known for each prospective contractor.

Stated thus, the problem of the contractor choice for project activities resembles a lot the well-known problem of minimizing project costs depending on its lead time from the field of network planning and management. However, the crucial difference between these two problems is reflected in the fact that in network planning problems the function of activity costs represents the continuous function of activity lead time, while here this function represents a discrete function that has already been widely discussed.

The above-mentioned differences between these problems condition to a great extent different approaches to their solutions. However, before solving the given problem, it is necessary to formulate the appropriate mathematical model.

We will formulate this mathematical problem under the assumption that, apart from the lead time and the corresponding costs for each activity, we know their interdependence regarding the sequence of activities and that following this the corresponding network diagram (network model) has already been constructed: $G=(N,L)$ for the realization of the given project, where

$$N=\{1,2,\dots,i,j,\dots,n\},$$

denotes the set of all the events of the project, i.e. set of numbers that denote all events of the already constructed network diagram, where 1 denotes the initial, and n the final event of the project.

$$L=\{(i,j) \mid i,j = 1,2,\dots,n\},$$

denotes a set of ordered pairs of the set of events N , i.e. the set of all the project activities, where i denotes the initial, and j the final event of the project, and where the condition $i < j$ must be fulfilled. Now lead times of k contractor, and of each activity (i,j) , can be denoted by

$$t_{ij}^k, (i,j) \in L \quad k=1,2,\dots,K_{ij}$$

and the corresponding costs for the activity realization (i,j) by

$$C(t_{ij}^k), (i,j) \in L \quad k=1,2,\dots,K_{ij}$$

where K_{ij} represents the number of prospective contractors.

This notation being set, we can now set a mathematical model for the solution of the given problem of the contractor choice optimization for project activities, as follows:

Minimize the function of the goal:

$$Z = \sum_{(i,j) \in L} C(t_{ij}^k) \quad (1)$$

under the limitations:

$$t_{ij} \in \{t_{ij}^k \mid k=1,2,\dots,K_{ij}\}, (i,j) \in L,$$

which means that lead times for each activity (i,j) can only have discrete variable t_{ij}^k , which in fact represent activity lead times set by the prospective contractors for these activities.

$$t_{ij} \leq t_j^1 - t_i^0, (i,j) \in L, \quad (2)$$

where t_i^0 denotes the earliest possible starting time of the realization of the activity (i,j) , and t_j^1 the deadline for the activity. These time parameters are set within the time analysis of the network model, and the limitation requires that the lead times for each project activity cannot be longer than its maximum time allowed.

$$t_i^0=0,$$

is the time of the earliest possible realization of the first event within the network model, and thus the beginning of the project realization, is set by the zero time.

$$t_n^1=T \in [T_1, T_2],$$

is the time of the latest realization allowed of the n (final) event of the network diagram, i.e. the time of the completion of the entire project, equal to parameter T which is within the limits of the interval $[T_1, T_2]$, known in advance, where T_1 denotes the shortest possible project lead time equal to the length of critical path of the network diagram where lead times of all activities are

$$t_{ij}=t_{ij}^1,$$

and T_2 denotes the longest project lead time, equal to the length of the critical path where the lead time of all activities are

$$t_{ij}=t_{ij}^k, \text{ za } k=K_{ij}.$$

By solving this model we get optimal activity lead times

$$t_{ij}^* = t_{ij}^k, \quad k=1,2,\dots,K_{ij},$$

for which we get minimum project realization costs; not one but a series of optimal solutions, by means of which, for each possible project lead time $T \in [T_1, T_2]$, minimum costs necessary for its realization are determined. Thus, the given problem of the optimal choice of contractors for all activities of the given project is solved as well.[5]

3. PROBLEM SOLUTION

This model belongs to the class of combinatorial parametric programming models and can be solved by applying some of the algorithms for solving such models. However, the majority of those algorithms are unsuitable for practical application. Therefore, we will show how the problem can be solved by certain modifications of the existing *PERT-COST* algorithm for cost minimization of the project realization depending on its duration.[6]

In order to describe this algorithm in detail it is necessary to calculate cost increase for each project activity

$$\Delta C_{ij}^k = C(t_{ij}^k) - C(t_{ij}^{k+1}), (i,j) \in L, \quad k=1,2,\dots,K_{ij}-1, \quad (3)$$

that shows how much the realization costs for the activity will increase if its lead time is shortened from t_{ij}^{k+1} to t_{ij}^k . After calculating these cost increases it is possible to provide a detailed description of the algorithm for the solution of the problem of contractor choice optimization for all project activities. The algorithm consists of several discrete steps.

ALGORITHM

1. In the previously constructed network diagram, for all the activities of a given project, it is necessary to set

$$t_{ij}=t_{ij}^k, \text{ za } k=K_{ij}, (i,j) \in L,$$

and then to calculate T_3 , $C(T_2)$ and all time parameters.

Thus, the first optimal solution of the given problem is set. This optimal solution determines the longest possible project lead time duration T_3 , with the corresponding minimum costs $C(T_2)$. In this case, the realization of all project activities would be given to those contractors who require the longest activity lead times and the lowest realization costs.

2. Now there is the problem of second optimal solution, i.e. second project lead time $T < T_2$, with the corresponding minimum realization costs $C(T)$; optimal contractors are thus determined who will realize the given project within this deadline and at these costs. This procedure of finding the new optimal solution with shorter project duration and the corresponding minimum costs is of iterative character and is supposed to be repeated until it obtains the critical path where lead times of all the activities are $t_{ij} = t_{ij}^I$, which means that the project duration cannot be further shortened and the algorithm, therefore, ends.

In order to solve this problem it is necessary to shorten the project duration, while extra costs necessary for its realization remain minimum. This means that we need to determine those activities whose shortening will bring about the shortening of project duration, and those can only be critical activities since shortening the duration of those activities only leads to shortening the project duration as a whole. [7] However, we cannot shorten the time of any critical activity arbitrarily. It is necessary to shorten the time of the critical activity (i,j) with the lowest cost increase ΔC_{ij}^k .

If there are multiple critical paths in the network diagram, then, in order to shorten the duration of the whole project at minimum extra costs needed for its realization, it is necessary to shorten the lead times of all critical paths following a criterion set beforehand. Moreover, it should be determined how much lead times of these critical activities are shortened, while keeping extra costs necessary for its realization at the minimum. These problems will be solved in the following way:

Set the critical path (or all critical paths, if there are more than one) and all critical activities it consists of, and then set the cost increase ΔC_{ij}^k of all critical activities. On each of the critical paths shorten lead time of those critical activities (i,j) which have the lowest cost increase ΔC_{ij}^k . After that, input into the network diagram the changes in the lead times and record new (further) cost increases for all activities whose lead times were shortened in the previous step. Then, make a new time analysis and set a new project lead time T and calculate the corresponding minimum costs

$$C(T) = C(T_2) + \sum \Delta C_{ij}^k, \quad (4)$$

where the sum of the cost increases ΔC_{ij}^k relates only to those activities whose lead times were shortened in the previous step.

Check whether the critical path is obtained with the lead times of all activities $t_{ij} = t_{ij}^I$. Based on that there are the following possibilities:

2.1. The critical path where lead times of all activities are $t_{ij} = t_{ij}^I$ is obtained. The algorithm thus ends because the project duration cannot be further shortened.

2.2. The critical path where lead times of all activities are $t_{ij} = t_{ij}^I$ is not obtained. In this case go back to step 2 of the algorithm and repeat the whole procedure.

This way the given problem is entirely solved, and the data on project lead time duration $T \in [T_1, T_2]$, contractors of all activities, as well as on minimum project realization costs $C(T) \in [C(T_1), C(T_2)]$, recorded in a separate table, are the required optimal solutions.

4. CONCLUSION

The final result of this problem is a discrete function of minimum project realization costs $C(T)$ depending on its duration $T \in [T_1, T_2]$. This discrete function on the plane $T, C(T)$ can be shown by several points whose abscissas represent project duration while ordinates represent corresponding minimum costs. By choosing any of these points on the plane, where the choice criterion can be either lead time duration or project realization costs, we choose at the same time the lead times for all project activities as well as their corresponding costs. Depending on these results optimal contractors for all project activities are chosen.

Finally, it should be noted that in practice there are different variants of this problem. The problem shown here represents one of its more general forms.

5. REFERENCES

- [1] N. Christefides: *Graph Theory on Algorithmic Approach*, Academic Press, New York, London, 1975.
- [2] J. Vuleta: *Metode ekstremizacije na grafovima*, IEI i Naučna knjiga, Beograd, 1985.
- [3] J. Vuleta: *Optimizacija raspodele poslova na izvođače*, Zbornik radova SYM-OP-IS '90, Kupari, 1990.
- [4] J. Subić, Z. Vasiljević, A. Jean: *The Impact of FDI on the European economic development in the context of diversification of capital flows*, Business transformation through innovation and knowledge management: An Academic Perspective, Vols 1-4, (2010), vol. br. , str. 779-787.
- [5] I. Milojević, M. Mihajlović, M. Cvijanović, *Impact of organizational failure of relevance consolidated budget*, Ekonomika poljoprivrede, Vol. LIX, №1 (1-176), 2012, str. 63-71.
- [6] V. Kovacevic-Vujcic, *Improving the rate of convergence of interior point methods for linear programming*, Mathematical Programming, Volume 52, Numbers 1-3, 1991, 467-479.
- [7] J. Zubović, M. Jeločnik, J. Subić, *The analysis of HR index in Serbian financial sector*, Industrija, vol. 39, iss. 1, 2011, pp. 227-242

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SELECTION OF THE BEST CONTRACTOR FOR REALIZATION OF EACH PROJECT ACTIVITY USING MULTI-CRITERIA ANALYSIS

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Abstract: This paper presents a specific problem of transporter selection optimization in the transport issue. The main characteristic of this problem is that every route has a capacity limit constraint, while the cost of transport per unit is partitioned and well known in advance. These costs are determined based on the potential transporters' offers. This transport problem is solved by an appropriate transport network and by application of a method for the minimization of costs related to non homogeneous flow realization in the network with known value. With this problem solved, the transporter selection is optimized, that is, identified are those transporters who will transport specified amount of given product from all producers-warehouses to all consumer centers with minimum total transport costs.

1. INTRODUCTION

Selection of the most appropriate (optimal) contractor for any activity, and therefore for the entire project, is one of the most significant problems necessary to solve at the realization of any project, and particularly complex ones, consisting of a large number of different operations or activities, the realization of which requires a large number of different contractors. This is because the selection of project contractors has decisive influence on costs, time, quality and other factors important not only for the realization itself, but also with regard to other results expected after realization of the given project [1].

For that very reason, when making a decision on activity contractor selection, it is necessary to conduct a thorough analysis and take into consideration all relevant factors related to it. For an example, although the price and time schedule quoted by the potential contractors for the realization of an individual activity or a whole project should be considered first, these factors need not be decisive for the selection of the best project contractor. It is necessary to determine if those contractors also meet all other technical, technological and performance (manufacturing) requirements foreseen for the realization of the given project [2]. Depending on the type of project to be realized, those requirements may be diverse and numerous, and the most frequently considered ones are: potential contractor's size, technical equipment and production capacities, then business reputation and solvency of potential contractors, their experience, opinion and assessment of previous investors, as well as many other factors significant for the realization of the given project. This clearly shows that the problem of selection of the best (optimal) project contractors is very complex, multi-criteria issue, whose solution is not at all simple.

So far, these problems have been solved in different ways, but mostly without application of any optimization methods. More precisely said, the problem of project contractor selection has been resolved by applying one of the possible solutions to the given problem and not the optimal one. That is why the attempt has been made here to express one specific, and, from the practical point of view, simplified issue of project contractor selection, in the form of mathematical model of integer multi-criteria programming, type 0-1, the solution of which determines the optimal solution to the given problem. The main specific characteristic of this problem is reflected

in the method and procedure of solving the set multi-criteria model. Here, the set mathematical model of integer programming type 0-1 is first transformed into an appropriate network model, and then, such model is solved by application of graph theory [1;3].

2. PROBLEM DESCRIPTION AND MODEL FORMATION

As above said, this paper deals with realization of project consisting of various activities, which can also be viewed as phases in project realization. We will mark the activities with an index $i=1,2,\dots,n$, where number n represents the total number of variables $x_i^{j_i}$, $j_i \in N$, whose value equals 1, if the contractor j_i realizes the activity i , while in all other cases, the value of these variables equals 0.

Some of the potential contractors may tender for performing larger number of activities at the same time. If all those activities, according to the given order, are arranged in sequence, such case may be treated as a case where one contractor competes for performing one activity, and that can be presented with complex variable which we will write down in the following developed for activities, and then we will introduce the assumption that all these activities are arranged in some logical order of their performance, that is, that there is dependence regarding their realization. For the realization of each of these activities, there is (competes) a different number of potential contractors, which we will mark with $j_i=1,2,\dots,n_i$, where n_i represents the total number of potential contractors of activities i .

In order to more easily set a mathematical model, and transform it into a network model later, we will presume that all potential contractors j , form a set, which we will mark with N . After introducing these marks, it is possible to also introduce the

$$X_b^{j_i} = X_b^{j_i} + X_{b+1}^{j_i} + \dots + X_i^{j_i}, \text{ where } j_i \in N \text{ i } b < i, (1)$$

which can be explained in a following way: based on the upper index which represents the contractor's mark, it can be seen that the potential contractor j_i may perform activities i , and based on the bottom indices which represent the mark of activities, it is clear that that same contractor may perform not only activity i , but also all other activities that precede it, all up to the activity b , including the very activity b . If the contractor j , realizes all activities from b to i ,

then the value of this complex variable equals $i-b+1$, which also equals the number of addends in the given expression. Therefore, it can be conditionally considered that the value of each of these addends equals one. In all other cases, the value of this variable equals 0.

However, if one contractor tenders for the performance of activities not ordered in sequence, but represent several independent wholes, then, during analysis and problem setting, it may be considered that each of this independent whole is performed by a different contractor, that is, other additional (fictitious) contractors may be introduced, but, after problem solving, those activities are assigned to real contractors for realization.

It is clear that the results of realization of each potential contractor $j_i=1,2,...,n_i$, of each activity $i=1,2,...,n$, have different effects on the results of the whole project realization. That is why the problem of selection of the best or optimal contractor of each activity, and therefore of the whole project is posed. By selecting optimal conductors, besides meeting all technical and technological project realization requirements, expressed through limitation of mathematical model, it is necessary to optimize previously set objective functions. Depending on the nature of the problem, we can set a number of different criteria functions, that is, we can conduct optimization of the selection of project contractors depending on different optimality criteria. We will mention only some of those criteria which can occur in the process of solving the best project contractor selection problem:

- the lowest costs of the whole project realization;
- the shortest time for the whole project realization;
- the selection of the most experienced contractors for project realization;
- the selection of the contractors with best references for project realization;
- the selection of the most reliable performers for project realization, etc.

Here, we shall assume that there are $k=1,2,...,K$ different criteria functions which should be maximized or minimized, and that they can be presented by means of the following mathematical relations[4]

$$Z_k = \sum_{j_i \in N} [f_k(x_i^{j_i}) + f_k(x_b^{j_i})], \quad k=1,2,...,K, \quad (2)$$

After this explanation, the problem of contractor selection optimization can now be formulated in short, in the following way: out of all potential project activity contractors, those that meet all technical and technological requirements and at the same time maximize or minimize the objective functions set in advance, should be selected.

In order to be able to solve the problem of this set multi-criteria optimization of project contractor selection, it is necessary to first form an adequate mathematical model, that is, to set and present by means of appropriate mathematical relations, previously selected criteria, which are expressed through objective functions in the mathematical model, as well as all the project realization requirements, which are expressed through limitations. After that, the required optimal or final (optimal multi-criteria wise) solution to the set problem is obtained by solving mathematical model.

It has already been mentioned before that objective functions may be represented by means of the following mathematical relations

$$Z_k = \sum_{j_i \in N} [f_k(x_i^{j_i}) + f_k(x_b^{j_i})], \quad k=1,2,...,K, \quad (3)$$

where each of these K functions represents one precisely defined optimality criterion. The nature and specific characteristics of the observed problem will determine which criteria to observe and how to conduct their quantification.

As for the limitations and conditions in which the observed activities as well as the entire project are realized, we will limit the analysis only to the most significant limitations characteristic for almost all projects. Those limitations may be expressed by means of the following relations:

$$\sum_{j_i=1}^{n_i} x_i^{j_i} \leq 1, \quad i=1,2,...,n, \quad (4)$$

which means that out of all potential contractors n_i , which can realize activity i , only one contractor will work at its realization.

$$\sum_{j_i=1}^{n_i} x_b^{j_i} \leq i - b + 1$$

where b and i can take any value from the interval $[1,n]$, whereas $b < i$ always. The said relation expresses the condition that, out of the total number of the potential contractors n_i , only one contractor will work at the realization of all activities $i - b + 1$.

Besides the above mentioned, it is necessary to have in mind the following limitations which arise from the very nature of the problem

$$\sum_{j_i \in N} [x_i^{j_i} + x_b^{j_i}] = n \quad (5)$$

which means that all the activities of the set problem should be realized, that is, that the set project should be fully realized.

$$x_i^{j_i} = 1 \text{ or } 0, \quad i=1,2,...,m, \quad j_i=1,2,...,n_i,$$

which depends on whether contractor j_i realizes the activity i or not.

$$x_b^{j_i} = i - b + 1 \text{ or } 0, \quad i=1,2,...,m, \quad j_i=1,2,...,n_i,$$

which depends on whether contractor j_i realizes the activities b and i or not, as well as all the activities between them.

Although the complex variables in this model may take whole number values, other than one, or zero, still, if we take into consideration the previously described properties of these variables, we may presume that this model belongs to the class of the model of whole number multi-criteria programming type 0-1 and can be solved with some of the known methods for solving such model classes.

However, we will abstain from the application of such methods and we will show how this model can be solved by applying graph theories. To this effect, we will first transform the set mathematical model into an appropriate network model, and then, we will show how the set model of whole number multi-criteria programming type 0-1 can be solved by means of such network model.

3. SET MODEL SOLVING

Main problem to be solved here is the transformation of the set mathematical model into an appropriate network model. We will conduct this transformation in the way that we will observe the set problem as a separate system which we will graphically present through an appropriate network (network model) $G = (N, L)$, where N stands for the node set and L for the arc set of the given network. We will define that system, that is, all its states and the state change options, in the following way: first, we will define the requirement that a conductor for realization of any activity i is determined as one of the separate system states. To this set of separate states, we shall also add a so-called final system state, which we shall mark with $n+1$, so that there are exactly $n+1$ of such states ($i=1,2,...,n,n+1$) and we will call them the main or basic system states. Besides these main ones, we will also define so-called secondary system states which are determined from the requirement that a contractor $j_i=1,2,...,n_i$, realizes activities $i=1,2,...,n$, or all activities from b to i . That means that the variables $x_i^{j_i}$ and $x_b^{j_i}$ determine all possible secondary system states, which, together with $n+1$ of the main states, represent the set of all nodes N of the future network $G=(N,L)$.

After determining all nodes of future network model, it is possible to derive its construction in the following way:

first we construct the node with the mark 1 and behind it, vertically arranged, we construct the node set $x_i^{j_i}$, $j_i=1,...,n_i$. After that, we construct the node marked 2 and behind it the sets of nodes

marked $X_1^{j_2}$ and $X_2^{j_2}$, $j_2=1, \dots, n_2$. This procedure of constructing the future network nodes will be continued until we construct the node marked n and behind it in a vertical order, the sets of nodes $X_1^{j_n}, X_2^{j_n}, \dots, X_n^{j_n}$, $j_n=1, \dots, n_n$ and in the end, as a last (final) network node, we construct the node marked $n+1$.

In this way, all the nodes from the set N of the future network model $G=(N,L)$, that is, all possible states of the above defined system are determined. Now, it is necessary to connect all these nodes with the future network arcs, in accordance with the previously given realization requirements for each activity and for entire project, which defines the requirements of the system transfer from one state to another. We will do this node connecting with oriented arcs in the following way:

We will first connect with arcs the node marked 1 with each node from the set $X_1^{j_1}$, $j_1=1, \dots, n_1$. We will assign to each of these arcs a vector with K components equal to the values of the objective function $f_k(X_1^{j_1})$, $k=1, 2, \dots, K$ i $j_1=1, \dots, n_1$. We will call these vectors 'arc length'. After that, we will connect all the nodes from the set $X_1^{j_1}$ with fictitious arcs (arcs whose lengths equal 0), with the node marked with number 2. In the same way, it is necessary to connect with arcs node 2 and the node set $X_2^{j_2}$. These arcs are assigned vectors of 'length' whose components equal the values of the objective function $f_k(X_2^{j_2})$. After that, we will connect all the nodes from the set $X_2^{j_2}$ with fictitious arcs to the node marked with number 3. This procedure of node connecting $i=3, \dots, n$, which represents the main system state, with node sets $X_i^{j_i}$, representing secondary states, and assigning vectors of 'length' to these arcs, the elements of which equal related values of the goal function, as well as connecting with fictitious arcs node sets $X_i^{j_i}$ with node $i+1$, we will continue until, in the end, node marked n is connected with node set $X_n^{j_n}$, $j_n=1, \dots, n_n$. These arcs should be assigned 'length' vectors, whose elements equal the value of objective function $f_k(X_n^{j_n})$. In the end, all nodes from the set $X_n^{j_n}$ we will connect with fictitious arcs with node marked $n+1$.

In this way, all network arcs representing potential contractors performing only one activity of the given project are constructed. The only thing left is to also construct all network arcs representing potential contractors which perform several activities. Such potential contractors are represented by means of variables $X_b^{j_i}$, where $b, i \in [0, n]$ and $b < i$, and in the network model they will represent arcs whose initial node, one of the basic system states, is marked with b , and the final node, one of the secondary system state, is marked with $X_b^{j_i}$. These arcs should be assigned 'length' vectors which equal the objective function value $f_k(X_b^{j_i})$, and then, it is necessary to connect all nodes of the given model marked with $X_b^{j_i}$ with fictitious arcs to appropriate nodes $i+1$.

With this transformation of mathematical into network model, we obtain the network in which each path between the nodes 1 i $n+1$ corresponds to one of the possible solutions of the set problem of the best (optimal) contractor of all project activities, and, the other way round, each possible solution to multi-criteria model corresponds to one of the paths between nodes 1 and $n+1$ in network model. More precisely said, between paths, from node 1 to node $n+1$ in the network model, and possible solutions to the integer multi-criteria programming model, there is an unambiguous correlation. [5]

It is this property of the network model that we will use for solving the set model of multi criteria whole number programming type 0-1 and we will show how this model can be solved by graph theory application [1] and [3].

It is known that there are several different methods and procedures for solving the multi criteria optimization problem [6] and [7]. By application of certain methods, the set multi criteria model is reduced to mono-criterion one, whereas by solving one criterion model the optimal solution of the initial multi criteria model is determined, too. By application of other methods, first established are different alternatives or solutions which can also represent the set of non inferior solution of the given multi criteria model, and then, by applying any of the method for multi criteria alternative ranking, the final solution (optimal multi criteria wise) of the set multi criteria optimization model is determined [6] and [7].

Due to space limitations, we will not deal here with multi criteria optimization methods, and their application to the solution to the selection problem regarding the best contractor of all project activities. We will only note that this problem may be successfully solved by applying any multi criteria optimization method. In addition, we will say that the compromise programming method is very suitable for the solution of this problem. This is because all non-inferior solutions to the set multi criteria model can relatively easily be fixed by applying the algorithm in order to designate non-inferior paths in the network [3]. After that, by applying L_p metrics [7] these solutions may be ranked, and in this way, final (optimal multi criteria wise) solution to the set multi criteria optimization model can be defined.

4. CONCLUSION

This paper presented one real problem of the selection of the project activities best contractors, and then, it was shown how this problem can be illustrated by means of appropriate multi criteria optimization models (mathematical and network) type 0-1. However, because of space limitations, due attention has not been paid to these problems solving. That is why we will give here only a few observances about the necessity and importance of applying multi criteria optimization methods in solving practical issues. [4]

It should be immediately pointed out that a great number of practical problems from different areas has been successfully solved by applying these very methods. Application of these methods has given especially good results in solving the problems of wider economic and social interest, such as: energetics, water management, ecology, diverse developmental issues and projects, and so on, whereas from that point of view, application of the multi criteria optimization method can be considered, not only justified but useful and necessary.

5. REFERENCES

- [1] J. Vuleta: *Methods of Extremization on Graphs*, IEI and Naučna knjiga, COBISS.SR-ID 26606092, Beograd, 1985.
- [2] J. Vuleta: *Optimization of Work Distribution per Contractor*, Collection of Papers SYM-OP-IS '90, Kupari, 1990
- [3] D. Cvetković, V., Kovačević: *Combinatorial optimization*, The Operational Researchers Society of Yugoslavia, ISBN 86-7172-011-X, Beograd, 1996.
- [4] M. Čupić, M. Suknović: *Decision*, Faculty of Organizational Sciences, Belgrade, 2010.
- [5] I. Milojević, M. Mihajlović, M. Cvijanović, *Impact of organizational failure of relevance consolidated budget*, Ekonomika poljoprivrede, Vol. LIX, N°1 (1-176), 2012, str. 63-71.
- [6] I. Nikolić, S. Borović: *Multi-criteria Optimization*, Center of Military Schools of Yugoslav Army, COBISS.SR-ID 16429583, Beograd, 1996.
- [7] S. Opricović: *Multi-criteria Optimization of Systems in Construction Industry*, Faculty of Construction Engineering, COBISS.SR-ID.141555719, Beograd, 1998.

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THE TRANSPORTER SELECTION OPTIMIZATION IN TRANSPORT ISSUE

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Abstract: This paper presents a specific problem of transporter selection optimization in the transport issue. The main characteristic of this problem is that every route has a capacity limit constraint, while the cost of transport per unit is partitioned and well known in advance. These costs are determined based on the potential transporters' offers. This transport problem is solved by an appropriate transport network and by application of a method for the minimization of costs related to non homogeneous flow realization in the network with known value. With this problem solved, the transporter selection is optimized, that is, identified are those transporters who will transport specified amount of given product from all producers-warehouses to all consumer centers with minimum total transport costs.

1. INTRODUCTION

In the structure of total operating costs of each enterprise, transport costs represent one of the most significant items. That is why transport issues, especially transport costs problem deserve particular attention. Previous theoretical and practical elaborations considered numerous and diverse transport problems and different methods, procedures and algorithms have been elaborated for their solving. However, and besides, numerous transport problems are still not solved in a satisfactory way. With this in mind, this paper attempts to analyse and solve one specific transport problem in a particular way.

Most transport problems require goods delivery from producer, or certain warehouses, to consumers, or consumer centers, with minimum total transport costs, where all the requirements related to the route or transporter selection, or the selection of the means of transport used for goods transportation is expressed through only one indicator, and that is, most often, the transport cost per product unit from producer to consumer. That is a considerable simplification and banalizing of transport problem, and therefore a significant shortcoming of a transport problem set in this way.

As opposed to the problems simplified in this way, transport problem, that is, transport costs minimization problem, will be set and analysed here by means of real transport network in which transport costs are partitioned per route and per different transporters, and the solution to the problem consists of selecting those transporters, among a number of potential transporters, who will transport specified quantity of some product from all producer centers to all consumer centers with minimum transport costs. Common transport methods will not be used for solving thus set transport problem [1]. Instead, the first thing to do will be to set an appropriate mathematical model which will be solved by application of graph theory. For solving that kind of model, a particular algorithm has been developed, based on the network flow theory, that is, on cost minimization related to the realization of non homogeneous network flow with set value in the network.

2. DESCRIPTION OF A PROBLEM AND FORMATION OF MATHEMATICAL MODEL

In this paper, transport issue is viewed through a real transport network which we can mark with $G(N,L)$ and which consists of the node set N and arc set L . The node set, which in the given transport network is represented by crossroads and geographical locations, we will mark with a natural number sequence $1,2,...,n$, where n is a total node number of a given transport network. By this node marking, each network arc, which in transport network represents a route, that is, the part of a street between two crossroads or a road between two locations, is marked with two numbers. If the given network is oriented, then, they are numbers of initial and final node of the observed arc. On the contrary, if the network is not oriented, then, they are the numbers of neighbouring nodes. We will most frequently mark the numbers used to number the nodes with i or with j , which means that $i,j \in N$, while we will mark the arcs with a pair (i,j) so, it can be noted down that $(i,j) \in L$. Without reducing general character of this problem, we will assume here that we have an oriented network, and that i always marks initial node, and j final arc node (i,j) . With the help of such transport network, we will reconsider the problem of transporter selection optimization.

Out of all n nodes of the given network, there is one or several nodes in which specified product is produced or stored. We will call this node set production – warehouse centers, and we will mark it with S . Also, there is a node set that we will mark it with T which we will call consumer centers, which request or consume this product. In the given transport network, we can also have nodes which do not belong either to the set S or to the set T , that is, they do not represent either producer or consumer centres. We will mark such node set with R and we will call it the set of neutral or transitive nodes. Besides, we will assume that in these nodes, it is not possible to change transporter transporting a specified product. That means that, if any transporter begins the transport of specified quantity of product from production-warehouse center, then it will deliver that product quantity to a certain consumer center. Now, the problem of transporter selection optimization in transportation network can be set in the following way:

In transport problem for which there are limitations regarding capacity and data about transport unit costs, for several potential transporters for each route, transporters to be selected out of all potential transporters are those which will transport specified quantity of a product, from all production centers to all consumer ones with minimum total transport costs. In order to present the problem conceived in this way through an appropriate mathematical model, it is necessary to previously introduce the following marks and assumptions:

We will mark the quantity of the given product as x_{ij}^k , $(i,j) \in L$, $k=1,2,\dots,K$ which is transported per route (i,j) k^{th} transporter, and we will assume that the following values are known:

v_i – available quantity of a specified product in each of the production-warehouse center $i \in S$;

w_j – demand for the specified product by each consumer center $j \in T$;

c_{ij}^k , $(i,j) \in L$, $k=1,2,\dots,K$, product unit transport costs per route (i,j) , of k^{th} transporter;

D_{ij} , $(i,j) \in L$ – route throughput or a capacity (i,j) , if related to a capacity transport problem which will be discussed here. Otherwise, it will be considered that the route throughput is unlimited, which is a simpler transport problem.

Beside these, let us also introduce an assumption that we have here a closed transport problem, that is, that the total available quantity of a specified product of all production-warehouse center equals total demand of all production centers, that is, we will presume that $V=W$, where

$$V = \sum_{i \in S} v_i \quad W = \sum_{j \in T} w_j$$

After introducing these marks and assumptions, it is possible to form mathematical model for solving set problem. However, before we proceed with mathematical model formation, in order to solve it more easily later, we will carry out network transformation $G=(N,L)$, into a new network model $G^*=(N^*,L^*)$, in the following way:

We will add two nodes to the network $G=(N,L)$ which we will mark with s and t . After that, we will connect node s with arcs (s,i) to all nodes $i \in S$ and to these arcs we will assign capacities $D_{si}=v_i$ and transport costs $c_{si}^k=0$, $i \in S$, $k=1,2,\dots,K$. In the same way, we will connect all nodes $j \in T$ with arcs (j,t) to node t and we will assign to these arcs capacities $D_{jt}=w_j$ and transport costs $c_{jt}^k=0$, $j \in T$, $k=1,2,\dots,K$

With this transformation, real transport network $G=(N,L)$, with several production and consumer centers, is transformed into an auxiliary (fictitious) network $G^*=(N^*,L^*)$, with one production center, whose total demand equals V , and one consumer center, whose total demand equals W , and according to previously introduced assumption $V=W$. By means of this transformed network $G^*=(N^*,L^*)$, set transport problem of optimal transporter selection can be translated into the next, equivalent transport problem:

Transporters to be selected, out of all potential transporters, are those which can transport total available quantity of specified product V , from production center s , to consumer center t and fully satisfy its demand W , with minimum total transport costs.

For solving this problem, we can set the following mathematical model:

Objective function to be minimized

$$F = \sum_{(i,j) \in L^*} \sum_{k=1}^K c_{ij}^k x_{ij}^k, \quad (1)$$

under limitations:

$$\sum_{j \in A_s} \sum_{k=1}^K x_{sj}^k = V \quad (2)$$

$$\sum_{i \in B_t} \sum_{k=1}^K x_{it}^k = W \quad (3)$$

$$\sum_{j \in A_i} \sum_{k=1}^K x_{ij}^k - \sum_{j \in B_i} \sum_{k=1}^K x_{ji}^k = 0, \quad i \in N, \quad (4)$$

$$\sum_{k=1}^K x_{ij}^k \leq D_{ij}, \quad (i,j) \in L^* \quad (5)$$

$$V=W \quad (6)$$

where A_s and A_i , $i \in N$, stand for sets which immediately follow node s , that is node i , and B_t and B_i , $i \in N$, stand for node sets which immediately precede node t , that is node i , while said limitations have the following meanings:

According to limitation (2), total available quantity V of specified product is transported from node s . This transport can be conducted only through arcs (s,i) , that is, through nodes $i \in S$, in precisely determined amounts $D_{si}=v_i$. That means that from nodes $i \in S$, which in real transport network G represent production centers, total available quantities of specified product v_i are transported, and that represents one of the set requirements of the specified problem. In a similar way, it can be shown that total demand of consumer centers $j \in T$ is satisfied, as according to limitation (3), entire demand W has to be transported to a fictitious consumer center t , through real consumer centers which in real transport network are represented with nodes $j \in T$.

Limitation (4) expresses the requirement that the quantity of the specified product to be transported to each of the neutral node $i \in R$, equal the quantity of product transported to each of those centers, which means that in those nodes there is neither production nor consumption of a specified product, and that is, also, one of the set requirements for the specified problem.

Limitation (5) expresses the requirement that transported quantity of product per each route $(i,j) \in L^*$, fictitious network $G^*=(N^*,L^*)$, and therefore real network $G=(N,L)$, cannot be greater than throughput of that route, while limitation (6) expresses the requirement that total available quantity of a specified product in all production centers V equals total demand W of all consumer centers.

Based on the provided explanations about set mathematical model limitations, it is clear that initial problem presented through real transport network G , is equivalent to transport problem, expressed through fictitious network G^* and described mathematical model (1)-(6). That means that solving one of those problems simultaneously solves another one. For that reason we will present here only a procedure for solving the problem presented through fictitious network G^* , and then we will show how the optimal solution of the initial problem of transporter selection optimization is determined, with the help of this solution, in transport issue.

3. SET PROBLEM SOLVING

The set mathematical model (1) - (6), as well as corresponding network model $G^*=(N^*,L^*)$, falls into a class of so-called linear non homogeneous network model. Besides the fact that there is a large number of practical problems which can be solved with the help of this model, solution options are very limited, primarily due to mathematical model bulkiness and too many numerical operations necessary to conduct to solve it [1] and [2]. That is why we will exhibit one algorithm, to be used for solving the set model, based on generalization of the known method for minimization of costs for realization of homogenous flow in the network. By applying this method, we can determine the shortest route between nodes s and t in an auxiliary network previously constructed on the basis of the known protocol and which is called flow dependant network. In such network, by eliminating contours of negative length of the first and second type, the non homogeneous flow is determined, given value V , in transformed network $G^*=(N^*,L^*)$, and therefore, the transporters which transport optimal product quantities $(x_{ij}^k)^*$ per routes $(i,j) \in L^*$, are simultaneously determined, so that entire available quantities of specified product v_i , from all producer centers $i \in T$, are transported to consumer centers and their demand w_j , $j \in T$, is satisfied, with minimum transport costs. This auxiliary network, based on the flow determined in previous iteration is constructed in each iteration and serves as the basis for subsequent iterations, and its definition and procedure of its construction is shown in detail in

[2] i [3], so, we will not repeat them here, due to space limitations, but will proceed with presentation of the very algorithm for solving the set problem.

ALGORITHM

Step 1 Set $q=0$ and then $x_q = x_0 = 0$, that is $x_{ij}^k = 0$, $k = 1, 2, \dots, K$, $(i, j) \in L^*$. Therefore, we obtain the value flow $V_0 = 0$, for which minimum value of the objective function value is $F_q = F_0 = 0$. After that, it is necessary to set $q=1$, where ordinal iteration number is marked q , and proceed with the next algorithm step, which, in fact, begins itinerary procedure for set problem solving.

Step 2 Auxiliary network should be constructed $G(x_q^e)$, (in general case $G(x_q^e)$), dependant on the flow x_q^e , (in general case x_q^e), value V_0 (in general case V_q), and then examine if thus constructed auxiliary network contains contours of second type negative length. If we establish the existence of such contours, we should conduct their elimination and enter appropriate flow changes in the auxiliary network. [4] After that, the shortest routes p_q^k need to be determined, (in general case p_q^k) between nodes s and t in the auxiliary network, and then, determine route p_q^e , on the basis of the requirement

$$d(p_q^e) = \min_k \{d(p_q^k)\}.$$

After that, we should proceed with the third algorithm step.

Step 3 Throughput ε_q of the route p_q^e should be determined in the following way:

$$\varepsilon_q = \min \{D_{ij}(x_q^e)\}, (i, j) \in p_q^e,$$

and then it should be examined if $V_q = V_{q-1} + \varepsilon_q$ is greater than, less than, or equals V , where flow value obtained in previous iteration is marked V_{q-1} and depending on that, there are following options:

3.1 If $V_q < V$, then flow $(x_{ij}^e)_{q-1}$ from previous iteration should be replaced with flow $(x_{ij}^e)_q$ in the following way:

$$(x_{ij}^e)_q = (x_{ij}^e)_{q-1} + \varepsilon_q, (i, j) \in p_q^e \text{ i } c_{ij}^e(x_{ij}^e)_{q-1} > 0,$$

$$(x_{ji}^e)_q = (x_{ji}^e)_{q-1} - \varepsilon_q, (j, i) \in p_q^e \text{ i } c_{ji}^e(x_{ji}^e)_{q-1} < 0.$$

That is how new flow valued $V_q = V_{q-1} + \varepsilon_q$ is obtained, so, it is necessary to set $q=q+1$ and return to the second algorithm step and begins new iteration.

3.2 If $V_q = V$, then, it is necessary to make identical flow changes as in the previous case **3.1**, and then to construct auxiliary network $G(x_q^e)$, dependant on the flow x_q^e , and see if that network contains contours of second type negative lengths. If the existence of such contours is established, they should be eliminated. Thus, the flow value $V_q = V$, is not changed, and the auxiliary network depending on the flow does not contain any contour of negative length either of the first or second type, which means that the optimal flow is determined $(x_{ij}^k)^*$, set value V . Algorithm finishes here, and based on the obtained optimal flow $(x_{ij}^k)^*$, the set problem of transporter optimal selection is solved, as value $(x_{ij}^k)^*$ represents the optimal value of the specified product, which k^{th} optimal transporter will transport per route (i, j) . [5] The only thing left is that, by means of the relation

$$F^* = \sum_{(i,j) \in L^*} \sum_{k=1}^K c_{ij}^k (x_{ij}^k)^*, \quad (7)$$

minimum objective value function is determined, that is, minimum total transport costs.

3.3 If $V_q > V$, then it is necessary to calculate $h = V - V_{q-1}$, and then to make the following flow changes:

$$(x_{ij}^e)_q = (x_{ij}^e)_{q-1} + h, (i, j) \in p_q^e \text{ i } c_{ij}^e(x_{ij}^e)_{q-1} > 0,$$

$$(x_{ji}^e)_q = (x_{ji}^e)_{q-1} - h, (j, i) \in p_q^e \text{ i } c_{ji}^e(x_{ji}^e)_{q-1} < 0.$$

After that, the auxiliary network dependent on newly obtained flow should be constructed x_q^e , and the identical procedure as in the previous section 3.2 should be conducted.

In this way, the set problem of transporter optimal selection is fully solved in transport issue, and the algorithm verification, that is, evidence that through its application the optimal solution is really obtained, is presented in detail in [2,6], wherefore that evidence will not be repeated here.

4. CONCLUSION

Based on the above said, it can be concluded that here presented problem of transporter selection optimization in the transportation issue and especially the procedure of its solving, represent significant improvements compared to such standard transportation problems. It can best be comprehended by concrete problem solving [3]. However, due to space limitations, it is not possible to present it here, so, we will indicate only to some obvious facts which relate to problem expansion, that is, introduction of greater number of transporters and transportation cost break down per road and per transporter. It is clear that these expansions increase the number of possible solutions, that is, selection options, and consequently increase the possibility to reduce total costs.

However, besides obvious improvements realized by implementation of these expansions, compared to standard transport problem, those expansions may prove to be significant difficulties in the process of solving the very problem. That relates to a certain degree to the very formation of mathematical and appropriate network model, and to a greater extent to the very proceeding and work out of corresponding algorithms for their solving, as, it is known, some theoretical problems connected to these models solving are still not solved.

5. REFERENCES

- [1] J. Vuleta: *Methods of extremization on graphs*, IEI and Naučna knjiga, Beograd, 1985.
- [2] D. Cvetković, V. Kovačević: *Combinatory Optimization*, Society of Operational Researchers of Yugoslavia, Beograd, 1996.
- [3] J. Vuleta: *Optimization of network transport model*, Industry – Magazine for Industry Economics No.1-2., Beograd, 1997.
- [4] M. Čupić, M. Suknović: *Decision*, Faculty of Organizational Sciences, Belgrade, 2010.
- [5] V. Kovacevic-Vujcic, *Improving the rate of convergence of interior point methods for linear programming*, Mathematical Programming, Volume 52, Numbers 1-3, 1991, 467-479.
- [6] I. Milojević, M. Mihajlović, M. Cvijanović, *Impact of organizational failure of relevance consolidated budget*, Ekonomika poljoprivrede, Vol. LIX, N°1 (1-176), 2012, str. 63-71.

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THE IMPACT OF BALANCE SHEET STRUCTURE ON THE PERFORMANCE OF INDUSTRIAL ECONOMIC ENTITIES IN THE REPUBLIC OF SERBIA

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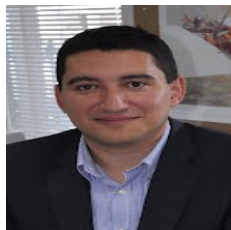
Key words: asset structure, financial leverage, default risk



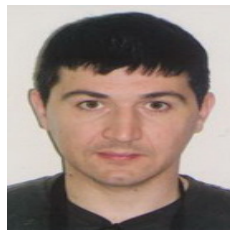
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Abstract: The goal of this paper is to examine whether the percentage level of certain balance sheet items at the end of 2008 had an impact on the profitability of industrial economic entities of Serbia in the period from 2009 to 2011 and to what extent. The research included a sample of 3,866 industrial economic entities from the Republic of Serbia, which were grouped on the basis of a local size classification into medium-sized and large legal entities. Results indicate that economic entities where the percentages of property, plant and equipment were at higher levels recorded worse results in the period of three years from the beginning of the crisis. On the other hand, economic entities which had high percentages of liquid items recorded outstanding results. We show that economic entities which had higher percentages of long-term loans recorded better results than economic entities which mostly had short-term loans.

1. INTRODUCTION

Defining an optimal balance sheet structure for the achievement of the desired ratio between the safety and the success of a business is the constant focus of financial managers within economic entities. The ratio of profitability (which reflects success) to solvency (which speaks of the safe running of a business) confirms that these two are mutually linked, bearing in mind that success brings long-term safety and vice versa. The dynamics of the interdependence of these measures is significantly determined by the structure of the assets and liabilities on the balance sheet of an economic entity. Bearing in mind that there are limited financing sources, as well as constant pressure and challenges to extend the existing sources and make them even more profitable, financial managers face two main types of challenge.

The first type of challenge concerns the nature of investment, since expansion of existing capacities implies a strong investment of liquid assets into fixed assets, thus starting an investment cycle which should result in a market share increase and the profitability of the economic entity. The procurement of assets is frequently financed from loan capital sources, which puts additional pressure on the liquidity and profitability of economic entities. The second type of challenge concerns the nature of speculation, and it implies the procurement of assets. This would occur due to an expected rise in prices, with procurement targets being assets on the markets for which speculative bubbles are formed in times of economic prosperity – this happens in the real estate and securities markets. In both cases, the moment in time when the decision is taken is of the utmost importance.

A period of crisis presents a special temptation, since market corrections are frequent at such a time and are unpredictable in terms of their intensity and duration. The period studied in this paper, from 2008 to 2011, is a specific example, due to the strong market correction in the real estate and securities markets and the drop in interest rates. In this paper we start with an assumption that changes in the structure of financing sources have a statistically significant impact on the profitability of the economic entities we analyzed. In the first part of the paper we will analyze certain factors affecting the profitability of an economic entity, and in the second part we will analyze the impact of the financing source on the profitability of an economic entity. In the last part of the paper we will identify existing

forms of balance structures, and we will illustrate the level of discrepancy in profitability which has been noticed between two forms of financial structure.

2. LITERATURE REVIEW

Recent surveys show that if a high percentage of a business's working capital is invested in real estate, this makes the economic entity sensitive to bad productivity shocks, and hence investors require a premium for having shares in such economic entities [1]. Financially constrained firms in a time of crisis de-lever by selling assets to lower-leveraged firms, which may lead to capital losses, so the system risk they face is higher [2]. The motives for a company to hold cash may be solely of a transactional nature, where an economic entity directs itself towards liquid reserve holdings due to caution about unexpected cash flow variations which might be initiated by the effects of market risk [3]. On the other hand, the motives for a company to hold cash at a level above its transactional needs might be of a financial nature as well. In that case, corporate cash is being used for financing prospective business projects, avoiding an asymmetric information issue between the management and the shareholders, and annulling the transaction costs of obtaining an asset from external sources [4].

The precautionary motive in holding cash indicates that more risky economic entities dispose with higher reserves of cash and cash equivalents [5]. Furthermore, it has been noted that economic entities with worse corporate management have lower levels of cash reserves [6]. Economic entities which are financially constrained tend to increase their cash reserves in recession periods, which results in an increase in the value of their working capital in such circumstances [7]. The question is whether a high percentage of cash makes an economic entity counter-cyclical.

Besides the percentage of assets which are liquid resources, the structure through which resources are sourced has also a certain impact on the profitability of economic entities. Recent surveys which deal with the impact of this structure on the profitability of economic entities affirm that there is a negative connection between debt level and profitability, and a positive connection between solvency and profitability [8]. It is important to emphasize that the time period covered by a survey is crucial for the results which are obtained, and that survey results differ significantly depending on the

territory (state) where the survey has been carried out [9]. Moreover, when analyzing the impact of financial leverage on profitability it is of the utmost importance to analyze the impact of each debt type individually [10]. The main reason for this is that only an analysis like this can provide credible results. On the other hand, it has been found that highly leveraged firms lose a substantial market share to their more conservatively financed competitors in industry downturns because of the indirect costs of financial distress [11]. Our survey, described in the remainder of this paper, was conducted in order to check the accuracy of the aforementioned claims.

3. RESEARCH METHODOLOGY

For the first part of the paper, where we will analyze the impact of the balance structure of economic entities on performance, a random sample of 3,866 economic entities was selected from the category of medium-sized and big legal entities, on the basis of the local legal classification of the size of a legal entity. This sample includes more than 60% of all economic entities in the Republic of Serbia which are classified within this category. For the second part of the paper, where we will analyze the trade-off between bankruptcy risks and profitability for an economic entity, we selected a random sample of 53,996 economic entities from legal entities of all sizes. This sample includes more than 50% of all economic entities registered in the Republic of Serbia.

Financial reports for the economic entities in the samples were collected according to what was needed for the survey. All financial report data were taken from the Serbian Business Registers Agency (SBRA). The percentage of certain balance sheet entries among the assets and liabilities was expressed as a percentage of the total working capital of the business. The analysis comprised those items which are, so far as possible, not affected by the activities of the economic entity and are the following: property, plant and equipment; investment property; cross-holdings; long-term investments; other long-term financial investments; short-term financial investments; cash and cash equivalents; long-term loans; and short-term loans. Stock and sales receivables have been excluded from this list due to their strong connection with the core activities of the economic entity.

In order to include a three-year period in the analysis and to reduce the impact of extra items, we have used the following profitability indicators:

1. Cumulative yield rate to working capital (the sum of all business profit for the three years from 2009 to 2011 divided by the value of the business's working capital at the beginning of 2009); and
2. Cumulative yield rate to capital (sum of all net financial profit over the three years from 2009 to 2011 divided by the value of total capital at the beginning of 2009).

If a particular economic entity had negative capital at the beginning of 2009, the calculation of the indicators would not make sense, so these data were not taken into account. In the first part of the analysis we quantified the connection between the proportion of certain items on the balance sheet and profitability by using the Spearman correlation and partial Spearman correlation methods, while k-means cluster analysis was used in the latter part of the paper. The reasons for the use of non-parameter methods are the breach in the assumption of a normal distribution and to avoid asymptotic yield values to capital in cases where an economic entity has low capital value.

4. RESULTS AND FINDINGS

4.1. Impact of size effect and financing sources on the profitability of the economic entity

The aim of the first survey is the analysis of the impact of the balance sheet structure of an economic entity on its performance. Using the Spearman correlation, we will examine the impact of the size effect and the sources of finance on the profitability of economic entities. Our results are presented in Table 1.

Table 1. Correlation between finance sources and profitability of economic entities

			Total revenue 2008	Total assets 2008	Long- term loans % 2008	Short- term- loans % 2008	Cumulative ROA 2009- 2011	Cumulative ROE 2009- 2011
Spearman's rho	Total revenue 2008	Correlation Coefficient	1.000	.672**	.174**	.121**	.314**	.265**
		Sig. (2- tailed)	0	0	0	0	0	0
		N	3,432	3,432	3,431	3,431	3,431	3,019
	Total assets 2008	Correlation Coefficient	.672**	1	.271**	.127**	.013	-.072**
		Sig. (2- tailed)	0	0	0	0	.456	0
		N	3,432	3,447	3,446	3,446	3,446	3,027
	Long-term loans % 2008	Correlation Coefficient	.174**	.271**	1.000	.247**	.046**	.009
		Sig. (2- tailed)	0	0	0	0	.007	.629
		N	3,431	3,446	3,446	3,446	3,446	3,027
	Short-term- loans % 2008	Correlation Coefficient	.121**	.127**	.247**	1	-.034*	.008
		Sig. (2- tailed)	0	0	0	0	.044	.672
		N	3,431	3,446	3,446	3,446	3,446	3,027
	Cumulative ROA 2009- 2011	Correlation Coefficient	.314**	.013	.046**	-.034*	1	.799**
		Sig. (2- tailed)	0	.456	.007	.044	0	0
		N	3,431	3,446	3,446	3,446	3,446	3,027
	Cumulative ROE 2009- 2011	Correlation Coefficient	.265**	-.072**	.009	.008	.799**	1
Sig. (2- tailed)		0	0	.629	.672	0	0	
N		3,019	3,027	3,027	3,027	3,027	3,027	

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Since a connection between profitability and the working capital of the economic entity, revenue and long-term loans can be noted ($p < 0.05$), those variables will be controlled in the second table. Using the bootstrapping technique for the variable "Short-term loans" on the sample of 1,000, the statistical significance was at the level of 0.104 for Return on Assets (ROA), and 0.674 for Return on Equity (ROE). That variable will therefore not be controlled in the upcoming analysis. ROA does not include the effect of financial leverage, which means that economies of scale and market share are crucial for a strong business outcome for economic entities. A presentation of the results of the partial analysis follows.

Table 2. Connection between profitability and the working capital of the economic entity, revenue and long-term loans

Control Variables	Property, plant and equipment nt % 2008	Investment property nt % 2008	Cross-holdings nt % 2008	Other long-term financial investments nt % 2008	Short-term financial investments nt % 2008	Cash and cash equivalents nt % 2008	Cumulative ROA 2009-2011	Cumulative ROE 2009-2011
Property, plant and equipment nt % 2008	1.000	-.093	-.065	-.006	-.147	-.142	-.154	-.232
Investment property nt % 2008	Correlation 0	1.000	.101	.100	.069	-.010	-.036	-.023
Cross-holdings nt % 2008	Significance (2-tailed) 0	Significance (2-tailed) 0	1.000	.180	.184	-.022	-.036	-.042
Other long-term financial investments nt % 2008	df 3014	df 3014	df 3014	3014	3014	3014	3014	3014
Short-term financial investments nt % 2008	Correlation -.065	Correlation .101	Correlation 1.000	.180	.184	-.022	-.036	-.042
Cash and cash equivalents nt % 2008	Significance (2-tailed) 0	Significance (2-tailed) 0	Significance (2-tailed) 0	0	0	.173	.002	.022
Cumulative ROA 2009-2011	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014
Cumulative ROE 2009-2011	Correlation -.006	Correlation .100	Correlation .130	1.000	.150	.048	-.081	-.093
Total assets 2008 & financial investments nt % 2008	Significance (2-tailed) .732	Significance (2-tailed) 0	Significance (2-tailed) 0	0	0	.008	0	0
Total revenue 2008 & Short-term financial investments nt % 2008	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014
Long-term loans 2008	Correlation -.147	Correlation .069	Correlation .134	.150	1.000	.049	.019	.047
Cash and cash equivalents nt % 2008	Significance (2-tailed) 0	Significance (2-tailed) 0	Significance (2-tailed) 0	0	0	.007	.308	.010
Cumulative ROA 2009-2011	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014
Cumulative ROE 2009-2011	Correlation -.142	Correlation -.010	Correlation -.025	.048	.049	1.000	.179	.173
	Significance (2-tailed) 0	Significance (2-tailed) .579	Significance (2-tailed) .173	.008	.007	0	0	0
	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014
	Correlation -.134	Correlation -.036	Correlation -.036	-.081	.019	.179	1.000	.154
	Significance (2-tailed) 0	Significance (2-tailed) .047	Significance (2-tailed) .002	0	.308	0	0	0
	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014
	Correlation -.232	Correlation -.023	Correlation -.042	-.093	.047	.173	.754	1.000
	Significance (2-tailed) 0	Significance (2-tailed) .211	Significance (2-tailed) .022	0	.010	0	0	0
	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014	df 3014

Analyzing the results in the previous table, we can see that the variables "Property, plant and equipment" and "Cash and cash equivalents" have the biggest impact on the profitability of the economic entities in the sample. Therefore in what follows we will try to explain the reasons for the existence of this correlation between these variables and the profitability indicators. It should be noted that the balance sheet item "Property, plant and equipment" had a significant negative impact on ROA and ROE. In other words, economic entities which had invested more in this item in 2008 had worse results (ROE) during the crisis period (from 2009 to 2011). The reason for this can lie in the high values for the items "Losses relating to sale of property", "Losses relating to sale of plant and equipment" and "Value reduction of material fixed assets". We consider that these items played an important role, since liquid assets are scarce in a crisis period, so economic entities frequently opt for forced sales of property, plant and equipment at much lower selling values than their book values. On the other hand, in such economic conditions the market values of fixed assets fall steeply, which results in a devaluation of fixed assets in financial reports. The negative difference is in both cases shown within the items of the profit and loss statement listed above, and it reduces the net results and accordingly the ROE and ROA.

We note that the impact on ROE is much more noticeable than that on ROA. We think that an explanation for this lies in the reduction in value of the item "Revaluation surplus" in the statement of changes in equity. On a revaluation of fixed assets, which is conducted particularly frequently in a crisis period, the potential reduction in the value of fixed assets will not automatically be recognized in the form of a reduction in active balance sheet items. According to the IFRS (International Financial Reporting Standards), a reduction in the value of fixed assets should be recorded in the form of a reduction to the revaluation surplus by the amount being recognized in previous periods. If the reduction in the value of fixed assets is higher than the reserves then the difference is recognized as expenditure in the profit and loss statement. Therefore, if this occurs, revaluation will affect the net results, the invested property of the economic entity and accordingly the ROA. However, a reduction in

the revaluation surplus does have the effect of reducing the denominator of the ROE – the total owned capital.

Economic entities which had a significant percentage of their business property as "Investment property" in 2008 might have been expected to show a similar impact on ROA as previously explained, but to a lesser extent. The difference here comes from the fact that, according to the IFRS, all reductions and increases in value of investment property after the initial valuation should be booked as income or expenditure. Revaluation surpluses are not formed or used here. The previous statement explains the fact that the strengths of this item's impact on ROA and ROE is approximately the same, but the impact on ROA is more noticeable. The reason for this can be a reduction in the value of investment real estate due to a drop in rents, which is very frequently seen in the economy in a time of crisis.

Economic entities which had invested more in Short-term financial investments in 2008 had a positive change in ROE. The reason for this lies in the fact that these investments were presented as liquid assets which offered financial stability to these economic entities in the crisis period. We noticed a negative correlation between this item and investments in property, plant and equipment, so it can be concluded that short-term investments were used as an alternative to investments in property, plant and equipment, thus preventing losses in business operations. The item "Cash and cash equivalents" had the strongest positive impact on profitability indicators, and cash and cash equivalents were also used as an alternative to investments in property, plant and equipment and offered significant financial flexibility to economic entities. We noted a positive impact of this item on the financial indicators ROA and ROE, as well as that the strength of correlation was almost exactly the same for both indicators.

4.2. Financial leverage impact on risk of bankruptcy and profitability of economic entity

We will present the results of our second survey in this section, where we have primarily tried to analyze the impact of the structure of financing sources on the risk of bankruptcy (default risk) and the profitability of the economic entity. It may be assumed that the risk of an insolvency procedure being started is additionally increased if the economic entity increases its indebtedness; however, the use of borrowed money has its own benefits. In the table below we present data showing the existence of a trade-off between the safety and the profitability of business operations.

Table 3. Profitability of economic entities according to their level of indebtedness

Debt ratio levels	Decrease in revenues %	Cumulative ROE 2009 – 2011	Bankruptcy, restructuring or liquidation	
	Median	Median	No	Yes
			Row N %	Row N %
Debt ratio between 0 and 0.1	-0.73%	3.49%	95.6%	4.4%
Debt ratio between 0.1 and 0.2	-2.81%	17.88%	96.6%	3.4%
Debt ratio between 0.2 and 0.3	-0.45%	19.90%	96.6%	3.4%
Debt ratio between 0.3 and 0.4	-3.43%	20.47%	97.2%	2.8%
Debt ratio between 0.4 and 0.5	-3.92%	23.36%	96.2%	3.8%
Debt ratio between 0.5 and 0.6	-4.90%	23.36%	96.3%	3.7%
Debt ratio between 0.6 and 0.7	-5.95%	25.71%	96.0%	4.0%
Debt ratio between 0.7 and 0.8	-8.20%	30.96%	95.6%	4.4%
Debt ratio between 0.8 and 0.9	-14.21%	32.25%	94.7%	5.3%
Debt ratio between 0.9 and 1.0	-20.79%	37.93%	92.2%	7.8%
Debt ratio more than 1.0	-20.20%	0	86.9%	13.1%

Economic entities which did not have on-going bankruptcy, restructuring or liquidation procedures have been excluded from the columns headed Decrease in revenues % and Cumulative ROE 2009 – 2011. It is noticeable that, as the indebtedness of the economic entities increases, the percentage of those economic entities undergoing bankruptcy proceedings also rises. The assumption that there is a reduction in revenues for economic entities which intensively use financial leverage has been confirmed, due to the indirect costs of financial distress [12]. Table 4. shows analytic data on the frequency of financial distress within economic entities, and includes restructuring and liquidation as forms of bankruptcy proceedings.

Table 4. Profitability of all economic entities including those in bankruptcy according to level of debt

Debt ratio 2008	Bankruptcy		Restructuring		Liquidation		Bankruptcy, restructuring or liquidation		Cumulative ROE 2009 - 2011		Cumulative net earnings 2009-2011	
	No Row %	Yes N %	No Row %	Yes N %	No Row %	Yes N %	No Row %	Yes N %	Mean	Median	Mean	Median
Debt ratio between 0 and 0.1	98.6%	1.4%	100.0%	0.0%	97.7%	2.3%	96.3%	3.7%	-1,048.15%	3.49%	12,271.64	54.00
Debt ratio between 0.1 and 0.2	99.0%	1.0%	99.6%	0.4%	98.6%	1.4%	97.2%	2.8%	43.01%	17.88%	17,872.02	652.00
Debt ratio between 0.2 and 0.3	98.5%	1.5%	99.6%	0.4%	98.9%	1.1%	96.9%	3.1%	73.99%	19.90%	21,015.19	801.50
Debt ratio between 0.3 and 0.4	98.9%	1.1%	99.8%	0.2%	98.8%	1.2%	97.5%	2.5%	55.65%	20.47%	15,965.76	795.50
Debt ratio between 0.4 and 0.5	98.1%	1.9%	99.5%	0.5%	98.8%	1.2%	96.4%	3.6%	47.08%	23.36%	11,583.28	855.00
Debt ratio between 0.5 and 0.6	97.7%	2.3%	99.6%	0.4%	98.9%	1.1%	96.2%	3.8%	54.38%	23.36%	27,459.82	767.00
Debt ratio between 0.6 and 0.7	97.5%	2.5%	99.6%	0.4%	98.8%	1.2%	95.9%	4.1%	44.37%	25.71%	13,722.47	627.50
Debt ratio between 0.7 and 0.8	96.9%	3.1%	99.4%	0.6%	99.1%	0.9%	95.4%	4.6%	45.29%	30.96%	-3,562.20	535.50
Debt ratio between 0.8 and 0.9	95.4%	4.6%	99.6%	0.4%	98.8%	1.2%	93.8%	6.2%	-160.45%	32.25%	-391.80	319.50
Debt ratio between 0.9 and 1.0	91.3%	8.7%	99.0%	1.0%	98.6%	1.4%	88.9%	11.1%	-469.38%	37.93%	-6,919.10	122.00

It should be noted that the legal form of the economic entity shows significant influence on the correlation between bankruptcy and rate of indebtedness. Therefore, in the table below we have presented comparable data for economic entities according to whether or not bankruptcy proceedings have been initiated within these entities in the period 2008-2011.

Table 5. Indebtedness of economic entities according to legal form

Legal form		Debt to total assets 2008	
		No	Median
Closely held corporation	Bankruptcy	No	.4988
		Yes	.7444
Cooperative	Bankruptcy	No	.7587
		Yes	.8928
General partnership	Bankruptcy	No	.7449
		Yes	.9036
Limited liability	Bankruptcy	No	.6921
		Yes	.9163
Limited partnership	Bankruptcy	No	.7573
		Yes	.9377
Other	Bankruptcy	No	.4702
		Yes	1.2653
Publicly traded corporation	Bankruptcy	No	.4995
		Yes	.9322
State owned	Bankruptcy	No	.3749
		Yes	1.3058

The data indicate that the median values of the indebtedness ratio differ according to the type of economic entity. The biggest difference may be found with economic entities which are state owned and classified as "other". The smallest difference is for general partnerships and limited partnerships (when the difference in medians is not statistically relevant, $p > 0.05$). The reason for the lack of statistical relevance for the difference between these median values lies in the fact that economic entities of these two types have the lowest property values. Economic entities with higher property values generally have a lower rate of indebtedness, but they also have a lower standard deviation for their indebtedness rate. Economic entities with total revenues below €232 million in 2008 have an average value for their indebtedness ratio (mean = 0.9654) and standard deviation (Std. Dev. = 0.7093), while economic entities with total revenues higher than €15.529 million in 2008 have an

average value for their indebtedness ratio (mean = 0.6249) and standard deviation (Std. Dev. = 0.299). Moreover, the correlation between whether bankruptcy proceedings are started and the level of financial leverage is much more noticeable within bigger economic entities. The reason for this lies in the fact that bigger economic entities have much better stability in terms of financial leverage and revenue rate (and we previously proved that these two items have a huge impact on the profitability of an economic entity). We noted that voluntary liquidation is very common with smaller economic entities, and in certain cases this presents an alternative to bankruptcy.

In order to identify the prevailing forms of the investing structure of economic entities, as well as to illustrate the size of the effect that property structure and financing source have on the profitability of an economic entity, we conducted sample analysis via the k-means cluster analysis method. The given number of clusters was two, and rates of revenue and business property were not included as variables in this analysis. In the table below you may find the outcome of the analysis.

Table 6. Investing structure of economic entities

Structure	Cluster	
	1	2
Property, plant and equipment % 2008	0.16%	0.59%
Investment property % 2008	0.04%	0.02%
Cross-holdings % 2008	0.05%	0.01%
Other long term financial investments % 2008	0.01%	0.00%
Short-term financial investments % 2008	0.04%	0.02%
Cash and cash equivalents % 2008	0.05%	0.02%
Long-term loans % 2008	0.07%	0.09%
Short-term loans % 2008	0.15%	0.09%

Out of the 3,446 valid items in the sample for this survey, 1,565 economic entities were grouped within the first cluster and the rest within the second. Analyzing the data from the previous table, we may draw the conclusion that two investing methods existed and accordingly were suitable financing sources. The most significant differences in capital structure were in terms of investing in property, plant and equipment and using short-term financing sources (all values in the ANOVA analysis were statistically relevant, $p < 0.01$). Economic entities in the first cluster mostly used short-term borrowing and invested less intensively in property, plant and equipment. On the other hand, economic entities in the second cluster mostly used long-term borrowing and invested more intensively in property, plant and equipment, i.e. more in fixed assets in general.

In the table below you may see the comparable values of the cumulative profitability indicators for the two clusters, as well as the natural logarithm (LN) of the value of business property and total revenues. While the differences in size of the economic entities in the two clusters obtained are not very great, the differences in values of the medians of profitability indicators are very large.

Table 7. Profitability of economic entities from two clusters

	Cluster Number of Case	
	1	2
	Median	Median
Cumulative ROA 2009-2011	0.19%	0.05%
Cumulative ROE 2009-2011	0.49%	0.07%
LN Total assets 2008	12.78	12.74
LN Total revenue 2008	13.13	12.57

The effect of the differences in investment activities of the economic entities in the two clusters is significantly higher when it comes to ROE than for ROA. The explanation for this is that those economic entities that financed procurement of property, plant and equipment from long-term loans had depreciation costs if the market dropped. The other reason may be the expenditure effect of interest rates, and capital losses and devaluation on items of property, plant and equipment, which made the difference in success even bigger.

Having in mind their limited resources, economic entities opted for investment in fixed assets and capacity expansion, or for liquid reserve holdings, which reflects the negative correlation coefficients between these items that were noticed previously. From this result we may draw the conclusion that investing in property, plant and equipment was the alternative to almost all other investments, and that long-term sources were mostly borrowings.

5. CONCLUSION

In this paper we confirm that there is a statistical relationship between the percentage of certain positions in assets structure and the financing source of the economic entity, and that they have an impact on the profitability of an economic entity. We have shown the outcome of an analysis of the impact of asset structure on profitability: economic entities which faced the crisis with more liquid property had better results, in difficult economic conditions, than economic entities which faced the crisis with major investments in fixed assets. Furthermore, it turned out that the size of an economic entity was a key factor for the achievement of a high ROA. That means that all the advantages which large legal entities have, being economies of scale, better market position, etc, positively affect the level of the profitability indicator. Besides the size of the legal entity, the structure of investment (i.e. whether the economic entity has enough cash or has overinvested in property, plant and equipment) is also very important for the achievement of a high ROE rate. We have illustrated the effect of two different patterns of financing structure and investment on the profitability of the economic entity. Moreover, we have confirmed the findings from previous researches which indicated that economic entities that, in a time of crisis, extensively used financial leverage had a disproportionally high reduction in revenue due to the influence of the indirect costs of financial distress.

6. REFERENCES

- [1] **S.Tuzel**: *Corporate real estate holdings and the cross-section of stock returns*, Review of Financial Studies, Vol. 23 No. 6, (2010) 2268-2302, ISSN: 0893-9454
- [2] **V. V.Acharya, S. Viswanathan**: *Leverage, moral hazard and liquidity*, The Journal of Finance, Vol.66 No. 1, (2011) 99-138, ISSN: 0893-9454
- [3] **S.Ross, R.Westerfield, J. Jaffe**: *Corporate Finance*, McGraw-Hill, ISBN 978-0072831931, New York, 2002.
- [4] **S.Myers, N. Majluf**: *Corporate financing and investment decisions when firms have information that investors do not have*, Journal of Financial Economics, Vol. 13 No.2, (1984) 187-221, ISSN: 0304-405X
- [5] **V. V Acharya, S.A. Davydenko, I.A. Strebulaev**: *Cash Holdings and Credit Risk*, National bureau of economic research, Working Paper No. 16995, (2011)
- [6] **J. Harford, S.Mansi, W.Maxwell**: *Corporate governance and firm cash holdings in the US*, Journal of Financial Economics, Vol.87 No.3, (2008)535-555, ISSN: 0304-405X
- [7] **M. Ferreira, C. Custodio, C. Raposo**: *Cash Holdings and Business Conditions*, Retrieved November 04, 2012, from Social Science Research Network: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=608664
- [8] **A. Bevan, J. Danbolt**: *Capital structure and its determinants in the UK: A decomposition analysis*, Applied Financial Economics, Vol.12 No. 3, (2002)159-170, ISSN: 0960-3107
- [9] **L. Weill**: *Leverage and Corporate Performance: A Frontier Efficiency Analysis on European Countries*. Retrieved November 09, 2012, from Social Science Research Network:http://papers.ssrn.com/sol3/papers.cfm?abstract_id=300640
- [10] **J. Goddard, M. Tavakoli, O. Wilson**: *Determinants of profitability in European manufacturing and services: Evidence from a dynamic panel mode*, Applied Financial Economics, Vol.15 No.18, (2005) 1269-1282, ISSN: 0960-3107
- [11] **T. Opler, S. Titman**: *Financial distress and corporate performance*, The Journal of Finance, Vol.49 No. (3), (2012) 1015-1040, ISSN: 0893-9454
- [12] **J. Stiglitz, A. Weiss**: *Information imperfections in the capital market and macroeconomic fluctuations*, American Economic Review, Vol.74 No.1, (1984) 194-199, ISSN: 0002-8282

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IS THERE SKILL BIASED TECHNOLOGICAL CHANGE? EVIDENCE FROM AGGREGATE PRODUCTION FUNCTION OF CHINA

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Key Words: Skill-Biased Technological Change; Aggregate Production; Nonlinear panel model

Abstract : *The paper makes an empirical study on the presence of the skill biased technological change with China's panel data from 2002-2010 based on aggregate production and nonlinear panel data estimate. It points out that there is skill biased technological change in China. China's technology can conduct skill demand growth, So the skill premium is increasing. While the fact that it is difficult to be employed remind us to enhance the quality of university students on the basis of the Quantitative expansion.*

1 INTRODUCTION

Since 1980s, the labor market structures and the compensation structure have undergone a profound change in the developed nations such as the USA. That is, the "growing together" from the midst of 1970s has evolved into "the growing apart". The great divide among different qualities of labors has gradually increased, which is considered as the result of the gap of education returns. Based on Mincer's equation, Goldin, Claudia, and Lawrence F. Katz. (2007)'s estimate on return to education in 1980 and in 2005 shows that the return of high school students has increased from 0.063 to 0.072, it has increased by 0.9%. While college educational return has increased by 5.3% from 0.076 to 0.129. Autor et.al.(1998)'s Skill-Biased Technological Change viewpoints have offered one convincing explanation for rising college premium in the condition of Continued expansion of higher education period or increasing of supply of high quality labor. The other researchers such as Welch(1970), Tinbergen (1975), Bound & Johnson(1992), Goldin & Katz(1995), Johnson(1997), Berman, et.al.(1998) have further clarified that the capital-skill complementarity based on elements of microcosmic configuration level can be regarded as one of the most convincing evidences to explain college premium increasing and high or low skilled staff income divide.

China has started the expansion of higher education programs since the late 1990s. "The Revitalizing Plan of the Twenty-first Century Education", "The Decision of Deepening Educational Reform and Comprehensively Promoting Quality Education", "Higher Education Law of the People's Republic of China" and other relevant policies are as the marks, then China's higher education has expanded quickly. The university enrollment in 1999 increased by 47.32% more than the last year; thereafter, the average annual rate of 28.58% continued to increase until 2010, the scale of college students reached 6,618,000. The scale of higher education has been more than Russia, India and the United States, and jumped to the first in the world. But Accompanied by an increase in college students and the labors with higher education synchronously, higher education returns are still maintained a rising trend(Qi Liangshu, 2005; Xuesong Li and James J. Heckman, 2004). Based on a treatment control framework, Wu Yao-wu and Zhao Quan (2010) assessed the influence of Higher Education expansion on the college premium since 1999. The result is that university graduates and high school graduates have obvious income gap, and the university remains a lucrative investment. Accordingly, can the experience study of the developed country explain this phenomenon in China? In other words, in the process of China's economic growth, does the technology display the feature of Skill -Biased Technological Change? Then in the premise of capital-skill complementarity, will the salary structure divergent and the college premium appear?

Griliches (1969) provided evidence from U.S. manufacturing data suggesting that capital and skilled labor are relatively more complementary as inputs than are capital and unskilled labor. Griliches referred to this finding as the "c

apital-skill complementarity" hypothesis. At the beginning of the "capital-skill complementarity" hypothesis being proposed, the United States of America and other developed countries were highly concerned about it at first. Most scholars use the manufacturing data as well as the cross-sectional data on the macro-level of the labor market to test this hypothesis. Such as Caselli and Coleman(2000), Krusell et al. (2000), Hollanders & Basterweel (2002), John Duffy & Chris Papageorgiou(2004) and etc, their conclusions have something in common, that is why did the proportion of employment of high skilled labor increased since 1980s? and why did the income inequality between high and low skilled labors became worse and worse in the labor market of the USA and other developed countries? Griliches' hypothesis has received renewed attention lately, as the US and other developed nations have invested heavily in "skill-biased" information technology and this development appears to have coincided with a rise in the wages earned by skilled workers relative

to the wages of unskilled workers.

Thereafter, the empirical test of Skill -Biased Technological Change began deepening gradually. John Duffy & Chris Papageorgiou(2004) consider the nonlinear estimation methods for panel data, and used two-level CES production function specification and panel data pieced together for 73 developed and less developed countries to testify this hypothesis. They argued that at the aggregate production function level, there is little evidence to support the capital-skill complementarity hypothesis. One possible explanation is that capital skill is complementary or alternative degree along with the phase change of economy development. Another method commonly used to verify the capital-skill complementarity is not to choose the aggregate production function, but to use the data of microcosmic industry or enterprises. Berman et al. (1998) are based on the manufacturing data of 7 OECD national manufacturing industry under the assumption that the exogenous decision of technology and price elements to verify the existence of capital-skill complementarity by absorbing the technical progress factor directly into the cost function. Nina (2000) also used this method to validate the existence of capital-skill complementarity in Chilean manufacturing industry. Hollanders & Basterweel(2002) validated the existence of capital-skill complementarity in Holland manufacturing industry. From the present researches based on the non-aggregate production function to verify the capital-skill complementarity hypothesis, the related researches have almost got consistent evidence.

However, Goldin and Katz (1998) have recently reminded us that physical capital and skilled labor have not always been viewed as relative complements. they suggest that capital-skill complementarities, to the extent they exist, may only be transitory phenomena that change with changes in production processes. As countries progress through various stages of development, skilled labor may change from being relatively more substitutable with capital and unskilled labor to being highly complementary to these two inputs. It therefore seems important to consider the evidence for capital-skill complementarity over long periods of time and across countries at different stages of development. Therefore, considering the capital-skill complementarity should give full consideration to the development of economy in different stages. Berman and Machin (1994), Robbins & Pavcnik (2003) argued that skill -biased technological change has been diffused from developed countries to middle income countries, and some developing countries begin to show the trait of skill -biased technological change.

Later, some scholars began to apply the similar research framework to Chinese samples. Yao Xianguo, et. al.(2005) based on the enterprises level data of manufacturing industry in Zhejiang province by taking the method similar to Berman et. al. (1994) and Machin (1998) have verified the existence of capital-skill complementarity in China. They think, Chinese enterprise technical progress to some extent exhibits skill-bias feature, which leads to the demand increase of the skilled labor in enterprises, and the skilled labors occupy the proportion of employment and their income increases. Sheng Xin(2011) used Pavcnik and Hamermesh model and 29 Regional Panel Data from 2003-2007 years in China to validate the existence of capital-skill complementarity. Song Dong lin (2010) makes an empirical study on the presence of the skill biased technological change with China's data from 1978 - 2007. It points out that China's technology can conduct skill demand growth, and make the structure of labor market variable and the skill premium, namely there is skill biased technological change in China.

However, the present study focusing on the skill-biased technological change is based on linear homogeneous production framework, that is to say, under the assumption of constant returns to scale to test the existence of capital-skill complementarity in China. However, Wang Jun hui (2008) emphasizes that the assumption of constant returns to scale does not apply to Chinese economy, and the increasing returns is universal in the process of economic growth. Therefore under a more general framework of production function to

validate the skill-biased technological change, the result can provide a more rational approximation for the real economy.

In addition, the scholars are mainly based on Berman, et. al. (1994) and Machin (1998) method which adopted linear logarithmic measurement model to directly inspect the impact of technology progress on the wage ratio or demand ratio between skilled and non-skilled. However, this method is based on the assumption that markets are perfectly competitive, enterprises take maximize profit for the decision-making target, and in a perfectly competitive market the wage is equal to the marginal product of a labor. While the competitive markets assumption may seem reasonable for developed countries, it may be less reasonable for developing countries where factors may be less mobile and markets less complete.

Finally, in various types of Statistical Yearbook of China, economic census data and economic database, there are neither the wage data according to the classification of education level, nor the wage statistics according to occupations. Different skill labor wage data are crucial to validating the skill-biased technological change.

In view of the above consideration, this article attempts at a more relaxed constraints, referring to the methods of Fallon and Layard (1975), John Duffy & Chris Papageorgiou (2004), and based on the aggregate production function, to utilize China's Regional Panel data to test the existence of our capital-skill complementarity. This paper is structured as follows: the second part is the theoretical model; the third part is estimation procedure and data; the fourth part is the estimate results; the last part is the conclusion.

II. The Theoretical Model

Suppose aggregate output, Y , is given by a three-factor production technology. Where K denotes the physical capital stock, S denotes the quantity of skilled labor and N denotes the quantity of unskilled labor. Denote by $\sigma_{i,j}$ the elasticity of substitution between inputs i and j . Elasticity of substitution is defined as the ration of the change rate of two factors' proportion to the marginal rate of technical substitution. By definition, the quantity of skilled labor and the capital elasticity of substitution can respectively be written as:

$$\sigma_{K,S} = \frac{d(K/S)}{(K/S)} \cdot \frac{d(MP_S/MP_K)}{(MP_S/MP_K)}$$

$$\sigma_{K,N} = \frac{d(K/N)}{(K/N)} \cdot \frac{d(MP_N/MP_K)}{(MP_N/MP_K)}$$

And in form, they can be written as:

$$\sigma_{K,S} = El_{R_{K,S}}(K/S) = \frac{R_{K,S}}{K/S} \cdot \frac{\partial(K/S)}{\partial(R_{K,S})}$$

$$\sigma_{K,N} = El_{R_{K,N}}(K/N) = \frac{R_{K,N}}{K/N} \cdot \frac{\partial(K/N)}{\partial(R_{K,N})}$$

$El_x(z)$ denotes X 's elasticity of Z , and $R_{i,j} = \frac{F_j}{F_i}$ is the Marginal

Rate of Technical Substitution inputs i and j . When $\sigma_{K,N} > \sigma_{K,S}$,

by using the definition of elasticity of substitution, we can get $\frac{\partial(F_S/F_K)}{\partial(K/S)} \cdot \frac{1}{SF_S} > \frac{\partial(F_N/F_K)}{\partial(K/N)} \cdot \frac{1}{NF_N}$. At last, using the chain

rule one can show that $\frac{F_{S,K}}{F_S} > \frac{F_{N,K}}{F_N}$, $F_{i,j}$ is the cross-partial

derivative, then we can get:

$$\frac{F_{S,K}}{F_S} > \frac{F_{N,K}}{F_N} \Leftrightarrow \frac{\partial}{\partial K} \left(\frac{F_S}{F_N} \right) > 0. \text{ And } \frac{\partial}{\partial K} \left(\frac{F_S}{F_N} \right) > 0 \text{ means}$$

when increasing the physical capital and compared with unskilled labor, the Marginal product of skilled labor will increase faster, that is to say, the capital skill-complementarity occurs. Therefore, if we want to prove the existence of the capital skill-complementarity, we

Because of lack of data, Chinese scholars mostly adopt approximate alternative: for example, Dong-lin Song (2011) adopts the ratio of the average wage of staff in manufacturing industry to that in agriculture, forestry, animal husbandry and fishery to reflect the wage premium of high and low-skilled labor. But in the Census Labor Data in 2000, there are 7372380 people in manufacturing industry, whose education level is less than high school, and who occupies the entire manufacturing workforce as high as 88%. At the same time, there are 251062 people who received college or higher education in agriculture, forestry, animal husbandry and fishery. So the concept that the ratio of wage among industries is taken as the labor skill premium is debatable. In addition, about the measurement of the key variable technology progress, there are no unified standards in the domestic scholars. { Song Dong-lin (2011) uses DEA method to calculate Malmquist, Sheng Xin (2011) uses the number of patents, R&D expenditure and total volume of import and export trade to measure, and Xian-guo Yao (2005) uses the ratio of the total value of imported machinery equipments to the equipment value of machines to measure. }.

only need to prove $\sigma_{K,N} > \sigma_{K,S}$. In order to assess the extent of

capital-skill complementarity, we must work with a functional form that is general enough to accommodate different elasticities of substitution. Fallon and Layard[7] use the following production function of two-level CES form:

$$Y = A[a(bK^\theta + (1-b)S^\theta)^{\frac{\rho}{\theta}} + (1-a)N^\rho]^{\frac{1}{\rho}} \quad (1)$$

where A is a positive technological parameter, a, b are distribution parameters and $\theta, \rho \leq 1$ are the elasticity of substitution parameters.

By using the definition of the elasticity of substitution, and according to Model (1), we can easily get:

$$\sigma_{K,S} = \frac{1}{1-\theta}, \sigma_{K,N} = \sigma_{N,S} = \frac{1}{1-\rho}, ; \text{ and therefore we only need}$$

to prove $\rho > \theta$. If so, the "capital-skill complementarity" hypothesis is true. Although some foreign scholars propose the expanded version and restrictive version of Model (1), see e.g. [8、17] prove that Model (1) is the preferred specification to test the capital skill complementarity based on the aggregate production function. Therefore, based on the data availability and results' practicability, the following version of two-level CES form is concerned in this paper:

$$Y_{ij} = A[a(bK_{ij}^\theta + (1-b)S_{ij}^\theta)^{\frac{\rho}{\theta}} + (1-a)N_{ij}^\rho]^{\frac{m}{\rho}} \quad (2)$$

Model (2) is easily testified that it is m -order homogeneous function, where m is the Returns to scale factor, i, j denote section and time respectively. In order to analyze the increase of college premium from the perspective of skilled-labor demand, then based on the regional panel data of China, this thesis implements the nonlinear panel estimation technique on Model to verify the existence of capital skill-complementarity. In order to distinguish the utility between different areas, considering the random disturbance factors, we set the random effects μ_{it} (the random effects), though the fixed effects can also be set from the theoretical model. However, as to the fixed effects, increasing 30 regional dummy variables will decrease the efficiency of nonlinear estimation. It is more important that in our unsteady transition economies, the random effects are more in line with the economic reality. Considering the speed of technological progress, the production function of two-level CES form is as follows in the empirical test:

$$Y_{ij} = A \left\{ a \left[b(K_{ij})^\theta + (1-b)(S_{ij})^\theta \right]^{\frac{\rho}{\theta}} + (1-a)N_{ij}^\rho \right\} e^{\lambda t + \mu_i} \quad (3)$$

Based on Model (3), if $\rho > \theta$, it can prove the skill is skill biased. This thesis will carry out empirical test based on Chinese data.

III. Estimation Procedure and Data

As to the two-level CES production function, and due to its nonlinearity, direct estimation requires the programming of precision algorithm. Therefore, many scholars, such as Stokey [19], Goldin and Katz [11], mention it's restricted edition in order to simplify the difficulty. While some scholars, use Taylor series linearization method proposed by J.Kmenta for indirect estimation. The two-level CES linearization processing requires twice Taylor series expansion, even if only expanding to the second order each time; so for the model recognition, high order must be eliminated, and the serious multicollinearity will be faced with. Even though most scholars use ridge regression estimation techniques to address the multiple collinear problems, ridge regression is at the expense of non-bias, and then the deviation between the estimation value and the real value is apparent. Because of its nonlinear estimation difficulties, the nonlinear estimation method of two-level CES function is not widely used in China, especially based on the panel data of two-level CES nonlinear estimation, the novelty of this thesis is not only based on the precision algorithm to implement the nonlinear panel estimation, but also before the nonlinear estimation uses the usual linearization method to implement ridge regression estimation, and then takes ridge regression as the initial value of nonlinear estimation. Through the comparison of the estimated value of two kinds of methods, the severe errors can be caused by linearization processing. This thesis is trying to get the precise verification of skill -biased technological change.

1. Theoretical Basis of the Linearization Estimation Method of Two-level CES Model

The first level of Model (3) is :

$$Y_{ij} = A \left\{ a(Y_{i,j})^\rho + (1-a)N_{ij}^\rho \right\} e^{\lambda t + \mu_i} \quad (4)$$

The second level is:

$$Y_{i,j} = \left[b(K_{ij})^\theta + (1-b)(S_{ij})^\theta \right]^{\frac{1}{\theta}} \quad (5)$$

Take formula (5) 's natural logarithm and be based on $\theta = 0$ to expand to the second order of Taylor, then the result is:

$$\ln Y_{i,j} = b \ln(K_{ij}) + (1-b) \ln(S_{ij}) + \frac{1}{2} \theta b(1-b) [\ln(K_{ij}) - \ln(S_{ij})]^2 \quad (6)$$

Take formula (4)'s natural logarithm and be based on $\rho = 0$ to expand to the second order of Taylor, then put the expansion formula to (6), and at last, the following linear equation will be got:

$$\begin{aligned} \ln Y_{ij} = & \ln A + mab \ln(K_{ij}) + ma(1-b) \ln(S_{ij}) + m(1-a) \ln N_{ij} + \\ & \frac{1}{2} \rho ma(1-a) [\ln(S_{ij}) - \ln(N_{ij})]^2 + \\ & \left[\frac{1}{2} \theta mab(1-b) + \frac{1}{2} \rho ma(1-a)b^2 \right] [\ln(K_{ij}) - \ln(S_{ij})]^2 + \\ & + \rho ma(1-a)b [\ln(S_{ij}) - \ln(N_{ij})] [\ln(K_{ij}) - \ln(S_{ij})] + \\ & + \frac{1}{2} \theta \rho mab(1-b) [\ln(S_{ij}) - \ln(N_{ij})] [\ln(K_{ij}) - \ln(S_{ij})]^2 + \\ & + \frac{1}{2} \rho ma(1-a) \theta b^2 (1-b) [\ln(S_{ij}) - \ln(N_{ij})] [\ln(K_{ij}) - \ln(S_{ij})]^3 + \end{aligned}$$

$$+ \frac{1}{8} \rho ma(1-a) (\theta)^2 b^2 (1-b)^2 [\ln(K_{ij}) - \ln(S_{ij})]^4 + \lambda t + \mu_i \quad (7)$$

In order to reduce the computational complexity and multicollinearity, the high order and cross terms should be omitted, and then the result is:

$$\begin{aligned} \ln Y_{ij} = & \ln A + mab \ln(K_{ij}) + ma(1-b) \ln(S_{ij}) + m(1-a) \ln N_{ij} \\ & + \frac{1}{2} \rho ma(1-a) [\ln(S_{ij}) - \ln(N_{ij})]^2 + \\ & \left[\frac{1}{2} \theta mab(1-b) + \frac{1}{2} \rho ma(1-a)b^2 \right] [\ln(K_{ij}) - \ln(S_{ij})]^2 \\ & + \lambda t + \mu_i + \varepsilon_{ij} \quad (8) \end{aligned}$$

2. The Nonlinear Panel Estimation of Two-level CES Model

In order to precisely verify the existence of skill-biased technological change in China, the second step of the empirical estimation is to implement the nonlinear panel estimation on Model (3). Accordingly, both sides of the natural logarithm in Model (3) are taken first and the result is:

$$\ln Y_{ij} = \ln A + \frac{m}{\rho} \ln \left\{ a \left[b(K_{ij})^\theta + (1-b)(S_{ij})^\theta \right]^{\frac{\rho}{\theta}} + (1-a)N_{ij}^\rho \right\} + \lambda t + \mu_i + e_{ij} \quad (9)$$

Where, i donates the region, j donates the year and $\mu_i \sim N(0, \sigma^2)$ donates a random effect term. $e_{ij} \sim N(0, \sigma^2)$ is the error term. Because the complexity of Model (9) and the nonlinearity of parameter, direct estimated parameters are unable to use OLS estimation, and therefore, the marginal maximum likelihood is used to estimate. Because the common method of solving the nonlinear optimization is to find the iterative optimization algorithm, in this paper we choose Quasi-Newton Method. The (dual) quasi-Newton method uses the gradient, and it does not need to compute second-order derivatives since they are approximated. It works well for medium to moderately large optimization problems where the objective function and the gradient are much faster to compute than the Hessian; but, in general, it requires more iterations than the TRUREG, NEWRAP, and NRRIDG techniques, which compute second-order derivatives. QUANEW is the default optimization algorithm because it provides an appropriate balance between the speed and stability required for most nonlinear mixed model applications.

In order to control the unobservable effect in some regions, the random effect is set in the model. An important part of the marginal maximum likelihood method described previously is the computation of the integral over the random effects. Because the random effect term is put into Model (9) in the form of linear, and when we implement the marginal maximum likelihood, we choose the adaptive Gaussian Quadrature method. It approximates a given integral by a weighted sum over predefined abscissas for the random effects. A good approximation can usually be obtained with an adequate number of quadrature points as well as appropriate centering and scaling of the abscissas. This paper tries to search step 0.05 in Quasi Newton iteration of one dimensional linear. Based on the above nonlinear panel, the marginal maximum likelihood estimate program can be realized through the SAS NLMIXED package.

3. THE DATA

Using the perpetual inventory method created by Goldsmith in 1951 computes the physical capital stock K_{it} , then the following result can be got: $K_t = (1 - \delta)K_{t-1} + I_t$, where the investment I elects the Gross fixed capital formation and where the depreciation rate fixed at 0.096. Because of the perpetual inventory method definition, the sooner the base period is chosen, the smaller the effects of the base year capital stock estimation error on the follow-up years will be. According to data availability and comparability, this thesis takes 1952 as the base year. The output variable Y_{it} is denoted by GDP in each region, and is deflated by GDP index to the base year 1952. About skilled(unskilled) labor, there is no a uniform standard in the literature, but most of the studies consider those who receive university education are more efficient than those who receive high school or lower education. In order to analyze the change of college premium from the perspective of

demand, we have chosen the number of employees with university education or above as the proxy for skilled labor, and the number with high school or lower education as the proxy for unskilled labor.

The above data are taken from the "Statistical Yearbook of China", "Labor Statistical Yearbook of China", "Statistic Information in 55 years of New China". In addition, since the base year of physical capital stock has chosen 1952, Because the higher education in China has a huge expansion occurring in 1999, the wage effect, employment effect and technical characteristics will appear in 2002 or future years after the expansion of enrollment. Therefore, we choose 30 regional panel data (Chongqing will be incorporated into Sichuan.) in China to verify empirically from 2002-2010.

IV. Results

Table 1 Model (9) Results Based on the Ridge Regression Estimate

Explanatory Variable	Coefficient	Standard Deviation	Value of P
$\ln k$	0.3531185	0.017590	0.000***
$\ln s$	0.2667946	0.0132315	0.000***
$\ln n$	0.2458186	0.0204725	0.000***
$(\ln k - \ln s)^2$	0.0181437	0.0027585	0.000***
$(\ln s - \ln n)^2$	-0.023967	0.00421	0.000***
t	0.0317625	0.010544	0.003***
$\ln A$	1.054477	0.211889	0.000***
R^2	0.8509		
Likelihood Function	-124.5494		

Note: *** represents the significance at the 1% level.

In Table 1, the Model fits very well, and is generally significant, and each estimate coefficient is significant below the 1% level. From the output elasticity of the three input factors, we can see the capital output elasticity of China in present stage can reach a maximum of 35.3%, which is roughly equivalent to the conclusion drawn by references[18-19], but is lower than the research conclusion drawn by Zhao Zhiyun [20]¹. The existing literature is mostly based on constant returns to scale and assumes to calculate the element elasticity, while whether the premise constraints are reasonable or not is to be verified. Most studies are based on the framework of C-D production function; the Model implies that each element has the elasticity of unit substitution, which obviously does not meet the realistic economic condition. Considering estimate technology, model selection and sample period could lead to estimate bias, our small capital output elasticity explains, to some degree, that the capital has been deepening during the improvement of overall labor skills in China, and the extensive economic growth mode in the initial stage of reforming and opening transforms to intensive economic growth mode. Relative to skilled and unskilled labor, China's economic growth is mainly driven by material capital at present stage. Moreover, the conclusions drawn from the model description, theoretical hypothesis and the different samples are not comparable. In this thesis, the calculation results are the output elasticity of skilled labor is 26.68%; the minimum of unskilled labor is only 24.58%; when the number of skilled labor increases 1%, its promoting effect on the economy is 12 percentages higher than the unskilled labor. It is expected that skilled labor can promote economic growth, which also reflects the value of knowledge. The estimated parameters are converted to the original nonlinear model parameter according to the above deduction, as shown in Table 2.

Zhao Zhiyun and others (2006), under the assumption of constant returns to scale based on nonparametric local linear from 1978- 2004 in China, estimate that the output elasticity of capital is 0.56 on an average, and the output elasticity of labor is 0.44 on an average; and based on the C-D production function they estimate the output elasticity of capital is 0.69, the output elasticity of labor is 0.31. Guo Zhiyi, Cao Jianyun (2007) also use ridge regression estimate technology with the consideration of the institutional factors, also based on the C-D function they estimate during 1979-2004 our country output elasticity of capita is 0.368.

1. Ridge Regression Estimate

The key step of the ridge estimate is the selection of ridge parameter, so the paper considers the following aspects: the stability of every parameter to be evaluated, the slight increase of residual square and the ridge trace diagram shape and the economic meaning of each coefficient. From ridge trace diagram 1, we can see each regression coefficient begins to stabilize approximately after $k=0.15$; in diagram 2, the coefficient of determination and related graphs of show that after $k=0.15$ the coefficient of determination shows regularly slow decline, and has no obvious fluctuation. So then, we implement the ridge regression of $k=0.15$ on Model(9), and the estimate results are shown in table 1.

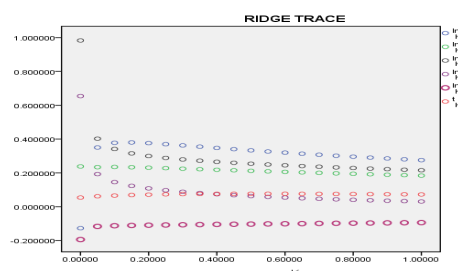


Chart1

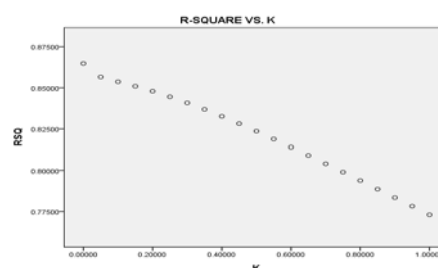


Chart 2 R-Square vs. K Ridge Trace

From Table 2, we can get the following conclusions: first, from the distribution parameters of elements, we can get when $a=0.716057$, the output of skilled labor share is $a(1-b)=0.3$, which is little different from the output elasticity of skilled labor 0.2458. This conclusion is basically the same with Marshall's, a representative of new classic and integrated school: under the hypothesis of the enterprise profit maximization, the proportion of output that enterprise labor income accounts for should be as same as the labor elasticity in the enterprise production technology. The output share of capital is $ab=0.407885$, which is higher than the output elasticity of capital 0.3531, and the output share of unskilled labor is 0.283. In the output of the distribution of elements, the highest share is the output of capital, second is the output of skilled labor, and the minimum share is the output of unskilled labor. Considering the larger proportion of the unskilled labor, it's apparent that the college premium is prominent.

Table 2 The Original Parameter Estimate Value of Ridge Regression

Parameter	A	λ	m	a	b	ρ	θ
Estimate Value	2.870474	0.0317625	0.865732	0.716057	0.569626	-0.27232	-0.34112
Elasticity	E_k	E_s	E_N	$\sigma_{K,S}$		$\sigma_{K,N} = \sigma_{S,N}$	
Estimate Value	0.3531	0.2668	0.2458	0.745647		0.785965	

Note: E_k , E_s , E_N , $\sigma_{K,S}$, $\sigma_{K,N}$ respectively represent the output elasticity of capital, the output elasticity of skilled labor, the output elasticity of unskilled labor, the substitution elasticity of skilled labor and capital, and the substitution elasticity of unskilled labor and capital.

Second, the output elasticity of labor is significantly higher than that of unskilled labor. On average, the number of university education labor increases by 1% each, which can spur economic growth by 26.68%; the number of high school education labor increases by 1% each, which can boost economic growth level by 24.58%. There are different effects between two types of human capital on economic growth. The estimate values of elastic parameters ρ , θ further validate our judgment. The substitution elasticity of skilled labor and capital is 0.745647; the substitution elasticity of unskilled labor and capital is 0.785965; the substitution elasticity between skilled labor and unskilled labor is 0.785965. These show that compared to the unskilled labor, the skilled labor is more irreplaceable, that is $\rho > \theta$, which is significant in statistics. And from the perspective of aggregate production function, we can get the evidence of capital-skill complementarity, or it can be said that China's current technological change is skill biased. In such an economic body, the increase of skilled labor is the urgent demand of technological change. Based on the supply-demand framework, we can find when other factors are unchanged, the trend of skill-biased technology change is bound to increase the wages of skilled labor. Significantly, the coefficient is 0.03176, which shows the technological progress in our country increases at the speed of

3.176%.

However, although the above estimation is feasible in the theory, the linearized model is the approximation of the real two-level CES model, then based on the real two-level CES model, is there still the capital-skill complementarity in China? Next, based on the region panel data in China from 2002-2010, we implement the nonlinear panel estimation on Model (9) under the SAS NL MIXED package.

2. Maximum Likelihood Estimation of Nonlinear Panel Two-level CES

Next we use the Quasi-Newton to implement of maximum likelihood estimation, and due to the more parameters to be estimated, the joint density is difficult to optimize, then we use the marginal distribution to calculate step by step. When calculating the marginal distribution, the Adaptive Gaussian Quadrature method is adopted. The Initial values select each estimated value of parameter from the results of ridge regression in Table 2, the initial value of σ^2 selects the residual sum of squares of ridge estimate, and we set boundaries between [0, 1] for the elements distribution parameters a , b and the growth rate of technological progress period λ . The specific iterative process and condition of convergence, estimate results are shown in Table 3.

Table 3 The Iterative Process of Quasi-Newton of Nonlinear Panel Estimation

Iteration	Calls	NegLogLike	Diff	Max Grad	Slope
1	2	574.0582	618.2935	18.15373	-17231.8
2	4	553.6081	20.4501	15.075	-3.36597
3	6	553.0513	0.556826	65.10371	-1825.8
4	8	544.0343	9.016984	8.802433	-7.48168
5	9	538.8361	5.198141	27.23136	-7.2773
6	10	530.3498	8.486311	67.3775	-6.1856
7	11	520.8087	9.541143	285.7077	-54.6084
8	12	511.9288	8.879931	52.14327	-365.539
9	16	483.2337	28.69503	167.2085	-87.7041
10	21	470.138	13.09571	173.0983	-100.907
11	25	461.618	8.520056	69.30115	-21.5329
12	27	457.9021	3.715833	80.69153	-7.33462
13	30	450.8512	7.050934	17.26468	-5.43987
14	115	448.2289	2.622307	12.25299	-8.92703
15	172	448.2289	7.39E-13	12.25299	-1906.93

NOTE: FCONV convergence criterion satisfied.

Note: Iteration, Calls, NegLogLike, Diff, Max Grad, Slope respectively represent the numbers of iteration, the numbers of call function, the value of objective function, and the difference between adjacent function values, the maximum of absolute(projected) gradient components and each iterative direction.

According to FCONV (relative function convergence criterion), when the nonlinear model iterates 15 times, the call function

achieves convergence when reaching 172 times. The parameter estimate results are shown in table 4.

Table 4 Estimate Results of Nonlinear Panel of Model (9)

Parameter	Estimate	Standard Error	DF	Probit>t	Ridge regression estimate
A	40.3696	5.0619	239	<.0001	2.870474
m	1.7665	1.089	239	0.1061	0.865732
a	0.7285	0.4822	239	0.1322	0.716057
b	0.9038	0.1995	239	<.0001	0.569626
θ	-3.264	1.2954	239	0.0124	-0.34112
ρ	-0.7291	0.126	239	<.0001	-0.27232

λ	0.6207	0.02902	239	<.0001	0.0317625
σ_ε^2	1.18E-12	0.0000	239	<.0001	0.170239
σ_μ^2	2	0.1852	239	<.0001	—

Compared with the ridge regression results, nonlinear estimate results confirm the existence of capital-skill complementarity on our regional level. Because the regional random disturbance is introduced, we can more accurately grasp the technical characteristics on macro level. The random disturbance variance is remarkable at 1% level, which shows there are great regional differences in China, and these differences fluctuate randomly. After controlling the regional differences, the overall technological characteristic in China is the trend of increasing returns to scale, and the scale factor is 1.7665. but obviously our ridge regression estimate result is low, which does not match the present stage of economy growth in China. Compared with the existing literature of scale research on economy, the nonlinear estimate result is more reliable. Endogenous growth theory thinks that the increasing returns to scale is composed of the technological progress and manpower capital accumulation, and the technological progress is the results of the deepening of labor division and the improvement of professional level. Our sample period coincides with a huge expansion in higher education, the structures of labor education having an apparent change, and the labor ratio of university education increasing. Therefore, the increasing returns to scale can be caused by the following factors: one is caused by the knowledge accumulation, which promotes the productivity of RD manufacturers, and reduces the production costs; the product diversification improves the productivity, so that the production of the final products exhibits increasing returns to scale. On the other hand, the spillover effect of the investment of human capital, the effect of learning by doing and training lead to increasing returns to scale. In China after a huge expansion of higher education, the improvement of human capital and the spillover effect of knowledge lead to the change of technological progress. This also means that at present our country's resource configuration is optimized, the human capital accumulation brought about by educational expansion becomes the source of the improvement of capital allocation efficiency. The macro-control policy is reasonable. The mode of economic growth has changed from the extensive development mode at the beginning of reform and opening-up policy to the intensive growth mode or extension type. This is consistent with the Lucas' (1993): the human capital accumulation through "learning by doing" in developing countries is the main source of increasing returns to scale. Therefore, we think as to the developing countries like China, the externality of "learning by doing" plays an important role in the formation of the increasing returns to scale.

The output elasticity of elements and element contribution in our country have been a focus of academic debate, but the writer has no intention of intervening in these debates, just in the process of looking for the evidence of capital-skill complementarity, gets the element elasticity in a relative sense. But in any case we still get the evidence of capital-skill complementarity, which further confirms the expansion of higher education has brought about economic growth effect. The substitution elasticity of capital and skilled labor is 0.234522, which is significantly less than the substitution effect of capital and unskilled labor 0.578336, and shows that skilled labor is irreplaceable. The main meaning of capital-skill complementarity is as the capital stock growing, the marginal output of skilled labor increases, while the marginal output of unskilled labor reduces. According to the wage decided theory, the wage growth of skilled labor necessarily is faster than that of unskilled labor. This is from the perspective of labor demand to analyze the reason why the college premium rises in China, and to some extent explains why the current wage income continues to expand in China.

However, since china presents the feature of skill -biased technological change at a national level, technological progress inevitably increases the demand of college labor, so how can we explain the fact of the difficult employment of college students? Look at a group of data: according to the statistics of "Statistical Yearbook of Chinese Labor", in 1996 the national staff with college degree or above account for 2.8%, in 2000 for 4.5%, in 2010 for 10.1%; while the urban employment with college education accounts for 20.3%. Meanwhile there is another fact that the national unemployed with college degree or above account for 4.6% in 1996, and the people with junior high school degree account for 57%, which is the largest proportion. The unemployed personnel at the age of 20-24 and with college degree or above account for 8.4%, and at the age of 25-29, the unemployed with college degree or above account for 3.1%. In all the unemployed with college degree or above, those at the age of 50-54 account for 15.4%, which is the largest proportion. This group of data has dramatically changed in

2010: among the national employed, those with college degree or above account for 20.3%; those at the of 20-29 and with bachelor's degree account for the largest proportion, reaching 27.1%; then viewing the reasons for unemployment, having no job after graduation accounts for the highest, up to 27.2%. With the expansion of higher education and skill-biased technological change, although the demand for college students is increasing, at the same time, the average employment rate of college student becomes more difficult. Does the higher education expand excessively? Are college students superfluous? However, in 2010 the proportion of college graduates is less than 9% per 100,000 populations in China, far less than the developed country. The expanding enrollment plan has not yet met the demand for higher education, and even the presence of excess of college students "is relative. The possible explanations are as follows:

First of all, at the same time of the expansion of college students' quantity, does some college students' ability drop? The university expansion can let more people receive university education, and since June 1999 china began the implementation of the national student loan policy, the students, with high ability but without enough money to afford to the university, can enter the university after the expansion, while a number of students with lower ability compared with the former colleges students can also go to the university. The higher education expansion could make the capacity distribution have some changes between university degree group and high school degree group, and then do the unemployment college students have lower ability? The ability correction model, based on the British students' proportional growth of Robin A. Naylor and Jeremy Smith (2009), shows the average ability variation of college students and non-college students weakens the impact of demand. Taber's (2001) studies have also suggested that when evaluating the college premium and employment of college students, the ability bias should be fully taken into account. In addition, Lai Desheng (2001) argues that the imbalance of educational structure and employment structure in this period of transition, and the disconnection between the allocation of educational resources and market are the main reasons why the college students' are "relatively superfluous". The difficult employment of university graduates is relative, with the characteristics of transition and structure. Consequently the education departments should accelerate the reform of the educational system as soon as possible, realize the change from the examination-oriented education to the quality education, and strengthen the exchanges between universities and enterprises. Finally, from college students to find their own reasons, the skill -biased technological change influencing the employment is not a simple sort according to the education degree, and the employment status and prospect depend on their work type. Zeng Xiangquan (2004) argues that students would rather wait than work in the developing areas, and most of the students think that their qualification is higher than the average, resulting in overall a highly expected income level. This overestimation of Chinese college students is far beyond the United States, Switzerland and other European countries. Based on the above reasons it is not difficult to understand the coexistence of China's current skill-biased technological change and the difficult employment of college students.

6. CONCLUSION

By using 30 regional panel data from 2002-2010 in China and based on the two- level CES production function to implement the nonlinear panel estimation technique, this paper empirically verifies the existence of the skill-biased technological change in China. Research shows that at present stage our country technology presents skills-biased features, and the high skilled labor is more irreplaceable than the low skilled labor. An increase in the supply of college students is the urgent demand of technological progress. However, at present stage the skill-biased technology does not achieve the effective joint with the supply of college students and solve the problem of difficult employment of college students, so the future expansion policy should continue to adhere to the quality improvement of college students on the basis of the volume expansion, gradually improving the supply contradiction of the quantity and quality of labor force, and the imbalance of economic growth and labor matching structure; striving to improve the adaptability of workers on the technological progress and new and high- tech application; finally realizing the coordinating development of technological progress, education premium and employment. As for how to use international experience for reference to measure

accurately the relative demand for two kinds of labor at present stage, taking into account an accurate measurement of college premium based on the ability bias, and evaluating to what extent China's current higher education expansion can be optimal will be our further research directions.

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REFERENCE

- [1] Claudia Goldin, Lawrence F. Katz, 2007, "Long-Run Changes in the Wage Structure: Narrowing, Widening, Polarizing." Brookings Papers on Economic Activity, 2, 135-165.
- [2] Autor, David, Alan Kuerner and Lawrence Katz. 1998, "Computing Inequality, have computers Changed the Labor Market?" Quarterly Journal of Economics, 113(4), 1169-1214.
- [3] Berman, E. J. Bound and S. Machin. 1998, "Implications of Skill-Biased Technological Change: International Evidence" Quarterly Journal of Economics, 113, 1245-1279.
- [4] Wu Yao-wu and Zhao Quan, 2010, Higher Education Expansion and Employment of University Graduates, Economic Research Journal, (9):93-108.
- [5] Griliches, Z. 1969. Capital-Skill Complementarity. Review of Economics and Statistics 51, 465-468.
- [6] Goldin, C., & Katz, L. F. 2007, "Long-run changes in the US wage structure: narrowing, widening, polarizing" (No. w13568). National Bureau of Economic Research.
- [7] John Duffy, Chris Papageorgiou, and Fidel Perez-Sebastian, Capital-skill complementarity? Evidence from a panel of countries, The Review of Economics and Statistics, 86(1), 327-344. (2004).
- [8] Caselli, F. and W.J. Coleman II. 2000, "The World Technology Frontier", NBER Working Paper No. W7904.
- [9] Krusell, P., L.E. Ohanian, J.-V. Rios-Rull and G.L. 2000, "Violante Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis", Econometrica 68, 1029-1053.
- [10] Fallon, P.R. and P. R. G. Layard. 1975, "Capital-Skill Complementarity, Income Distribution, and Output Accounting", Journal of Political Economy 83, 279-302.
- [11] Berman, E. J. Bound and S. Machin. 1998, "Implications of Skill-Biased Technological Change: International Evidence," Quarterly Journal of Economics 113.
- [12] Yi Gang, Fan Gang and Li Yan, 2003, "A Theoretical Analysis on Economic Growth in China and Total Factor Productivity", Economic Research Journal, (8):13-20.
- [13] Goldin, C. and L.F. Katz, 1998, "The Origins of Technology-Skill Complementarity", Quarterly Journal of Economics 113, 693-732.
- [14] Pavcnik N. 2003, "What explains skill upgrading in less developed countries", Journal of Development Economics, 71, 311-328.
- [15] Yao Xian-guo, Zhou Li, Lai Jun, 2005, "technology Change, demand for Skill and Employment Structure: An Empirical Test on the Skilled-biased technological change Hypothesis Based on Micro-data of Manufacturing Sector", Chinese Journal of Population Science, (5):47-53.
- [16] Sheng Xin, Hu An-gang, 2011, "Empirical Study on the Impact of Technical Change on Human Capital Structure of Employment in China: Based on the Panel Data of 29 Provinces", Science of Science and Management, (6):172-179.
- [17] Song Dong-lin, Wang Lin-hui and Dong Zhi-qing, 2010, "Is There Skill Biased Technological Change? Evidence from China", Economic Research Journal, (5): 68-81.
- [18] Wang Jun-Hui, Hou Fang-Yu, 2008, "Constant or Increase Returns to Scale: An Empirical Study on China and Five OECD Countries", Journal of Finance and Economics, (8):6-14.
- [19] Stokey, N.L. Free Trade, 1996, "Factor Returns, and Factor Accumulation", Journal of Economic Growth 1, 421-447.
- [20] Wang Huo-gen, Shen Li-sheng, 2007, "A Spatial Panel Statistical Analysis on Chinese Economic Growth and Energy Consumption", The Journal of Quantitative & Technical Economics, (12):98-107.
- [21] Guo Zhi-yi, Cao Jian-yun, 2007, "An Empirical Study on the Influences of Human Capital on Regional Economic Growth: based on the method of Ridge Estimation Used in Multiple co-linearity Data", Chinese Journal of Population Science, (4):42-49.
- [22] Zhao Zhi-yun, Liu Xiao-lu, Lu Bing-yang, 2006, "Estimating the Output Elasticity of Factors In China, Economic Theory and Business Management", (6):5-11.
- [23] Taber, C., The Rising College Premium in the Eighties: Return to College or the "Return to Unobserved Ability? Review of Economic Studies, 68, 665-691. (2001).
- [24] Lai De sheng, Segmentation of labor Market and Graduate Unemployment, Journal of Beijing Normal University (Social Science) (4):69-76. (2001).
- [25] Zeng Xiang-quan, Job Seeking of college Graduates In Employment environment under Transition, Economic Research Journal, (6): 87-95. (2004).

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EXCEL FILE FINANCIAL FRAUD FORENSIC ANALYSIS – CASE STUDY

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Key words: fraud, financial accounting, financial fraud, forensic accounting, forensic investigation

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Abstract: As current business practices are changing, leaving more room for fraudulent activity, the new field of forensic accounting emerged. Fraud is growing and can be a huge problem for a business or a government entity. Most frauds involve financial matters, so accountants are the most useful people to investigate them. Forensic accountants are specially trained to investigate and report fraud in courtroom. For this reason, forensic accountants are often called fraud investigators or fraud examiners. Despite the fraud takes many forms, usually it is theft of funds or information or misuse of someone's assets. In this paper, we detailed a case of Excel file financial fraud forensic analysis. We outline some of the difficulties involved in tracing a fraudster by using some different approach than those well described in classic forensic examination such as postmortem, data mining and other techniques [5, 8, 20, 4]. In forensic examination step we used open sourced Deft 7.1 Digital Evidence & Forensic Toolkit [22] and verified results by another forensic tool, Meld - a visual diff and merge tool for compare files and directories. We refer to our process as combined digital forensic and accountant investigation. We conclude by discussing some future work that needs to be done before this approach can be properly evaluated.

1. INTRODUCTION

Generally, fraud includes wide range of illegal acts mainly based on intentional deception. Despite fraud takes many forms, it is always theft of funds or information or misuse of someone's assets that can cause loss of money, legal costs, investor confidence, and reputational damage. The fraud includes two subcategories: most significant - *financial* and fairly insignificant - *nonfinancial*. Financial fraud related to receivables, vendor, payroll and expense has become a common phenomenon inside many companies [6]. Most of the financial statement scandals involve some kind of revenue manipulation that is usually occurring in the client's books. The most common financial fraud is related to revenue overstatement. Companies simply invent revenues, as a credit or debit, producing faults balance sheet and income statement [9, 23].

So, an accountant and auditor have to look for this type of fraud throughout the internal control and audit processes. In this context, *forensic accounting* plays an important role in detecting these frauds that are not discovered in internal auditing process. Sometimes, forensic accounting is called as *forensic analytics*, meaning the analysis of digital data in order to detect, recover and reconstruct them or otherwise support or denied a claim of financial fraud. The main steps in forensic analytics are *data collection, preparation, analysis and reporting* [17].

2. FINANCIAL AUDITING AND FORENSIC ACCOUNTING

In *internal auditing process* the basic objective is a regular audit focused on a sample of transactions, and checks whether the information disclosed by the financial statements is supported by adequate material, and makes remark in audit report in case of any deviation, error, exaggerated assertions etc. [23]. Some auditing tools, such as CAATs (*Computer Assisted Auditing Tools*) [10], are currently used to deal with big financial data sets, process complex transactions and help auditor in implementing auditing procedures, such as [23]:

- Testing details of transactions and balances,
- Identifying inconsistencies and transaction's fluctuations,
- Sampling programs to extract data for audit testing,
- Testing general and application control of computer, and
- Redoing calculations performed by the accounting systems.

Forensic accounting differs from regular financial auditing, searching only for suspicious transactions, using a strict digital

forensic process [5, 20]. Employing forensic, accounting and auditing investigative skills, the *forensic accountant's* job consists of identifying, recording, settling, extracting, sorting and reporting exceptions, oddities, irregularities and suspicious transactions, and verifying digital financial data and other accounting activities, with the purpose to make evidence for legal process [1]. Unfortunately, there is no standard procedure to discover these frauds, as each fraud is a specific case. So, forensic accountant or *fraud investigators* or *fraud examiners* [17] can be defined as an accountant who assists with the financial fraud, prepared for, or heard in court. Sometimes he may be referred to as a *litigation support accountant* and act as an expert witness at trial [2, 13]. If an accountant wants to become *forensic accountant* he must take a variety of courses in financial and advanced accounting, and one or two courses in auditing and some other courses such as [2, 23]:

- **Forensic accounting:** Applied digital forensic to the accounting.
- **Computers:** Including accounting software (such as QuickBooks, SAP, Oracle...)
- **Law:** Basics of business, civil and criminal law as well.
- **Statistics:** The principles of *chance* or *odds* in the examined transactions.
- **Economics:** Behavioral economics for quantifying damages in litigation.
- **Psychology:** How to handle people, as an advisor?
- **Ethics:** If someone's acts within the limits of the law but is still wrong.
- **Languages:** If a criminal speaks a different language.
- **Criminology:** To understand how the fraudsters work.

To become a *forensic accountant*, someone needs to have a forensic accounting and fraud investigation certificate, issued by one of several professional associations such as *Certified Public Accountant* (CPA) or *Certified Forensic Examiner* (CFE) or *Certified Forensic Financial Analyst* (CFFA) etc. [2]. The *Network of Independent Forensic Accountants* (NIFA) is a grouping of qualified forensic accountants [1].

3. FINANCIAL FRAUD FORENSIC ACCOUNTING

Fraud can be manifested as a crime, corporate, management and occupational fraud, person's dishonesty and *intentional*

deception etc. Therefore, fraud, theft, irregularities, white-collar crime and embezzlement are almost synonyms [23]. The main factors that influence someone to commit a fraud are shown in the Figure 1.



Figure 1: The fraud triangle [23]

Pressure or motivation refers to something from the fraudster's personal life that motivates him/her to steal. *Rationalization* is how do fraudsters justify their criminal actions? *Opportunity* is perpetrator's position of trust or a weakness in, or absence of internal controls that provides the circumstances for fraudster to commit a crime [23].

4. REVIEW OF SOME KNOWN FORENSIC ACCOUNTING APPROACHES

Forensic accountants can use some mathematical models, such as *Benford's Law* and *Relative Size Factor (RSF)*, as well as *data mining* techniques [4].

The *Benford's Law*, as a duplication program, runs using Microsoft Excel 2007 on Windows XP. *The basis of this law is that fabricated figures (an indicator of fraud) possess a different pattern from random (or valid) figures* [4]. Despite of having few advantages, the Benford's law has many limitations. The detailed description is done in book [16]. The *Relative Size Factor (RSF)* detects unusual data that may be caused by errors or frauds [4].

The exponential growth of *big data* and technology [11], complex financial transactions and smarter fraudsters pose huge problems to the forensic accounting technique. So, some advanced techniques such as *data mining* can help forensic accountants, to [4]. Some of the general characteristics of fraudulent data transactions patterns that can be discovered by specific data mining tools are as follow [4]:

- Unusual variables or entries of transactions.
- Unusually high or low value of a variable.
- Accounting transactions are maintained in various files.
- Unexplained values of two or more unrelated records.

4. FORENSIC ACCOUNTING CASE EXAMINATION

As the most frauds involve financial matters, so the most logical people to investigate them are accountants. However, sometimes fraud can be very complex and a digital forensic examiner has to be involved in investigation. Otherwise, accountants have to be specially trained for digital forensic.

The very first task in forensic accounting is to apply digital forensic procedures for collection, preservation, acquisition, analysis and reporting digital evidences in courtroom [5, 8, 15, 19, 20]. However, financial fraud involves deliberately overstating assets, revenues and profits or understating liabilities, expenses, and losses, in such way that the forensic examiner can't understand properly. So expertise of the professional accountant could be inevitable. When forensic examiner and accountant together investigate financial fraud, they should go into digital and other evidences and look for so called *red flags* or accounting warning signs from all of the data sources, such as [7, 12]:

- Revenue recognition earlier than a product was sold;
- Unusually high revenues and low expenses at the balance;
- Growth in inventory that does not match growth in sales;
- Capitalization of expenses in excess of industry norms;
- Reported growing earnings as cash flow is declining;
- Far greater growth in revenues than in other companies;
- Gross margins out of line with peer companies;
- Unusual increases in the book value of assets;
- Impossible to determine the transaction actual nature;
- Changed or deleted invoices in the financial books;
- Written off loans to executives or other related parties etc.

Following a standard investigative methodology is crucial to successful and effective computer forensic [5, 8, 23].

- Protect authenticity of the data sources.
- Discover and recover all files needed for investigation.
- Analyze the collected data and create the chain of custody.
- Summarize findings, and make a log of all extracted data.

In typical financial fraud crime case, forensic examiner need to take forensic image of the accounting computer and software, and keep one copy as reference and other one as working copy [19, 20]. So, forensic examiner can parse information from the user's *RecentDocs Registry* key, and the key that listed Excel spreadsheet from the Outlook temporarily file (*.pst*) and other file server where users could possibly store data in regular backup process. In next step he can extract metadata and see recent modification dates and who has opened or edited or printed spreadsheet. These metadata includes time stamps correlated to file system and *Registry time stamps*, too [17]. The following data can be saved as hidden information inside MS Excel documents metadata [3, 14]:

- The names/initials of user, computer and company
- The name of the server or HD where user saved data
- Other file properties and summary information
- Non-visible portions of embedded OLE objects
- The names of previous authors and document revisions
- Hidden text and hidden cells
- Globally Unique Identifiers (GUIDs), etc.

Unfortunately, according to Microsoft's Knowledge Base [18] it is too difficult (if not impossible) to prove when an individual cell or sheet has been modified in a MS Excel file, especially if the *track changes* are not enabled previously.

But sometimes forensic accountant could be given Excel or another spreadsheet file to be examined. So, document analysis must be involved to find out how many times the file has been "revised", and when the last editing occurred, and the name of the user account that performed the last editing, as well as the last time it was printed etc. [14, 17].

In this case, the main accountant from the company "X" has given to the forensic examiner two MS Office Excel files, only - one from the ledger at the time of auditing, and the other one from the backup copy file. The forensic requirements did not include Excel metadata analysis. Also, *software forensic*, that can be used to identify its author [6], can't be easily applied to Excel, as financial fraud could include only one number. So, the forensic examiner regularly checked size of both files and realized that they were the same. Then he used open sourced *DEFT 7.1 digital evidence and forensic toolkit* [22], verified file signature and applied *file comparison* technique. Applying these techniques on the sheets with the thousands of entries is very useful, because it reports on the differences between the cells on separate sheets. The forensic examiner compared both Excel files without metadata (*.csv* format); using their MD 5 hash values (Figure 2).

```
[root@localhost Documents]# ssdeep original.csv > hash.log
[root@localhost Documents]# ssdeep -bm hash.log manipulacija.csv
manipulacija.csv matches hash.log:/home/nenad/Documents/original.csv (99)
```

Figure 2: Files comparison using MD 5 hash values

The hash values prove that those files are not the same, as shown in Figure 2. Checking percentage of the files similarities, using technique of *homogenous files discovery by segmented hashing*

method initiated with content (Figure 3), was the next step [21].

```
[root@localhost Documents]# ssdeep original.csv > hash.log
[root@localhost Documents]# ssdeep -bm hash.log manipulacija.csv
manipulacija.csv matches hash.log:/home/nenad/Documents/original.csv (99)
```

Figure 3: Homogenous files identification by segmented hashing initiated with content method

So, 99% of the two files similarities are identified, suggesting that a small change has been made in one of the two files.

The forensic examiner used *Diff* file comparison utility that

displays differences between the two files, made per line for text files (Figure 4) [22].

```
[root@localhost Documents]# diff original.csv manipulacija.csv
5020,5022c5020,5022
< 4817.,05/17/2012,50058,61320 PRIH.OD USLUGA NA INOST TR ,96, , , "1,000,000.00",
< 4818.,05/17/2012,50058,20300 POTRAZIV.OD KUPACA U INOST ,20, , "1,000,000.00",
< , , ,UKUPNO ZA NALOG: , , , "1,000,000.00","1,000,000.00",
> 4817.,05/17/2012,50058,61320 PRIH.OD USLUGA NA INOST TR ,96, , , "100,000.00",
> 4818.,05/17/2012,50058,20300 POTRAZIV.OD KUPACA U INOST ,20, , "100,000.00",
> , , ,UKUPNO ZA NALOG: , , , "100,000.00","100,000.00",
```

Figure 4: Application of *Diff* utility to find out differences between the two files

Results of the *Diff* tool application are shown in the Figure 4. The two differences, identified in the rows no. 5020 and 5022, have been changed (red arrows) in the backup file. The forensic examiner verified the proof using another forensic tool, *Meld*. This tool, using a GUI interface, verified differences among files and displayed discovered ones. Despite it is slower than *Diff* tool; it

displays more clear results (Figure 5). As shown in Figure 5 the two changes are displayed and the number of 1,000 000 has been changed with 100 000 one. So, main accountant accepted these evidences as a proof that the suspected accountant has made these changes.

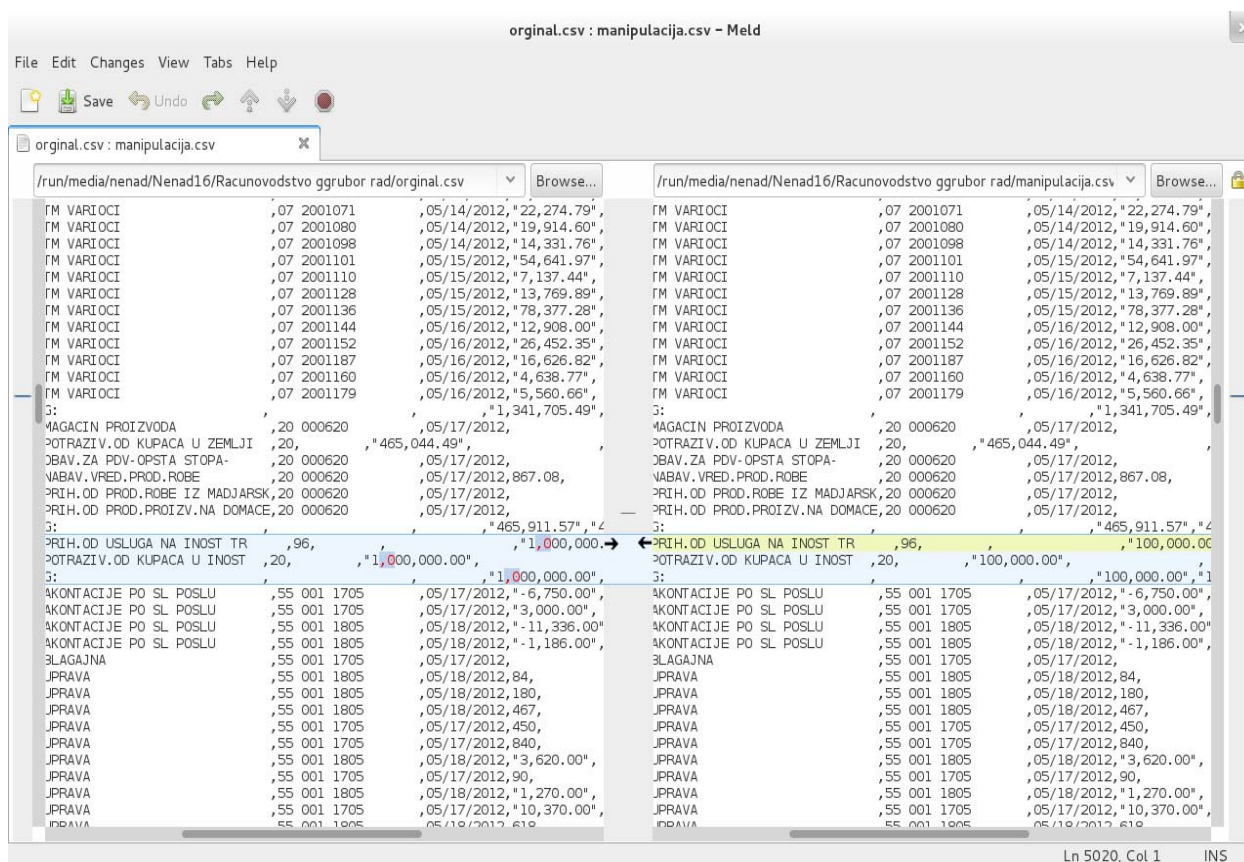


Figure 5: Files comparison using Meld tool

5. FORENSIC ACCOUNTING CASE RECONSTRUCTION

As it was case of internal corporate investigation, after

forensic examination, the main accountant of the company "X" took over this forensic report in order to reconstruct the case. According to the internal audit in the company "X" at the end of 2012 year,

financial auditor realized some differences between two financial reports - one reported as half year balance and another one as final financial report. Thus, for the first half of year (2012) the company's recently employed accountant has already made the financial records that have been approved by internal auditor. Meantime, the main accountant has become suspicious about some activities of the recently transferred and employed accountant. Therefore, he ordered taking backup of ledger as mandatory at the time of final report. In accordance with company's backup rule - to keep backup files outside of the company, the related accountant copied the ledger in Excel file onto his removable hard drive and he brought it to his house. Later on, the accountant changed, at the same time, some data on the backup file and replaces them instead of already reviewed ledger files. Since these data have been already approved at the first half of year (2012) and the changes decreased greatly debts of the company „F“, the accountant has received some money from the debtor. When he bought a new car, manager of the company „X“ has become suspicious and ordered internal investigation by main accountant who hired forensic examiner as a consultant to help them.

6. CONCLUSION

Forensic accountants and fraud auditors must know the fraud process very well. They must know how perpetrators are doing fraud and the characteristics of the various fraud schemes. This information enables them to perform effectively their investigation or fraud prevention programs. These fraud schemes are a major part of the critical knowledge it takes for fraud auditors and forensic accountants to do an effective job. Another major part is the understanding of the red flags associated with these fraud schemes.

Forensic accounting is the better way to protect accounting files or logs unchanged than just audit them. It can prove which users accessed what files, which changed or deleted them, who copied what and where? File integrity is paramount for every governing regulation and is part of every company security or digital forensic policy.

In this paper forensic examination of financial fraud is proved by use of the two forensic tools, *Diff* and *Meld*. In this fraud examination two problems are identified. First, accounting Excel files did not have *Track changes* activated, and, second, accountant's database server wasn't available to the examiner. This case of the corporate fraud investigation proved that both forensic examiner and financial accountant together give the best results in financial fraud examination. Forensic examiner followed strict forensic investigation procedure, as the case could end in the courtroom. Financial accountant performed analysis of forensic examination results, reconstructed fraud case and proved main accountant's suspicious.

For confirmation of the financial accountant and digital forensic examiner preferable team work, much more financial fraud cases should be investigated and analyzed in future. According to the authors opinions, both digital forensic examination and financial accounting are quite complex to be investigated by the same person. Probably, very few people could do alone any typical financial fraud investigation properly.

7. REFERENCES

- [1] B. K B Kwok, *Forensic Accountancy*, 2nd editions, LexisNexis, 2008.
- [2] D. Winch, *Finding and using a forensic accountant*, <http://www.accountingevidence.com/documents/articles/Forensic%20accountant1.pdf>, October 2007.
- [3] D. Kernan, *Hidden Data in Electronic Documents*, GIAC GSEC Practical (v.1.4b, Option 1), SANS Institute InfoSec Reading Room, 2004.
- [4] Dr. P.K. Panigrahi, *Discovering Fraud in Forensic Accounting Using Data Mining Techniques*, 1426 The Chartered Accountant, April 2006.
- [5] E. Casey, *Digital Evidence and Computer Crime, Third Edition: Forensic Science, Computers and the Internet*, ISBN-10: 0123742684, Academic Press, 2006.
- [6] E. H. Spafford, S. A. Weeber, *Software Forensics: Can We Track Code to its Authors?*, Purdue Technical Report CSD-TR 92-010, SERC Technical Report SERC-TR 110-P, Department of Computer Sciences, 1398 Computer Science Building, Purdue University, West Lafayette, IN 47907-1398, 19 February 1992.
- [7] F. Kass-Shraibman, Vijay S. Sampath, *Forensic Accounting For Dummies*, 2009.
- [8] H. Carvey, *Windows Forensic Analysis DVD Toolkit*, Ch. 8, pg. 411, Syngress Publishing. Inc. ISBN 13: 978-1-597-422-9, 2009.
- [9] <http://en.wikipedia.org>, *Forensic accountant*, (accessed at 10 of May 2013)
- [10] http://en.wikipedia.org/wiki/Computer-aided_audit_tools_CAATs (Accessed 20.02.2013)
- [11] IBM, *Big data at the speed of business*, <http://www-01.ibm.com/software/data/bigdata>, (accessed at May 2013)
- [12] J. Seward, R. Winters, *Forensic Accounting - the recorded electronic data found on Computer Hard Disk Drives, PDAs and numerous other Digital Devices*, LLC NY 10016, JSeward@RWCPAs.com, 2013.
- [13] J. R King, *Document Production in Litigation: Use an Excel-Based Control Sheet*, National Association of Valuation Analysts, March 4, 2009.
- [14] J. R. Jones, *Document Metadata and Computer Forensics*, James Madison University Infosec Techreport, Department of Computer Science, JMU-INFOSEC-TR-2006-003, 2006.
- [15] Jones, J. K., Bejtlich, R., Rose, W. C., *Real Digital Forensics - Computer security and incident response*, Addison-Wesley, 2008.
- [16] M. Nigrini, *Benford's Law : Applications for Forensic Accounting, Auditing, and Fraud Detection*, ISBN: 978-1-118-15285-0, John Wiley & Sons, Inc., 2012.
- [17] M. Nigrini, *Forensic Analytics: Methods and Techniques for Forensic Accounting Investigations*, ISBN: 978-0-470-89046-2, Wiley and Sons, 2011.
- [18] Microsoft Knowledge Base, *How to minimize metadata in Microsoft Excel workbooks*, Article ID: 223789, Revision: 5.1, 2007.
- [19] M. Milosavljević, G. Grubor, *Computer Crime Investigation*, University Singidunum, 2010.
- [20] M. Milosavljević, G. Grubor, *Computer System Digital Forensic*, University Singidunum, 2009.
- [21] N. Ristić, A. Jevremović, M. Veinović, *Homogenous files identification by segmented hashing initiated with content*, Telecommunications forum TELFOR 2012, 20-1665-1668.
- [22] S. Fratepietro & all, *DEFT 7 Manual*, <http://en.wikipedia.org/wiki/Diff>, 2013.
- [23] T. W. Singleton, A. J. Singleto, *Fraud Auditing and Forensic Accounting*, Fourth Edition, John Wiley & Sons, Inc., 2010.

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MODEL SYSTEM FOR REMOTE CONTROL AND MONITORING IN PUBLIC LIGHTING

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Key words: Remote control and monitoring, public lighting, model, PLC, communication



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Abstract: By using the system for remote monitoring and control of public lighting is achieved by rational and economical exploitation of street lighting and lighting of roads and intersections, efficient system maintenance and energy savings of 30-50%. Since the world of lighting consumes about 20% of the total electricity produced, telemanagement imposes a serious concept of energy saving. Also, by increasing the energy efficiency of public lighting, reduced CO₂ emissions, which is in line with the EU Directive on Environmental Protection (EN-2002/93/76 EEC). The paper will present the effects of energy savings, as a model system for remote monitoring and control of public lighting, which is expected economical and rational exploitation of public lighting.

1. INTRODUCTION

The paper presents a model system for remote control and monitoring of public lighting. The system is organized so that from one center you can monitor and control the entire lighting belonging to a given system, but you can also manage certain parts of the system (group of lamps or each lamp individually). The system has the ability to send commands, verify that the given command was executed as well as receive information on the current situation / status of lamps.

2. THE EXPERIENCE OF OTHERS

Experiences from developed countries tell us that the remote control and monitoring of public lighting in accordance with the EU directive on the protection of the environment, we will give the solutions only in some developed countries:

- *Echelon's Smart Street Lighting Solution*

Echelon's Smart Street Lighting Solution transforms streetlights into intelligent, energy-efficient, remotely managed networks that deliver dependable lighting at 30% less cost than low-energy luminaires alone. The city of Oslo, a Clinton Foundation Climate Initiative best practices example, reduced energy consumption by 62 % with Echelon's Smart Street Lighting Solution. In China, 500,000 smart streetlights using Echelon power line technology will come online by 2014, with an expected energy reduction of 55 % [2].

- *Maxim Powerline Communications for Street Lighting Automation*

The savings with PLC technology are seen in reduced energy usage and operational costs, which can be substantial. Consider an example of a new PLC system. The technology is currently used for tunnel lighting by Nyx Hemera Technologies. Its tunnel-lighting control system (TLACS) is delivering energy savings of 25 % for fluorescent lighting and reducing maintenance cost by 30 %. It greatly improves safety by matching the illumination level to the outside at the entrance and exit of tunnels [3].

- *Norway – E street project*

Over the last 5 years Hafslund ASA, the street lighting operator in Oslo, in corporation with Oslo Municipality-street department, has

been testing and implementing the most advanced intelligent street lighting in the world. By using electronic dimming gear and power-line communication each luminaires are individually controlled, monitored and manipulated to both save energy and increase safety level for the ordinance. Energy savings of 30 % [5].

3. MODELS

Model A - Lighting regulators

This model can programmatically turn lamps on or off in a whole transformer area and also monitor the lamps. Regulation of luminous flux is done at the entire transformer area with the regulation of the output voltage. The model works on the principle of pulse-width modulation. By applying this model energy savings of 20% can be achieved. The disadvantage of this solution is that this model can not be applied to mixed network of public lighting where lamps are installed with different light sources (for example, by reducing the output voltage, lamps with Hg light source would turn off at 200 V, while the lamps with NAVP light source would still shine and turn off on 185 V.

Model B - System for lamp lines controlling

This model can remotely manage and control public lighting on a level of one lamp line. Programmatically, according to a pre-defined scenario, the system turns lamp lines on and off and controls the lamp lines and the input voltage. Savings achieved by this model are about 10%. The disadvantage of this model is that the reduction of luminous flux can be done only by adding five vessels through a two-stage electronic ballast, which is an additional cost.

Model C - System for remote monitoring and controlling lamps using ZIG BEE technology.

This model provides continuous power control of lamps. Communication with the lights is done wirelessly by using ZigBee Meshnet topology, and a RF antenna that should be placed on each lamp pole and it has to have a good line of sight. By applying this model saving of 30 to 40% are achieved.

Model D - System for remote monitoring and controlling lamps using PLC technology

This model programmatically turns every individual lamp on and off and shows the current status and working history of each lamp. This model can continuously regulate power of the lamps. Communication with the lights is done by PLC modem through the low voltage network. By applying this model, saving of 30-35% are achieved. This paper will present the effects of energy-saving of model D, because it is expected that this model can achieve the most economical and the most rational exploitation of public lighting.

4. SYSTEM ARCHITECTURE

The system consists of a control center, several modules for data acquisition and a number of modules for the measurement and management of lights. This system allows a two-way communication - control and monitoring [1]. System for remote control and monitoring of public lighting is made of (Figure 1):

- Control Center (CC)
- Hub (HU)
- Lamps management module (LMM)

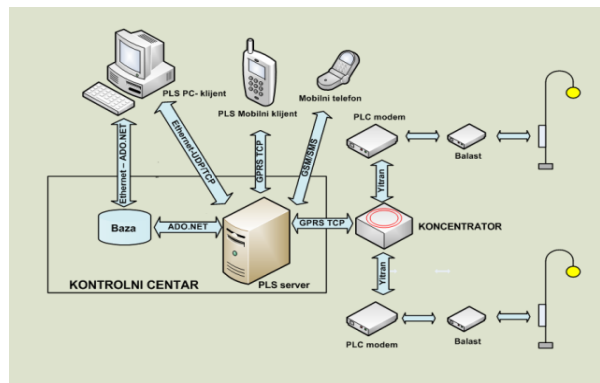


Figure 1. System architecture

Control Center (CC)

1. Monitoring server
2. Server database
3. Terminals
4. GW to the network

Server Monitoring allows for the implementation and the functions of monitoring and management. If necessary, these servers can be duplicated. Server Control Center consists of PLS server applications and databases, which can be executed on separate computers or, when the system performances allow it, on the same computer. PLS (Public Lighting System) server application communicates through GPRS (by the TCP protocol) with the hub, relying on the database. System users usually access the system from the terminal through the PLS Web client or via a mobile phone (client application for your mobile phone or text messages) [7].

Data saving is done with a database server (MS SQL Server), which can also be doubled, at the request of the operator. The connection with customers is achieved through a multi-terminal function. Terminals are realized as classical PCs, with the accompanying software.

With hubs in control cabinets, the control center is connected via telecommunication links that may be:

1. Ethernet
2. Modem (analog, ISDN, PLMN)
3. Special radio link
4. GSM/GPRS

Realization of these connections is a function of the gateway (GW) block. Capacity and type of GW depends on the total number of hubs, system capacity and the selected types of the communication path. The choice of the connection technology depends on the level of the existing infrastructure and the wishes of the system operator.

The basic functions of the control center are:

- Making the user interface for operating the system,

- Management of LMMs and hubs,
- Monitoring of LMMs (status display, LMM mode)
- System configuration,
- Statistics of the system,
- Monitoring system (recording of all events, alarms).

For smaller systems, with a few thousand lamps, a complete realization of the control center - server monitoring, database and terminal are executed with a single PC. Application SW for monitoring and management, database and the GUI part of the graphical user interface are running on the same platform [6].

Hub

Hubs are stored in distribution substations or distribution boxes. They are originally developed boards containing a communication controller: CCTR, GPRS modem, and PLC (Power Line Communication) modem.

Hub communication controller

The main function of the communication controller CCTR is to make a connection between the control center and the lamps. In terms of communications, a hub is a media gateway that transmits frames of data between two different types of networks.

Connection with the CC is provided through a GPRS network. This connection is realized as an IP network with TCP / IP communication protocol between CCTR and the CC. For communication with a GPRS modem it uses the UART and RS232 interface. For a connection with the lamps PLC modems are used or a narrowband communication system via a voltage distribution network. The connection to the PLC modem is a UART with RS485 physical interface. [4]

CCTR has the ability to work autonomously in the event of loss of communication with the control center. It collects and memorizes data related to the LMM to whom the CCTR is connected. CCTR is connected with the measuring group, making it possible to remotely read data about the consumption, from the meter.

PLC (Power Line Communication) modems

PLC (Power Line Communication) modem is a device which has the function of data transmission over the public low-voltage electricity grid: 230VAC/50Hz or 110 VAC/60 Hz. PLC modem transceiver performs a physical conversion of the signal for transmission over the electricity grid. If it is implemented as a stand-alone unit, the signals from RS232 (optional RS485) are modulated to DCSK signals for the CENELEC A band in a frequency range from 20 kHz to 80 kHz and it transmits them to the electricity grid using the appropriate adapter. In the reverse direction, it demodulates DCSK signals and transmits them to a host device through the RS232 (RS485) interface (Figure 2).

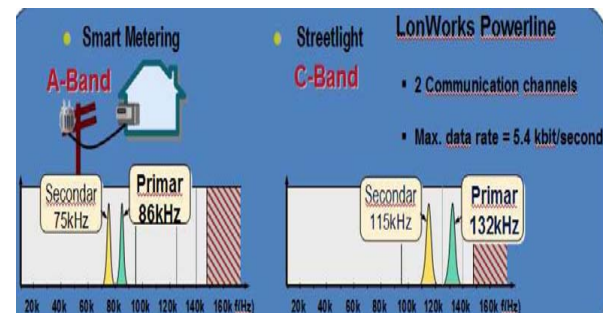


Figure 2. The PLC frequency range

In Europe, these signals must be in the range of 9 kHz to 148.5kHz, where the band is further divided into areas (Figure 3), where the A-region (from 9kHz to 95kHz) is used by electric power companies for the measurement of consumption and the C-field (from 125kHz to 140kHz) is used by consumers in the public light [8].

GPRS modem

GPRS modem is a device that has a function to allow serial communication with terminals for data transmission via GSM mobile

network. Serial communication with the GSM module is realized via the RS232 level transceiver and the data transmission goes via the mobile network with a GSM module that includes a GPRS function [10]. Basic functions of the hub are:

1. Autonomic route management
 - Independent automatic control of the lamps,
 - Lamp power control,
 - Lamp status reading along the route,
2. Communication with the server (done via GPRS modem)
 - Telling the exact time,
 - Transfer the new schedule which will operate the route,
 - Lower the new software,
 - Download data that is gathered by the hub from the route,
 - Look for transparent access to any PLC modems of the lamp,

3. Communication with PLC modems of the lamps.

Communication with PLC (Power Line Communication) modems of the lamps should be achieved through a low-voltage power supply network, with modulated signals which have allowable range for this type of communication. On the common power supply line, multiple PLC (Power Line Communication) modems can be connected as a communication medium. In the case of large signal attenuation along the route, individual PLC modems must be enabled to serve as repeaters for other modems.

4. Reading an electric meter

Electricity meter reading allows measuring the power of the current route and electricity consumption. The hub should be able to communicate with the meter to a standard protocol for meter tampering. Physical interface with the meter should be via RS232, RS485 interface or via PLC modems.

Lamps management module (LMM)

Lamps management module (LMM) is made of a switching and control unit, a PLC (Power Line Communication) modem and a ballast. Architecture of this system depends on the wishes of the users. The control module lamps (UMS) must provide the following functions:

- Communication with the CCTR and CC,
- Function of the electronic ballast,
- An indication of accuracy and the presence of light bulbs,
- Turning lights on and off,
- Control the level of luminous flux.

The main function of the participant module of the lamps:

- Execution of hubs command,
- Measurement of electricity in the lamps.

LMM is completely subordinate to the hub and executes his commands. In case of detection of loss of communication with the hub, it switches to autonomous mode that is pre-defined and provides the basic function of switching lights on and off [12].

Electronic ballast

Electronic ballast provides continues regulation of power and luminous flux of each lamp individually from 30% to 100% (Figure 3).

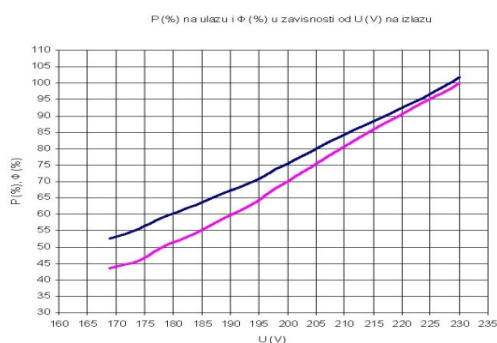


Figure 3. Power and luminous flux regulation

The functions of the electronic ballast are:

- Starting (firing) the light bulbs

The ballast should generate a high voltage pulse to the electrodes of the bulb to complete the initial ionization of gas.

- Current limitation

Ballast should limit the current through the bulb with the aim of maintaining the working range, as Na-lamps has a negative temperature coefficient of resistance and can reach its overload.

- Power factor correction

The electronic ballast should have a power factor correction at least 0.99.

Electronic ballast with power factor corrector is designed for a specific type of light source (the high pressure) and specific power (70W - 400W).

The principle of managing one or a group of lamps

Via the user interface, the operator sets or modifies system parameters, defines logical groups of lamps, sets the mode-scenarios for each group lights and monitors the state of the system.

Via the user interface, the operator is managing one or a group of lamps, by giving each lamp or group of lamps a scenario in which they will work. Scenarios depend on the requirements of the road lighting system and can be defined in a tabular or graphical form.

The system has an automatic adjustment of daylight. A table of daylight for the whole year is defined in the control center.

5. THEORETICAL RESULTS

In this chapter we will present a simulation of the system for remote monitoring and management of public lighting, as well as the results that have been achieved by this simulation. The goal of the simulation is to theoretically calculate energy savings using this model system for remote monitoring and management of lights. The system runs 22 lamps of 150 W to the following scenarios:

1. Lamps operate at 100% power from 16:00 to 22:00 and from 4:00 to 7:00 with 50% power from 22:00 to 4:00.
2. Lamps operate at 100% power from 16:00 to 20:00 and from 4:00 to 7:00 with 70% power from 20:00 to 24:00, with 40% power from 24:00 to 4:00.
3. Lamps operate at 100% power from 20:00 to 22:00, with 60% from 22:00 to 24:00 and from 4:00 to 5:30 with 40% power from 24:00 to 4:00.
4. Scenario when lamps operate at 100% power from 20:00 to 20:15, with 80% power from 20:15 to 22:00 and with 40% power from 22:00 to 5:30.

Savings that can be achieved can be calculated:

$$\eta = \frac{P_1 - P_2}{P_1} (\%)$$

Power of lamps installed in full mode is:

$$P_1 = P_s * N * (T_1 + T_2 + T_3)$$

Strength in reduced power mode:

$$P_2 = P_s * N * (T_1 + k_1 * T_2 + k_2 * T_3)$$

Where the,

Fixed parameters are:

U - lamps voltage (V)

N - number of lamps

Ps - power of lamps (W)

Variable parameters are:

T1 - time interval - lights are working in full mode

T2 - interval - lights are operating in reduced strength mode I (h),

T3 - interval - lights are operating in reduced power mode II (h)

k1 - power reduction factor I

k2 - power reduction factor II

Table 1. Theoretical results

Scenario	N	Ps	T1	T2	T3	K1	K2	P1	P2	η
		W	h	h	h			Wh	Wh	%
1	22	150	9	6	0	0,6	0	495 00	415 80	16
2	22	150	7	4	4	0.7	0.4	495 00	376 20	24
3	22	150	2	3.5	4	0.8	0.4	313 50	229 35	26
4	22	150	0.25	0.7 5	7.5	0.8	05	313 50	178 20	43

6. THE EXPERIMENTAL RESULTS

In this chapter we will present the experimental results of energy savings. The system was installed at the substation region of Ball Packaging Zemun. It oversees and manages 22 types of ONIX 2 lamps, with the light source and power NAVP 150 W.

Telemanagement system testing was performed by measuring the consumed active, reactive and the 15 minutes electric power, in three different modes (phases) with the control the quality of light.

Phase I

- Before setting the telemanagement system,
- Sodium lamps with light source and an electromagnetic ballast,

Phase II

- Installed telemanagement system,
- Lamps with light a source and an electronic NAVP ballast,
- No regulation of luminous flux, lamps work with 100% power,

Phase III

- Regulation of the luminous flux,
- Lights are working with 100% power from the moment they turn on to 22:00 and from 04:00 am to the moment they turn off;
- Lights are working with 60% power from 22:00 to 04:00.

Table 2. The experimental results

Phase	I	II	III
Time of testing	Jan 10. - Jan 20.	Feb 10. - Feb 20.	Mar 10. - Mar 20.
N – Number of working hours (h)	150	135	120
Calculated power			
P light bulbs (W)	150	150	150
Number of lamps (per piece)	22	22	22
Pinstal (kW)	3.3	3.3	3.3
Pprorač = Pinst*N (kWh)	495	445.5	396
Measured power			
A (kWh)	550	370	320
R (kVA)	100,12	17	9
Psr 15min	1895	1600	1300
SAVINGS			
$P_{sr 15 min II} / P_{sr 15 min I}$	$P_{sr 15 min III} / P_{sr 15 min I}$		
0.844	0.686		
15.6 %	31.4 %		

7. INTERPRETATION OF RESULTS

From the results obtained by simulating the system for remote monitoring and control of lights, depending on the intensity of traffic, priority of the road and requirements for brightness, using various scenarios, savings were achieved from 16% to 43%. (Table 1).

From the results obtained by testing the system (Table 2) we can conclude the following:

In the second phase of testing the telemanagement system was installed and in each lamp electromagnetic ballast has been replaced with an electronic ballasts. Lamps were operating in a full regime (100% power) and achieved saving of 15.6%. Savings can be achieved with a reliable switching of lights and eliminating the reactive power as the electronic ballasts has a power factor = 0.99.

In the third phase of testing by reducing power by 40% in the period from 22:00 to 04:00 savings were achieved of 31.4%. Savings are achieved by reducing power of lamps, eliminating the reactive power and by reliable switching of lights.

8. CONCLUSION

Telemanagement allows an increase of energy efficiency in a public lighting system as well as an increase in work reliability while reducing operating costs of maintenance. The basic principles of energy savings are:

- Maintaining a constant level of light flux during the installation. Installation of street lighting is designed so that it has a projected level of luminance 25% higher than required. Modulating light flux may decrease the level of brightness, which results in savings of up to 10%!
- Control the power of the light source - light sources are usually produced for specific power (70W, 100W, 150W, 250W and 400W for the high-pressure source), and the distance between the poles and brightness uniformity determine the geometry of the installation. In order to meet the above-mentioned factors higher power sources are used then it was estimated (if the required power budget is 120W, the source power of 150W will be adopted). With a continuous regulation savings of up to 25% can be achieved!
- Control depending on traffic - Traffic volume during the night hours, is considerably less than the daily traffic volume. Depending on the category of roads and time of day it is possible to continuously regulate the power and to achieve savings of up to 40%!

The great advantage of the proposed model system for remote control and monitoring of public lighting is the feedback information about the status of each light source, based on the possible rapid and timely intervention to remedy the problem. For these reasons, the application of this system is more cost effective in larger cities.

9. LITERATURE

- [1] Hensher D. A., Button K.: Handbook of Transport Modelling, University of Sidney, George Mason University, Elsevier Science Ltd, Oxford, 2000., pp. 1-10.
- [2] Banister D.: Transport planning, prema Hensher D. A., Button K.: Handbook of transport systems and traffic control, University of Sidney, George Mason University, Elsevier Science Ltd, Oxford, 2001, p. 9-19.
- [3] Miomir B. Kostić: Vodič kroz svet tehnike osvetljenja, Minel-Schröder, Beograd, 2000.
- [4] Miomir B. Kostić: Osvetljenje puteva, Minel-Schröder, Beograd, 2006.
- [5] Miomir B. Kostić: Teorija i praksa projektovanja električnih instalacija, drugo, prošireno izdanje, Akademsko misao, Beograd, 2005.
- [6] Philips Lighting: Lighting Manual, Fifth Edition, Netherlands, 1993.
- [7] Telemonitoring – Technical white paper, Schreder 2008
- [8] www.en.wikipedia.org/wiki/Programmable_Logic_Control.1er.
- [9] www.echelon.com > Applications
- [10] www.eetindia.co.in
- [11] www.dos-osvetljenje.org.rs
- [12] <http://www.e-streetlight.com>

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DEVELOPMENT OF ECONOMIC THOUGHT THROUGH THE GLOBAL ECONOMIC CRISIS

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Abstract: The pursuit of sustainable economic development of society is seriously called into question with origin and development of the global economic crisis. The entire society is geared towards the development of economic thinking to solve a problem caused and the economic development and prosperity. The free market, it had pursued the ideal of economic thought for more than a century, lost its importance and it is necessary to resort to various mechanisms of its regulation, primarily by the state, whose role is again gaining in importance. The previous limit the role of government and its suppression at the expense of other (private) actors led to a more pronounced difference between all classes of people. On the one hand we have the poorest people, who do not have even the minimum for survival, indebted middle class and new (old) class over-rich who use any means to make a profit. The aim of this paper is that through the prism of neoliberal ideas review the roots of the global economic crisis and the effect that has on the world. The development of economic thought has to answer the challenges of growing and successful through the global crisis.

1. INTRODUCTION

The global economic crisis, which had occurred at the beginning of the 21st Century, has called in question further development of economic thought that has emphasized, in the foreground, a neoliberalism as a direction which led towards sustainable economic and social development. The neoliberalism, as an ideology, has been based on liberalism ideas, which had been up-to-date until the end of 80's of the 20th Century. Basic postulates of the liberal theory had set the economists-neo-classicists, A. Marshall, L. L. Varlas et al., while theoretically, the liberalism had based on papers of A. Smith, D. Rikarda et al. The liberalists put in the foreground individual freedoms, a rule of law and a private ownership, while a main pretension is to radically limit a role of the state in economy. The basic state role would be in providing free trade implementation, the private property protection and concluded agreements implementation. A main assumption of the liberalism, to limit the state role, have had a point if take into a consideration a fact that this ideology has originated in interest of not numerous (rich and powerful) individuals. Some authors, when talking about the liberalism as an ideology which had been in power for almost four centuries, taking into consideration historical events which had followed this time period, often mention that numerous negative sociological occurrences had arisen exactly from it. Observing these

is against the state. Such consideration resulted from an idea that, for their consideration, the state is in power of party oligarchs, that has an unwieldy bureaucracy, that it is a largest consumer, while the private capital is, on the other hand, thrifty and rational. However, this attitude could not be accepted as an axiom of the neo-liberalism. The relation of the neo-liberalism toward the state is ambiguous and it origins from the following facts. On the one hand, the neo-liberalists, when observing the state collecting the tax from its citizens, justify its role and support its monopoly position. On the other hand, when the state carries out its basic task to be in its citizens' interest, then it jeopardize the neoliberal attitudes. It follows that the neoliberal theory exponents have a negativistic attitude toward a democratic system in the states.

They consider that the basic democracy principle, a majority principle, represents a threat for individual freedoms, so there

two ideological concepts, besides many similarities, since the neo-liberalism has derived from the liberalism, there are also series of dissimilarities that have been noticeable. The main dissimilarity lies in a fact that the liberalism insists on the individual freedoms principles and the rule of law at the national state level, so a social care issue has been regulated and solved to some extent. Unlike this direction, the neo-liberalism bases on attitudes of the trans-national organizations, to which the state restrictions represent a hindrance for further development (a profit). An issue of the individual freedoms and interests protection is completely marginalized, if not even excluded from each context. It makes a fact that we have, on one side a small number of rich, and on the other poor people, which number is increasingly growing.

Taking into consideration the basic assumptions of the neo-liberalism and a role of the state which has been limited, the neo-liberalists guarantee the individual freedoms of citizens within a market. They say that the citizens claim themselves the responsibility for their own acts and depend on them if they are going to ensure their own success. A system does not call into a question in case of any citizens' failure, but it is ascribed as their personal abilities.

A basic standpoint, represented by neoliberal ideology, could express by an attitude that the neo-liberalism considers that a power should be in hands of scarce elite, and that many functions pass to the international institutions. Supporting the privatization execution, the neo-liberalists consider that the complete privatization would cancel a need for the state and for the collective decision-making, because in that case, the collective interests would not exist. Starting from the attitude that the neo-liberalism has a negative relation toward the democracy, there should know that there is a significant dissimilarity between capitalism, in basic sense of the word, and the neo-liberal capitalism. The capitalism basically points out the private ownership on the market, while the neo-liberal capitalism tends to privatize all elements of population life, media, health services, education, etc. In that way, an authoritarian state, in which the majority freedoms would be limited in favour of rich and powerful minority, would be an ideal to strive.

2. NEOLIBERAL ROOTS OF THE GLOBAL ECONOMIC (FINANCIAL) CRISIS

An emergence of the world economic crisis, connected to the USA real-estate market, has not been accidental. Irresponsible policy making of banks in the USA, which have placed funds, owing to high inflow of cheap money from abroad, through mortgage loans, in order to make a profit, was an initial cap for a large scale crisis. Changing the law in the financial fields was provided to the banks to approve credits to clients with worse credit rating too, i.e. to persons whose creditworthiness has not satisfied crediting conditions. These persons were jobless, without property or permanent income. The credits granted in this way have identified as subprime credits and they, as a rule, grant with variable interest rates.

A size of the mortgage loans has increasing from day to day, and therefore a share of the subprime credits. This growth, at the beginning of the 21st Century, has been around 10% annually, and a decrease of interest rates to 1% has substantially affected to it. This situation on the real-estate market has been extraordinarily favourable to demand increase, which has surely caused also a growth of real-estates prices. The facts show that, in the first years of the century, the real-estates on the USA market had increased for over 150%, which had made problems, while numerous real-estates, sold by middlemen, appeared. A capital gains tax was cancelled in real-estates trading, which has been substantially favourable to all who had participated on the real-estates market.[1]

Greater demand than supply was a basic mode of real-estates market functioning. The interest rates on the mortgage loans, which had amounted 1% at the beginning of 2000, had started to increase all up to 20% [2] in 2007. This fact and growth of oil price on the global market, as well as food and groceries prices growth on the world market, had caused that many of those who have taken the mortgage loans, could not repay them. It had provoked, as a consequence, a condition to increase the real-estates supply on the market, as by those who could not repay the loans, as well as by the middlemen who had realized this market crisis. Such large amount of real-estates had caused demand decrease, which furthermore caused also a precipitous decline of real-estates prices.

What has basically been the main problem of the crisis emergence on the real-estates market in the USA has been actually, so called, housing loans securitization, i.e. claims for long-term mortgage loans have been transformed into securities issued according to unmarketable assets. Those securities have been a part of the security market. The securities have been constituted of mostly the mortgage loans of credit unworthy population. The same represented an active capital, by which had business on the securities market without any problem, and where to have favoured the facts that rating agencies had evaluated them as risk-free and insurance companies had secured them from the risk. [3]

The banks have used this situation on the securities market and claims from these loans had selling, without waiting for the funds from the long-term mortgage loans. The funds they had realized in this way, the banks place further through new credits. In this way, the securities amount from the mortgage loans has increasing. The risk from the loans repayment in this situation has not been anymore related to the banks, but for these loans buyers, from which the risk had farther passed through the securities, issued on the basis of the mortgage loans.

What made this situation alarming is a fact that the securities market has been connected globally, so the risky securities had appeared worldwide. This risk has become prominent when have proved that the overdrawn securities have been assessed as high quality. A cataclysm of the mortgage market has shown that these securities value increase has been apparent and it, first of all, had served for moneymaking of small number of people, managers in the biggest trans-national corporations.

A situation on the securities market, when the amount of financial sources in circulation had increased, based on loans easy to get (primarily the mortgage loans), it had provoked increasing interest for the consumption. If we take into consideration a fact that every consumption increase leads to saving decrease, then inevitably come to that people start to spend more above their real possibilities. This trend in the USA was characteristic until 2007, i.e. the real-estates market had crashed. The fact is that, from 90's to 2006,

people's incomes had been permanently increasing and increase of the securities prices had continually created a sense that economic growth has been something that cannot be stopped.

3. CONSEQUENCES OF THE GLOBAL FINANCIAL CRISIS

A financial crisis, provoked by the USA mortgage market crash, has provoked great consequences for all elements of economic life. Investment banks like „Goldman Sachs“, „Morgan Stanley“, „Lehman Brothers“ and other smaller have faced a bankruptcy. Three rating agencies for risk evaluation, „Moody's“, „Standard & Poor's“ and „Fitch“ were in the same situation, too.[4] However, what was especially disturbing in that moment was a fact that these institutions were not the only ones affected by the crisis. The securities, issued for the mortgage loans were issued all over the world, which meant that all these financial institutions, which have business with these securities, had been in position to have the same destiny as the institutions in the USA.

The only investment bank which had bankrupted in the USA was „Lehman Brothers“. However, the significance which the investment banks, financial conglomerates, mortgage corporations and other trans-national subjects had on the USA economy, had caused series of decisions in the state's establishment in order to help them in any possible way to avoid their bankruptcy. It was done in a way that the state had intervened with several thousand milliard dollars, by giving it to the subjects and knowing that they will bring back the money with influence they have in the world.

It is necessary to undertake the measures for stopping the growth of risky placement and preventing the crisis (or at least its consequences), and not to send a message to proceed with previous practice, which had shown ruinous results. In the first place should have higher social aims, not narrow (personal) economic privileges. The thing characteristic for the entire economic crisis is a fact that, with its further moving away and progress, the neoliberalism had shown its characteristics. A growth of wealth in dominant minority was disproportional to majority impoverishment. Important thing is that some economic entities have used got financial resources in a way they had, not only surmounted the crisis, but also made profits. A characteristic example which was stated in publicity is the investment bank „Goldman Sachs“, which had succeeded, two years after the crisis had started and after getting the financial support from the state, to realize the highest profit in its existence. The winners in such situation were especially managers whose bonuses had amounted hundreds of thousands of dollars. [5]

The financial crisis, which had spread without limitations and which today destroys economies worldwide, has inflicted the consequences of unimaginable proportions. Many industry branches had vanished, while the capital in those branches disappeared. Budgetary deficits appeared by decreasing state revenues, due to the economic activity decline and increase of public expenditures due to the state interventions, in order to support economies, which had going through the crisis. Many countries' public debts have achieved alarming values. Unemployment growth has especially affected the poorest.

The important thing is – due to the financial crisis have become more expensive banking credits, which has undoubtedly led to increase of enterprises' business expenses, as well as to enterprises' liquidity decrease. Decrease of crediting size has led to consumption decrease, and thereby also decrease of the total physical demand. Owing to the demand decrease, the enterprises were forced to decrease their production, and owing to sale and revenue decrease, the enterprises were forced to fire their employees, in order to reduce business expenses. Unemployment in the USA was amounted in 2009 7.2%, so that in 2011 it was amounted critical 9%. Therefore, predominantly aim of the USA state policy was to reduce the unemployment to some reasonable limit. Nevertheless, although has been determined that is necessary for a recuperation to employ, on monthly basis, approximately 263.000 employees, in this year that number ranges around 125.000, which is still insufficient. [6]

4. CAUSES OF THE FINANCIAL CRISIS EMERGENCE

Although the most of the authors speak on the USA real-estates market crash, as a basic cause of the global financial crisis,

the facts from everyday life speak different. Many authors, who represent the neo-liberal comprehensions, also speak that the uncontrolled state revenue of the most of countries, is a cause of the crisis. The IMF data in 2007, when the crisis have started to seize the world, point out to an example that the state revenue in regard to GDP had amounted in Ireland 24.9%, Greece 105.4%, Spain 36.1% and these countries have been first affected by the crisis. In the same year, the state revenue in regard to the GDP in Germany had amounted 65%, in Japan 220% and these countries had not had their financial sector crash, as previously mentioned. The data unequivocally speak in favour of the fact that are incorrect assertions of the neoliberal school representatives, who claim that the basic causes of the financial crisis are – excessive public consumption and public debt, although they instigate the crisis.

The main cause of major countries' financial crisis is a deficit of current balance, which they have for a long time. Making the current balance deficit, the countries were forced to depend on foreign capital, as inevitable to continue to function. With foreign capital inflow came to increased inflow of foreign currency too, which provoked a local currency decrease, which finally could deteriorate the current balance. [7]

Much more significant character of the crisis in economy of a state is a value of the current balance, as a sum of private and public debt towards abroad, since the current balance deficit leads to external debt increase. The IMF data point out that the countries, in which has began the financial crisis, had a continuity in the current balance deficit, which had approximately amounted (for the period 2002-2006) in Iceland 11%, Portugal 9.2%, Greece 9.1% and Spain 7%.⁷ The data that Germany and Japan, besides higher public debt in regard to the mentioned countries in this period had realized the current balance surplus, speaks in favour of this fact. Example of the countries which had the current balance deficit for a long time, Greece and Italy, shows exactly a correlation between the current balance and the public debt of the country.

5. CONCLUSION

The neoliberalism represents a base for making the global society, which is based on economic logic and unique global market. Continuing the liberal logic, in modified form, the neoliberalism, by the global market principle, appoints the trans-national organizations as founders of "new world order". It has caused a fact that has been placed in the foreground economic efficiency and profit, while an issue of justice and social care have been put aside and neglected. Making marginal the state role in economic and social sphere has contributed.

Exactly a domination of economic factor and greed of the trans-national organizations were a motive for the global scale economic crisis emergence. Uncontrolled desire for profit of all bigger banks in the USA has caused heavily indebted of major population, which has specifically reflected to the real-estates market. Granting the mortgage loans to person, who had not been solvent, only had caused a breakdown of the mortgage market and the overdrawn securities emergence. The global bank market has become a victim of several big investment banks from the USA.

A bankruptcy of one investment bank in the USA, disappearance of entire industrial branches and unemployment growth, especially in West Europe countries, are just some of the consequences which have affected the world in the first years of the crisis. But, a fatal thing is a fact that the poorest society layers have experienced tragic destiny, while the richest, which had spoken on the crisis and required the state support, succeeded in taking

advantage of the crisis and even increased their wealth. Many countries' public debt has achieved fantastic proportions, so at the beginning even had put a question of the European Monetary Union and euro as a mutual currency survival. Many experts analysis worldwide has shown that the bank sector crisis has hit at first those countries which had the current balance deficit for longer period of time, and which had caused a situation that once the states of "prosperity", Greece and Spain, had faced bankruptcy.

Unavoidably globalized field of economy has caused that the new economic crisis left the consequences on Serbian economy. The neo-liberal ideas, which had seized the Serbian economy at the beginning of this century, have reflected, in all their manifestations, on the economic sector functioning. It had a special significance from the beginning of the crisis, since the assertions of this idea's representatives were dominant in managing the state, and thereby also the economic policy formulation. The consumption growth, without adequate coverage by suitable investments, has only caused the public debt increase up to the heavily indebtedness level.

The neoliberal idea basically relies on the state economic policy control, thanks to which keeps and gets a permanence character. This idea's power is in force which stands behind it, and which has been an "engine" which set it in motion. A capital, in any form, has enormous financial power to affect, as the states' political life, as well as its other segments, like intelligence and media space, shaped in its own way.

The neoliberal roots of the global economic crisis are visible in every life segment, but this order's power does not allow to be jeopardized or to bring into a question its survival.

The conclusion, which unambiguously resulted from everything previously envisaged, is that the neoliberals had succeeded, in time when they were the weakest, to make such economic policy which had suited their needs. Coming out from the crisis by constant intervention of the state on the monetary market is in favour of the neoliberal idea, although they are tough opponents of the state interference. In this situation the state's reacting is in their favour. Punishing some banks and strengthening the financial regulations are measures the neo-liberalists can accept, because they are short-term and without greater consequences. These measures finally do not obstruct the neoliberal ideas implementation, enrichment and profit at the expense of the poor. It speaks in favour to the fact that the world, after coming out from the global financial crisis, is going to erase, maybe, a term of neo-liberalism, but such ideas will further on stay under some other name.

6. REFERENCES

- [1] T. E. Woods: *Meltdown*, Regnery Publishing, 2009, pp. 20-26
- [2] R. Ricol: *Rapport sur la crise financière*, septembre 2008, pp. 27
- [3] J.B. Dušanić: *Svetska ekonomska kriza – made in USA*, Škola biznisa br.1, Visoka poslovna škola, Novi Sad, 2010, p. 16
- [4] <http://www.twinside.org.sg/title/trig-cn.htm> accepted 17.05.2012
- [5] <http://www.fefa.edu.rs/files/pdf/StudijeIstrazivanja/sveska03GlobalnaFinansijskaKriza.pdf>, p. 11-12, accepted 19.05.2012.
- [6] http://www.fren.org.rs/attachments/046_kml15-11-trendovi9-medjunarodno.pdf p. 58, accepted 22.05.2012
- [7] I. Milojević, M. Mihajlović, M. Cvijanović, *Impact of organizational failure of relevance consolidated budget*, *Ekonomika poljoprivrede*, Vol. LIX, N°1 (1-176), 2012, str. 63-71

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PERSONALIZED eLEARNING SYSTEM ARCHITECTURE SOLUTION BASED ON LEARNING OBJECTS

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Key words: eLearning, personalized sequencing, student profile, metadata, pedagogical methods, learning styles.

Abstract: This paper presents the architecture of personalized eLearning system base on learning objects. Developed architecture provides derivation of student's profile, sequencing of personalized eLearning sessions and supports scenario for designing lessons content tailored to the individual student's needs. The example of personalization process is shown. Further, here is described how the personalization system INDeLER includes teacher's influence to the eLearning experience by composing different pedagogical aspects and corresponding didactics' and methodic' processes to the unique way of teaching tailored to the particular student's needs

1. INTRODUCTION

Web-based education is reaching a large number of learners and beside that it possesses a valuable advantage over traditional classroom teaching, and the possibility to be adapted to individual learner, which is hard to achieve in common teaching process.

Online learning gives the wide range of opportunities to examine student's different levels of motivation, different attitudes about teaching and learning, and different responses to specific environments and instructional practices and to tailor the eLearning experience towards exact student needs.

Although, it is often stressed out that current eLearning systems are lack in accompanying, guiding and motivating individuals and should follow more user centered approach. One of the main problems with eLearning environments is their lack of personalization.

Implementation of personalized eLearning systems is based on *Web Intelligent Tutoring Systems* (ITS) and on *Adaptive Hypermedia* (AH). The aim of AH is to improve efficiency of hypermedial applications by upgrading them to personalized applications [1]. Term *AIWBES* (*Adaptive and intelligent Web-based educational systems*), [2] marked the Web based Intelligent tutoring systems which have opportunity to be adaptable to the student needs. Some of them are described in [3, 4, 5]. AHA [6] or WebCOBALT [7] are adaptable systems but not intelligent. Examples of tutoring systems which used the technique of adaptable presentation are ELM-ART [3], InterBook [4] and MetaLinks [8]. Some examples of ITS architecture are SQLT-Web [9] and CALAT [10].

Design solution of multi-layer architecture based on Web including presentation layer, service layer and resource layer is presented in [11]. The software architecture is implemented in a real system using Struts + Spring + Hibernate framework which is cross-operating system, cross-database, and cross-application server. In [12] study an e-Learning management system with Web services oriented framework is proposed. The system is an open source application with client scripting facility. It also supports the cross browser and it is fully integrated with different databases; MS SQL Server, MS Access, Oracle and LDAP.

The objective of [13] is to design service-oriented reference architecture for personalized e-learning systems (SORAPES) and validate the architecture. The SORAPES is designed by re-using web services and learning objects. It is a layered architecture and highly-scalable for personalized e-learning system. This architecture was evaluated with a list of quality attributes.

The architecture describes in [14] is open and service-oriented, enabling the integration of existing learning services, especially those built with Web 2.0 features and functionality. Its implementation is described with a sample pervasive e-learning service. An article [15] presents a three-module architecture for a personalized e-learning environment for bioinformatics is presented. The architecture facilitates a personalized e-material recommender that does item-based collaborative filtering (CF) + adapted vector space model (VSM), explicit and implicit scoring, and a concept of tasks focused on rating literature for the e-learner.

In this paper, we outline our approach to pursue personalization according to obtained user profile, containing user's preferences, knowledge, goals, navigation history and possibly other relevant aspects that are used to provide personalized adaptations. Derivation process of student profile, by mapping student's psychological characteristics, attitudes and preferences to the metadata value, represented with vector XYZ of personalized model PeLCoM, is shown in paper [16].

In that direction we have designed the Personalized eLearning Course Model (PeLCoM) [17] and Information Learning Object Model for Personalized eLearning (ILOMPeL) [18]. Learning Objects (LO) represent the granular units of the model, and each LO is describes with metadata value of the personalization vector XYZ [19], that provides personalisation of learning experience such as: from the learners viewpoint it is possible to personalize the subject matter of the course and the organisational structure of learning resources, learning objectives, scope of the learning resources, level of the learning resources and the learning resources attitude to a specific domain of practise. From the aspects of the visualisation it is possible to choose various types of learning experience presentation. From the aspects of the curriculum visualisation and presentation, mathematical-logical, linguistic-verbal, musical, visual etc. differences are incorporated, as well as from the point of sequencing teaching materials, the diverse systems of program contents are supported, and also the different views to a lesson are defined and supported.

This paper presents the architecture of personalized eLearning system INDeLER (INDividualized eLEARning). This architecture unions the mentioned models PeLCoM and ILOMPeL and provides their functionality. After Introduction, Section II describes the architecture of personalized eLearning system INDeLER, which contains: User Interface Module, Expert Personalization Module, Learning Module, Student Profile Database and Learning Objects Repository. Section III presents by example, novel approach in designing lessons towards learning style and student's preferences contained in student's profile. Section IV concludes the paper.

2. INDeLER SYSTEM ARCHITECTURE

Three level INDeLER architecture contains several components: User Interface Module, Expert Personalization Module, Learning Module, Student Profile Database and Learning Objects Repository, as can be seen on Fig.1.

User Interface Module consists of *Student Interface* and *Teacher Interface*.

- *Student's Interface* enables registering to system, login, admission to course and assessments.
- *Teacher's Interface* enables supervising the course and student's activities, guideline, control, and creating teaching materials etc.

Teacher's Module consists of Domain Module and Pedagogical Module.

- *Domain Module* is responsible for definition and modification of topic network and course content which is domain knowledge base. Course content is presented by inter related learning

objects (LO). Domain Module provides searching facilities for specific teaching unit that needs to be presented to student. Structure of domain is presented with Information Learning Object Model for Personalized eLearning (ILOMPeL) [18].

Pedagogical Mmodule is responsible for didactic and diagnostic functionality, control and recommendation (*view – control – suggest*). Didactic functionality provide preparation of teaching materials that enables variety of combinations in order to adapt to particular student characteristics. Diagnostic functionality comprises evaluation of student's performances, provide feedback with modification of student profile and give directives for further work.

Expert Personalization Module consist of Personalisation Module and Student Module. The primary function of Expert Module is to partake in creation of learning syllabus for particular student according to defined parameters in student profile. In order to derive conclusions Expert Module uses specific knowledge linked to domain that is presented as metadata.

- *Personalization Module* takes student profile data and based on functional dependences of learning materials, generates syllabus for specific student, determines learning strategy that is the most suitable for him/her and defines presentation and visualization of learning materials which are appropriate to that student.
- *Student Module* generates and modify student profile in several steps:
 - gathers student data and builds *Student's information profile database*,
 - process gathered data, derives student psychological characteristics and generates *Student's psychological profile database*,
 - map the student profile to metadata of XYZ vector, and store processed data in *Student's metadata profile database*,
 - follow the process of learning and his/her results and store data in the *Student's history database*, modify student profile according to data provided by *Student's history database* or teacher's recommendations.

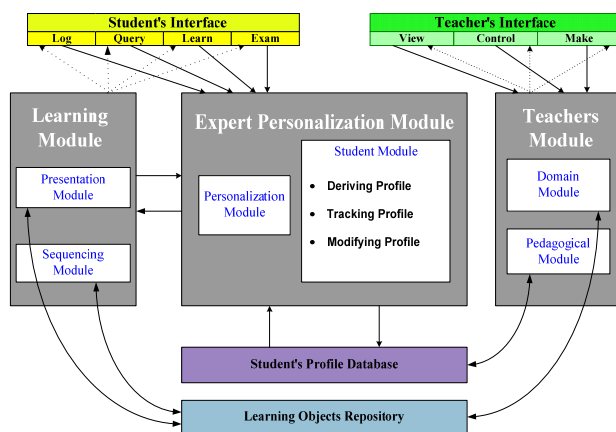


Figure 1. The architecture of personalized eLearning system INDeLER

Learning Module consists of *Sequencing Module* and *Presentation Module*.

Sequencing Module performs sequencing LOs into learning units, based on metadata for specific student, obtained from Personalization Module. It is done in a following way:

- sequencing on lecture level determines programme content type and selects the group of lectures with given learning goal;
- sequencing inside the lecture determines lecture structure and lecture's belonging parts;
- sequencing learning object by supplementing the basic LO with dependent ones, with the aim to creates different presentation and visualization views of the same lecture.

Presentation Module enables sequencing several types of views for the same lecture. It is realized by implementing dependent classes containing different visualizations of LO, although each LO

is primary stored in *black and white* form. Here, three view types are considered: text, text and audio (voice, music) and text and video (graphic, algorithms, simulations, animations, etc.).

Students' Profile Database contains student model providing system ability to perform individualized help at hand. Among other, it contains information on student knowledge and learning skills. Student profile is regularly updated according to the performed activities with system.

Learning Objects Repository contains *domain knowledge* and *pedagogical rules*. Domain knowledge is represented as interrelated learning objects. Teaching materials are represented with collection of LOs containing knowledge elements itself, presentation units (what student actually see on the screen) and assesment units for testing student. Learning materials are clasified by its function, eg. introduction, problem description, example etc. Presentation units are clasified by its media type, e.g. text, grafic, animation, video etc. [20].

3. SEQUENCING OF PERSONALIZED eLEARNING SESIONS

3.1. Student profile example

After answering Felder-Soloman ILS Questionnaire and Preference Test by student S09, acquired results on student profile are shown in Table 1. The third row states the possible categories for ILS Questionnaire, and the next row gives student's answers. The sixth row presents the question numbers for Preference test and student's answers are written in the next row.

Table 1. Students value of personalization tests

Resulting value of personalization tests											
Felder and Soloman ILS Questionnaire											
Std	A-R	S-I		Vi-Ve		Seq-Glo					
S09	A5	I3		Vi7		Glo3					
Preference Test											
1	2	3	4	5	6	7	8	9	10	11	12
c	b	c	c	c	c	c	a	b	b	b	c
Derived student's profile metadata value											
X1={1}, X2={1}, X2={4,3,5}, X3={3}, X4={2}, X5={2} X6={3} X6={1} Y1={2} Y2={1} Z1={3}											

The following notation is agreed:

- Felder-Silverman categories are denoted with: A (Active), R (Reflective), S (Sensing), I (Intuitive), Ve (Verbal), Vi (Visual), Seq (Sequential), Glo (Global);
- Weight component is presented as an index of the corresponding category. For instance, if the result is Active with weight component 7, we write it down as A7;
- Answers to questions from Preference tests are denoted with: a, b, c, where answer a has the smallest weight, and answer c has the highest weight (e.g. for particular question answer a denotes the lowest – BASIC level, and answer c denotes the highest – ADVANCED level).

The last row brings metadata values for personalization vector XYZ, which are derived based on student answers, [19].

3.1 Personalization Session Example

Personalization system INDeLER includes teacher's influence to the eLearning experience by composing different pedagogical aspects and corresponding didactics' and methodic' processes to the unique way of teaching tailored to the particular students needs. The example of INDeLER personalization process is shown.

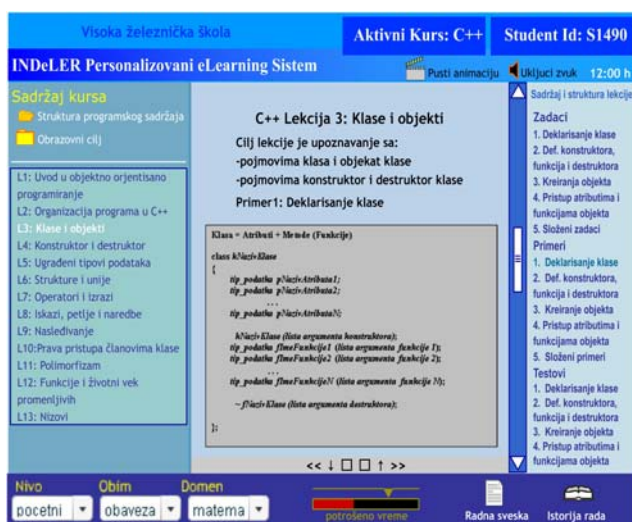


Figure 2. INDeLER screenshot of eLearning personalized session while student position is on lecture L3: Classes and Objects

Algorithm for personalization performs sequencing of personalized sessions that will present course learning material based on information from student profile, generated by Student module. Observing that generated profile for student S09 is presented in Table 4, than the Personalization module will perform sequencing of sessions for *Programming in C++* course in the following way together with several iterations.

After the first phase of personalization the response of eLearnig System INDeLER is shown on Figure 2. containing the screenshot of *eLearning personalization session* for learning C++. On the basis of user profile, system has performed personalization of learning materials and teaching methods. Left frame gives the suggested course content which is the most appropriate to student S09 according to content structure and education objectives. Besides, lecture personalization is performed and lecture content is presented in the right frame. Student is firstly offered tasks that should be solved, thereafter solved examples are shown to self-evaluate previous task. Lecture parts that contain introduction and theory are overleap because student with this type of learning style is not interested in such learning approach.

We have conducted an empirical evaluation to examine whether differently formatted eLearning courseware has an impact on the success and efficiency of learning process. The sample gathered 51 students, where 25 students in group G1 and 26 students in group G2. The experiment had three phases:

Phase I: time period Δt_1 (one teaching week) – pre-testing and distribution of students in two knowledge equivalent groups G1 and G2; student profile generation for G2 group and their cauterization in personalized groups according to the learning styles.

Phase II: time period Δt_2 (ten teaching weeks) – traditional teaching and evaluation for G1 group; personalized learning for G2 group and testing their knowledge.

Phase III: time period Δt_3 (three teaching weeks) – analyzing the obtained results of G1 (non personalized) and G2 (personalized) groups; deriving conclusions.

Figure 3. presents comparative results of both groups during the process of learning, quizzing and final examination from the Programming language C++ course. The X-axes shows categories that we followed: PO – average grade, PPP – average points of passed exams, PPU – average points for the whole group, %Položili – total number of students who successfully passed the exam.

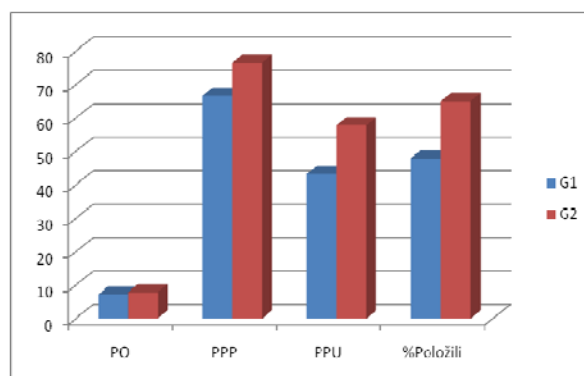


Figure 3. Comparative results achieved by groups G1 and G2

According to the performed analyses we can conclude that personalized group G2, comparing to non-personalized group G1 have achieved: 9% higher average grade for successfully passed students, 15% higher average student score for students who passed the exam, 34% higher average score, 17% greater total number of students who successfully passed the exam.

4. CONCLUSION

The three layer architecture for personalized eLearning system INDeLER is presented. It consists of User Interface Module (containing *Student's Interface and Teacher's Interface*), three main application modules: Teachers Module (containing *Domain module and Pedagogical Module*), Expert Personalization Module (containing *Personalization Module and Student Module*), and Learning Module (containing *Sequencing Module and Presentation Module*), and two databases: Students' profile Data Base and Learning Objects Data Base. Developed architecture supports personalization model PeLCoM and offer personalized eLearning experience adopted to the needs of each individual learner.

Sequencing algorithm based on student's profile is described, also. It composes the learning plan and generates the personalized eLearning sessions for each learning unit. Examples of personalized eLearning sessions are presented and described.

The example of INDeLER personalization process is also shown. We observe that student's attention, motivation and engagement are increased in spite of (towards) classical lectures and multimedia animation induces deeper understanding and faster relating of the learning material

Future development will go toward evaluation of suggested eLearning personalization methods using INDeLER system, and conducting an experimental study to examine the efficacy of suggested personalization method.

5. REFERENCES

- [1] Wu H., Houben G.J. and De Bra P., 1998. AHAM: A Reference Model to Support Adaptive Hypermedia Authoring. In the Proc. of the "Zesde Interdisciplinaire Conferentie Informatiewetenschap", Antwerp, Belgium, 1998, pp. 77-88.
- [2] Brusilovsky, P. and Peylo, C. 2003. Adaptive and Intelligent Web-based Educational Systems. International Journal of Artificial Intelligence in Education, IOS Press, 2003., Vol. 13, 156-169.
- [3] Brusilovsky, P., Schwarz, E., and Weber, G. 1996. ELM-ART: An intelligent tutoring system on World Wide Web. In: C. Frasson, G. Gauthier and A. Lesgold (eds.) Intelligent Tutoring Systems. Lecture Notes in Computer Science, Vol. 1086, (Proceedings of Third International Conference on Intelligent Tutoring Systems, ITS-96, Montreal, 1996. Berlin: Springer Verlag, pp. 261-269.
- [4] Brusilovsky, P., Schwarz, E., and Weber, G. 1996. A tool for developing adaptive electronic textbooks on WWW. In H. Maurer (Ed.), Proceedings of WebNet'96, World Conference of the Web Society, (pp. 64-69), 1996. San Francisco, CA, AACE.

- [5] **De Bra, P. M. E.** 1996. Teaching Hypertext and Hypermedia through the Web. *Journal of Universal Computer Science*, 1996., 2(12), 797-804.
[//www.iicm.edu/jucs_2_12/teaching_hypertext_and_hypermedia](http://www.iicm.edu/jucs_2_12/teaching_hypertext_and_hypermedia)
- [6] **De Bra, P., & Calvi, L.** 1998. AHA! An open Adaptive Hypermedia Architecture. *The New Review of Hypermedia and Multimedia*, 4, 115-139.
- [7] **Mitsuhara, H., Ochi, Y., Kanenishi, and K., Yano, Y.**, 2002. An adaptive Web-based learning system with a free-hyperlink environment. In P. Brusilovsky, N. Henze, & E. Millán (Eds.), *Proceedings of Workshop on Adaptive Systems for Web-Based Education at the 2nd International Conference on Adaptive Hypermedia and Adaptive Web-Based Systems, AH'2002* (pp. 81-91). , 2002. Málaga, Spain.
- [8] **Murray, T.** 2003. MetaLinks: Authoring and affordances for conceptual and narrative flow in adaptive hyperbooks. *International Journal of Artificial Intelligence in Education*, 13(2-4), 197-231.
- [9] **Mitovic, A.**, 2000. Porting SQL-Tutor to the web. In: *Proceedings of International Workshop on Adaptive and Intelligent Web-based Educational Systems, In Conjunction with ITS 2000*, 2000 Montreal, Canada.
- [10] **Nakabayashi, K., Maruyama, M., Kato, Y., Touhei, H., and Fukuhara, Y.**: 1997. Architecture of an intelligent tutoring system on the WWW. In: B. d. Boulay and R. Mizoguchi (eds.) *Artificial Intelligence in Education: Knowledge and Media in Learning System*, *Proceedings of AI-ED'97, World Conference on Artificial Intelligence in Education*, Kobe, Japan, 1997, Amsterdam: IOS, pp. 39-46.
- [11] **Lan Lina**, *Personalized e-Learning System Based on Multi-layer Architecture*, *Information Technology and Applications*, 2009. IFITA '09. , Vol.:3
- [12] **Mohammed A. Jabr and Hussein K. Al-Omari**, *e-Learning Management System Using Service Oriented Architecture*, *Journal of Computer Science* 6 (3): 285-295, 2010, ISSN 1549-3636, © 2010 Science Publications
- [13] **K. Palanivel, S. Kuppuswami**, *Service-Oriented Reference Architecture for Personalized E-learning Systems (SORAPES)*, *International Journal of Computer Applications*, © 2011 by IJCA Journal, Number 1 - Article 1, 2011.
- [14] **Mario Muñoz-Organero, Pedro J. Muñoz-Merino, and Carlos Delgado Kloos**, *Personalized Service-Oriented E-Learning Environments* Published by the IEEE Computer Society, 089-7801/10/\$26.00 © 2010 IEEE, IEEE INTERNET COMPUTING
- [15] **Wang, Hei-Chia, Huang, Tian-Hsiang** , *Personalized e-learning environment for bioinformatics*, *Interactive Learning Environments*, Volume 21, Number 1, 1 February 2013 , pp. 18-38(21), Publisher: Routledge, part of the Taylor & Francis Group
- [16] **Jovanović, D., Milošević, D., Žižović, M.**, *Personalized e-Learning by Mapping Student's Learning Style and Preference to PeLCoM Metadata*, *ANNALS of the University of Petrosani mechanical engineering*, VOL. 10 (XXXVII), Editura UNIVERSITAS, ISSN 1454-9166, PETROȘANI – ROMANIA, 2008. p. 103-112
- [17] **Jovanović, D., Milošević, D., Žižović, M.**, *INDeLER: eLearning Personalization by Mapping Student's Learning Style and Preference to Metadata*, *iJET International Journal of Emerging Technologies in Learning*, iJET, Vol 3, No 4, 2008. www.i-jet.org
- [18] **Jovanović, D., Žižović, M., Milošević, D.**, *"ILOMPeL: Information and metadata modeling for personalized eLearning"*, *Academic Journals Scientific Research and Essays*, ISSN 1992-2248, 23 March, 2012; 7(11) , pp. 1212-1229 DOI: 10.5897/SRE11.1781
- [19] **D. Jovanović, S. Ristić, M. Žižović**, *eLearning Personalization by Student's Psychological Characteristics*, *Teaching Psychology around the World: Volume 2*, Cambridge Scholars Publishing, 2009., Isbn13: 978-1-4438-0985-6, Isbn: 1-4438-0985-3, pp.550-574
- [20] **Vassileva, J.**, 1995. *Reactive Instructional Planning To Support Interacting Teaching Strategies*, *Proceedings of AI-ED 95, World Conference on AI and Education*, AACE: Charlottesville, VA, 1995, 334-342.

ANALOG CIRCUITS FAULT DIAGNOSIS BASED ON MULTI-UNIVERSE QUANTUM NEURON NETWORK

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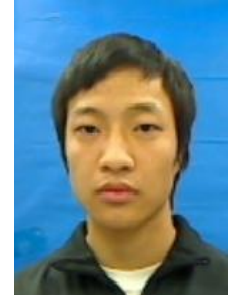
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Key words: Fault diagnosis; Multi-universe quantum neuron; Analogous circuit

Abstract: According to the uncertainty question of analogous circuit's fault diagnosis in control system, the multi-universe viewpoint which is produced based on the quantum state the superimposition phenomenon is applied to the structural design of the neural network, and a multi-universe quantum neural network model is produced. The structure system of this model include classical networks and quantum neural networks. So multi-universe quantum neural network model can use the special collapsing method to get a good diagnosis result, and also can quantify the sample structure distribution at input space. The example simulation and analysis proved that this model can more effectively solve the uncertainty problem in the fault diagnosis process compared with BP network. The model improves the fault diagnosis recognition precision greatly, and the rate of diagnosis accuracy could achieve over 95%.



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1. INTRODUCTION

In recent years, the control system is developing greatly towards the science and technology and complication direction, therefore technology request for fault diagnosis also becomes more urgent^[1-2]. In control system the electric circuit mainly includes the digital circuit and the analogous circuit. Currently the fault diagnosis technology of digital circuit is already mature, and it obtained the widespread application in the computer domain and in other correlation domain. While analogous circuit in the control system is far more complex than the digital circuit, and its diagnosis difficulty is greater than digital circuit. Although fault diagnosis on analogous circuit was researched earlier than digital circuit, its research progress is very slow, and much fault diagnosis technology of analogous circuit could not put into practice. Its basic reason mainly is that many uncertainties exist in the fault diagnosis process of analogous circuit.

Along with perfect electronic products function, control system's scale is more and more large and complication. It is very urgent to request a better fault diagnosis technology. In control system the electric circuit mainly includes the digital circuit and the analogous circuit. Currently the fault diagnosis technology of digital circuit is already mature, and it obtained the widespread application in the computer domain and in other correlation domain. While analogous circuit in the control system is far more complex than the digital circuit, and its diagnosis difficulty is greater than digital circuit. Although fault diagnosis on analogous circuit was researched earlier than digital circuit, its research progress is very slow, and much fault diagnosis technology of analogous circuit could not put into practice. Its basic reason mainly is that many uncertainties exist in the fault diagnosis process of analogous circuit^[1-3].

The artificial neural networks emerge rapidly in the fault diagnosis domain by its powerful study and parallel processing ability, its original intention is simulates the human brain structure to reflect the objective world and solve problem of the objective world^[4-6]. However, the traditional neural network model only can achieve non-linear mapping between the fault indication characteristic space and the fault pattern space, so the fault diagnosis technical content and the intrinsic essence disappeared. In order to more accurately express or quantify input space sample distribution after fusing indication parameter, and improve the revolving mechanical diagnosis precision, the multi-universe viewpoint which is produced based on the quantum state the superimposition phenomenon is applied to the structural design of the neural network, and a multi-universe quantum neural network model (MUQNN) is produced. Then this model is applied to the analogous circuit's fault diagnosis, which obtains good diagnosis effect.

2. MULTI-UNIVERSE QUANTUM NEURON NETWORK (MUQNN)

In the control system the fault diagnosis of analogous circuit is that information which is obtained in the node of the electric circuit is used to judge the fault on electric circuit, and definite fault primary device position. That is, fault diagnosis of analogous circuit can realize mapping from fault phenomenon space to fault reason space.

In the control system many reason can cause uncertainty of fault diagnosis of analogous circuit, such as tolerance, non-linearity, feedback, and so on. As existence of some uncertainty above, the rate of accuracy of fault diagnosis will reduce inevitably and even undetected and mistake phenomenon will appear. Then, a diagnosis model of multi-universe quantum neural network model is brought forward in the paper according to uncertainty of fault diagnosis, and applied in the fault diagnosis of analogous circuit^[7-8]. By application the method show that it has good resolution for uncertainty of fault diagnosis of analogous circuit between fuzziness classify boundary of fault diagnosis and fault mode. In addition, the method greatly improves precision and safety of fault diagnosis of analogous circuit in the control system.

2.1 Multi-universe quantum neuron network

The multi-universe quantum neural network structure system is similar to the classical network^[9]. The difference lies in the former have several copies of the entire network or part of copies of the network. Each copy trains a pattern by all study rule which is suit to this network architecture. But a part of the network is the classical network possibly, and another part is the quantum network. The classical part of network (non-repetition part) is used for processing all patterns. Activations of these parts come from the all its front redundant part and its weight changes are decided by all after that redundant part feedback.

It has four different part weights altogether for a three feedback network: the weight from input layer to hidden layer, the weight from hidden layer to output layer, and the deviation weight of hidden layer's neuron and output layer's neuron. Four marks are used to replace four different part weights, and they are respectively recorded by IH, HO, HB, OB. The network superimposition condition generate from the four parts. This article take multi-universe quantum neural network in which the four parts are in superimposition condition for search object, and its application of fault diagnosis on the analogous circuit is studied. A quantum neural network model with two universe is shown in Figure 1.

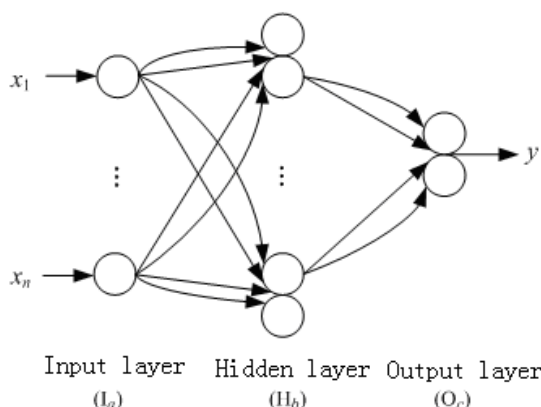


Fig.1 Multi-universe quantum neuron network

Each node between input layer and hidden layer and each node between hidden layer and output layer has several connections which express each sub-network weight's superimposition. In Fig.1. Hidden layer and output layer's neuron represents quantum neuron, which show that superimposition state of each sub-network deviation weight composition. When collapsing occurs, each superimposition state of the weight degeneration for an independent definite weight.

2.2 Collapsing rule

In this article multi-universe quantum neural network model uses the particular collapsing method, that is, when a quantum part collapses to the corresponding part of a fixed subnet, other quantum part also collapses to corresponding part of the same child network. Therefore the network's collapsing rule may be defined as follows simply:

- 1) Supposed x training pattern P_i ($i=1,2,\dots,x$), connected with x universe separately, for test pattern, calculate and get $M_i = |P - P_i|$.
- 2) Calculate $M_c = \min(m_i)$, where c represents universe subscript which is collapsed by the test pattern.

2.3 Main algorithm of MUQNN

Each input pattern of multi-universe quantum neural network correspondences to each input of sub-network. According to collapsing rule, compared training pattern of the child network with the input pattern, closest pattern can win. That is recognition input pattern will be collapsed to the wined sub-network for processing.

Supposed x networks compose the superimposition of entire network altogether and the multi-universe quantum neural network algorithm's main step is as follows:

- 1) Selects x pattern for the training set from the entire pattern set;
- 2) Initialize each sub-network;
- 3) Each sub-network don't carries on training with its corresponding training pattern until outlet error reach the permission scope;

Table 1 Standard sample of input and output

No.	V1	V2	V3	V4	F0	F1	F2	F3	F4
1	0.03	0.02	0.01	0.02	0.01	0.93	0.03	0.04	0.05
2	15.74	1.45	0.68	0.02	0.02	0.01	0.95	0.03	0.05
3	41.28	0.00	0.00	0.01	0.00	0.07	0.00	0.92	0.04
4	24.7	51.1	0.00	0.00	0.00	0.00	0.12	0.04	0.93
5	13.25	1.31	0.53	0.01	0.93	0.04	0.01	0.00	0.02
6	0.02	16.3	0.00	0.02	0.01	0.92	0.03	0.08	0.06
7	0.78	1.39	0.63	0.03	0.03	0.02	0.94	0.02	0.06
8	18.9	0.02	0.00	0.04	0.01	0.06	0.02	0.95	0.03

Table 2 Testing samples

No.	V1	V2	V3	V4	Fault type
1	0.02	0.01	0.01	0.03	C1 short circuit
2	13.63	1.42	0.67	0.03	C2 short circuit
3	41.72	0.00	0.00	0.01	D1 abrupton
4	42.68	12.5	0.00	0.00	D2 abrupton

- 4) Surplus pattern is used for waiting recognition sample, and the specific collapsing rule is used to decide each the universe to which waiting recognition sample will collapse;
- 5) Use the collapsed sub-network process waiting recognition sample, and get the result.

3. APPLICATIONS

To test clustering validity of this article's multi-universe quantum neuron network algorithm, a ITC' 97 international standard electric circuit CTSV filter was taken as a research object^[10-12], and concrete application of this method in fault diagnosis of analogous circuit was discussed. The electric circuit diagram of CTSV filter is shown as Figure 2.

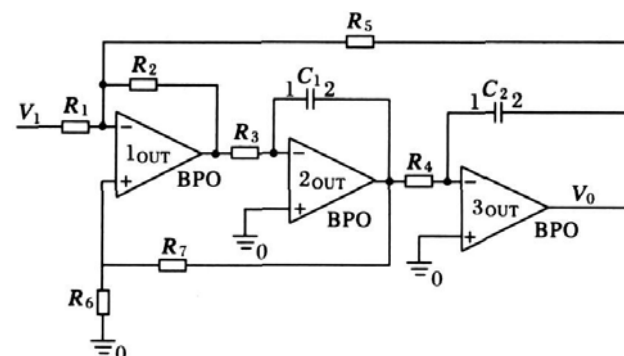


Fig.2 CTSV filter

By anglicizing circuitry principle, in the foundation of consulting the beforehand service record and listening to the correlation expert's advice, C1, C2, R2, and R4 these 4 key point voltage is selected to make judgment. The four key points' voltages is taken for the characteristic value separately. When network is studying and testing all data is got normalized processing. The fault phenomenon universe of discourse is:

$$V = \{V_1, V_2, V_3, V_4\}$$

The fault reason universe of discourse is:

$$F = \{F_0, F_1, F_2, F_3, F_4\}$$

Where, F0 is expressed with no fault of electric circuit, and F1 for short circuit of C1, and F2 for short circuit of C2. F3 is expressed with abrupton of R2, and F4 for abrupton of R4.

To test the multi-universe quantum neuron network algorithm's clustering validity, CTSV filter was taken as a research object in this article [11]. Take fault diagnosis for the four kind of typical fault of this analogous circuit

Two groups of characteristic values is taken separately, and constitutes the corresponding four kind of breakdown of eight group of study sample, and shown as table 1. In order to make contrast and analysis better, the conventional BP network is also used for simulation analysis simultaneously.

Table 3 Testing results

No.	BP network				QNFIS				Fact fault
	F1	F2	F3	F4	F1	F2	F3	F4	
C1	0.74	0.02	0.01	0.03	0.92	0.00	0.05	0.06	C1 short circuit
C2	0.04	0.78	0.05	0.03	0.02	0.95	0.01	0.03	C2 short circuit
D1	0.03	0.04	0.76	0.04	0.00	0.07	0.92	0.00	D1 abrupton
D2	0.01	0.00	0.07	0.81	0.00	0.00	0.12	0.92	D2 abrupton

Make cluster analysis for data of table 1 by using the network collapsing algorithm of fuzzy c- average value. Then carry on the training study for the multi-universe quantum neural network and the BP network separately. In order to confirm fault diagnosis ability for this network model, select 4 groups of unknown fault type's data to as the examination sample, and shown as table 2.

Then do training for the two network respectively, and the diagnosis result is shown as table 3.

From Table 3, we can see that the multi-universe quantum neural network model's diagnosis result is very correct, and consistent with the actual situation. Its diagnosis result precision is higher than other network model obviously. The main reason is that every sub-network of multi-universe quantum neural network is mutually independent, parallel computing, not disturbing mutually, and it has very short learning and training time, good convergence and high precision. Thus greatly increased the fault diagnosis precision and the fault recognition rate of accuracy have achieved 100%.

4. Conclusion

In this article aiming at uncertainty question of analogous circuit's fault diagnosis in control system, the multi-universe viewpoint which is produced based on the quantum state the superimposition phenomenon is applied to the structural design of the neural network, and a multi-universe quantum neural network model is produced. Network collapsing algorithm based on fuzzy c-average value also is produced and applied in the analogous circuit's fault diagnosis. The example simulation and analysis indicated that the multi-universe quantum neural network model can more effectively solve the uncertainty problem in the fault diagnosis process compared with BP network. In addition, it has the characteristic of quick convergence rate and higher diagnosis precision.

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REFERENCES

- [1] Perus M. Neuron-Quantum Parallelism in Brain-Mind and Computers. Informatica, 1996, 20: 173-183.
- [2] Ezhov A A, Ventura D. "Quantum Neural Networks". N. Kasabov(Ed.), Future Directions for Intelligent Systems and Information Science, Springer-verlag, 2000, 213-234.
- [3] Li Fei, ZHENG Baoyu. A study of quantum neural networks. IEEE Int. Conf. Neural Networks & Signal Processing, 2003:539-542.
- [4] Yuuki Nakamiya, etc. Basic Property of a Quantum Neural Network Composed of Kane's Qubits. Proceedings of International Joint Conference on Neural Networks. Montreal, Canada, 2005:1104- 1107.
- [5] RiGui Zhou, Hong Yuan Zheng, etc. Self-Organizing Quantum Neural Network. International Joint Conference on Neural Networks, Vancouver, BC, Canada, 2006, 1067-1072.
- [6] Ventura D, Martinez T R. Quantum associative memory. Information Sciences, 2000, 124 (1-4): 273-296.
- [7] Kenya Andressia de Oliveira, Alvaro Vannucci, Elton Cesar da Silva. Using artificial neural networks to forecast chaotic time series. Phvsica A, 2000, 284:393-404.
- [8] Yao Jianmin, Lin Ming xiu, Song Jianzhong. Discussion of analog circuit fault diagnosis technology based on neural net work[J]. Computer Simulation, 2005, 22(4) : 187- 189.
- [9] Wu Xin, Zhang Bo, Chen Tao. Large-scale analog circuit fault diagnosis based on neural n et work[J]. Computer Automated Measurement & Control, 2004, 12(11) : 1049- 1051.
- [10] Liao Zhiwei, Sun Yaming, Ye Qing hua. Artificial intelligent technologies for fault diagnosis in power system[J]. Pro-ceedings of the CSU-EPSA, 2003, 15(6) : 71- 79.
- [11] Ajit Narayanan, Tammy Menneer. Quantum artificial neural network architectures and components. INFORMATION SCIENCES, 2000, 128:231-255.
- [12] CHEN Ping, XIE Zhi-jiang, OUYANG Qi. Application of Quantum Neural Network Based on Multilevel Transfer Function in Fault Diagnosis of Steam Turbine Set. POWER ENGINEERING, 2007, 27(4): 569~572.

COMPARISON OF METHODS, USING FOR EVALUATION OF MINING FIRMS IN CONDITIONS OF SLOVAK REPUBLIC

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Key words: evaluation of the firm, discounted cash flow, mining firms.



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Abstract: *The paper contributes to the empirical evidence on the techniques and methods used by mining industry in Slovak Republic to estimate a company's value of particular mining companies. Present business environment is not stable, full of problems that have considerable influence to the value of the company. Successful can be only such companies that consider management of the value as main principle of their business and firm's strategy.*

1. INTRODUCTION

In forward market economies evaluation of exclusive layer of raw material is considered as one of the most complex but also most important operations after location and research of every layer. Namely every layer of the industrial mineral is unique due to its location, stocks, quality and other mining and geological conditions.

Particularity of the mining business and products' price at the market is that costs, invested to the mining and elaboration of raw material in mining company, is no criteria for product's price determination. Mining company makes business either with profit and it places its product at the market, or it cannot make business with profit and closes mines.

Evaluation of raw material layer is indeed specific problem, but it is problem that can be solved by classical tools for evaluation of production companies. [2] There are existing basically two possibilities to evaluate layer as a land, respectively consider it as a production company, bringing profit by its activity. Then layer is evaluated through mine (production company) and it is considered (layer) as a tool for money production. Its price is equal present value of future (expected) net incomes from its mining, regarding time horizon, price of capital invested, inflation and risk. Then also methods of discounted cash flow (DCF) can be considered as a way for determination of industrial mineral price.

2. PRESENT STATE OF MINING FIRM'S EVALUATION IN SLOVAKIA

Geological stocks on 621 exclusive layers achieved to 1st January 2011 16,459 mld. tones with considerable prevailing of not ores raw material (12,467 mld. tones). Total mining in 2010 achieved 29,7 mil. tones.

Particularity of mineral resources (exclusive layers) as an ownership of Slovak Republic is basically its nothingness as a public wealth and ownership, since relevant mining and geological legislative does not include institute for evaluation of layer in spite of the fact that Direction of Slovak Republic government No 661/1995 about raw material policy did not assume evaluation of raw material to be comparable with methodology of European Union states and UNO yet from 1997.

Market estimation of layers prices and raw material sources in Slovakia can exist only due to the Law about prices No 526/1990. But there is no reason to describe processes of price determination in

detail for whole broad mix of needs for evaluation of any variant of intangible property. [2]

One of the reasons why there is refusing evaluation of layers in Slovakia is argumentation of variability of indexes, characterizing the layer (quality, quantity and other geological and mining and technical parameters), prices variability, impossibility of estimation of their development, etc. [6]

As for the evaluation of mining companies in Slovakia, it presents part of the process of change in ownership structure or legal form of the company. Due to the difference in economical environment in Slovakia, mainly in comparing with USA, market of securities is acting only in limited measure. Due to the mentioned using of evaluation methods is much weakened. Decree No 254/2010 about determination of general value of the firm's property prescribes process of the evaluation in the frame of applied Slovakian legislative. [2]

Slovakian mining law fully ignores modern methods of raw materials layers evaluation, as well as classification of their stocks. Result is that Slovakian raw material wealth is considerably underestimated, in spite of the fact that there are investing vast amount of investment to the research of layers from state budget (in 2000 estimated value of Slovakian raw material wealth had been approximately 90-270 mld. Sk).

But for private research and mining companies, from abroad or domestic ones, situation is different then in case of state's ownership, since they can evaluate layer by modern accesses and to calculate financial value of its stocks. Decision if to invest or not to invest to further research depends on the way of evaluation. At the same time proper evaluation enables them to make business with layer. Due to the discrepancy among private evaluation and evaluation through state there is created in Slovakia linked state's and private interest, serving mainly to the hundreds of private businessmen, but not public interest of Slovakian inhabitants.

3. TRENDS OF MINING COMPANY EVALUATION IN THE WORLD

Present business environment is not stable, full of problems that have significant influence to the value of the society. Only companies that consider management of their value as a main principle of their business strategies could be successful at the market. Theory of value management (shareholder value) had been rising in 80ties in 20th Century in USA. First formulations of theory

for value management had been rapidly transmitting from advisory to the business practice.

Necessity to manage the value had been caused by following factors:

- ❑ Most able workers are most flexible ones,
- ❑ Boom in the development of business takeovers,
- ❑ Information is more and more available,
- ❑ Living cycle of products are shortening,
- ❑ Global competition and its effects to the whole economies – removing of duties and other regulation barriers, deregulation of business environment, instable interest rates, etc.

High performance rises by creation of maximal value from assets of the company that means by value management. Value management demands readiness to accept objective, value orientated view to the activity of the company.

Value management consists from the three steps realization: determination of restructuring opportunities, behavior according determined opportunities that usually include extend transactions (renouncement and takeover of the company, reorganization of the company) and engrafting in philosophy of the value creation to the access of the company management. [1]

Comparative Company Approach (CCA)

As for the company value determination during CCA there is resulting from concrete, really realized market prices for comparable companies. Potential market prices for evaluated object are then calculated according realized market price for compared company. First of all comparing companies must be chosen. At the small data base this step presents in practice heavily solved problem. Comparing companies are necessary due to the available information possibly about most actual, really realized market prices. [7] To CCA we rank Similar Public Company Method (SPCM), Recent Acquisitions Method (RAM) and Initial-Public-Offering.

Processes, ranked to *Comparative Company Approach* in German speaking areas, are difficultly used due to the lack of data base about proper comparing companies. Regardless of Exchange prices of registered companies, such data in Germany are heavily available, while in USA there are many sources of such information.

Using of *Similar Public Company Method* demands effective capital market and great number of companies, registered at the bourse. At the using of Recent Acquisitions Method there are necessary information about realized transactions. Advisor in USA has available sources of information, as for example Magazine „*The W.T. Grimm & Co. Mergerstat Review*“, which include information, ranked according industrial economies, averagely with 2000-3000 transactions per year. Contra USA advisor in Germany does not have detail information for example about purchase price during actual takeover of the company. In *Initial Public Offerings* there is only necessary information about establishment of the companies at the bourse. In USA there are available information sources, for example „*The IPO Reporter*“ or „*IDD Information Services*“, which provide extend information about establishment at the bourse. [4]

Multiplication method

For evaluation of small and middle companies in USA there are considered more and more so-called „*market multiples*“, which give information about realized market prices in the past in certain area and they are used as orientation help for estimation of market price of the company in the give area. Such multiples can be found also in German speaking areas. Their using is named as multiplication method.

During multiplication method value of the company is determined as a potential market price through multiplication of certain parameter of the evaluated company with branch specified factor that depends on the chosen base and such factor is marked as a multiples. Against *Comparative Company Approach* advisor does not need any information about really realized purchase prices or bourse values of concretely compared company. For using of multiplication method there is necessary only ranking of the company (or its individual parts) to the certain business branch and knowledge of multiples, common in this business branch. Multiples can be related according branches to the various comparing parameters. Regularly there are profit multiples, cash flow multiples and turnover multiples.

Multiplication method is based on many simplifications. It leads to the rough estimation of potential market price of the evaluated company. Potential market prices, estimated according multiples, can serve in the frame of evaluation as orientation parameters. [3]

Method of Discounted Cash Flow

Method of discounted cash flow (DCF) methods are used mainly in USA and Great Britain. But they gradually win recognition also in other countries. Their extension mainly to the continental Europe had been caused by globalization of investment processes that is connected with growing influenced of Anglo-Saxon investors. [8]

As for the DCF methods, they are characterized by value of the company that is determined by discounting of future cash flow. [3] As a result of the company evaluation there is determined market value of total capital, or market value of own capital, designed as „*Shareholder Value*“.

Such evaluation processes base on the following assumptions:

- There is no existing any transaction costs and any segmentation of the market,
- Market subjects have homogenous expectations,
- Information are for free,
- Costs of own, foreign and total capital are known,
- Tax rate, costs of foreign capital and business risk are constant,
- Costs of own capital are determined by capital structure.

DCF methods base also on the determination of potential cash flow of the company. We can speak about various DCF methods, where basic ones present:

Accesses based on the gross capitalization:

- WACC (Weighted Average Cost of Capital),
- TCF (Total Cash Flow),
- APV (Adjusted Present Value).

Accesses based on the net capitalization:

- Equity Approach.

As for gross capitalization Access, value of the evaluated company is determined by two steps. First step means determination of market value of total capital. It results from assumption that financing of necessary capital is made by owners and creditors. Market value of own capital corresponds to sum of market value of expected cash flow from owners and creditors. In second step value of single company is determined, which means value of own capital that is achieved by deduction of foreign capital from total volume of capital.

As for net capitalization, value of own capital is determined by discounting of expected cash flow, derived to owner, plus risk of the equivalent rendition demands of owners.

Comparing of the individual DCF methods and comparing of DCF methods with revenue methods

Comparing of DCF methods

DCF methods determine market value of the company as a market value of total capital, or generally designed as *Shareholder Value* – market value of own capital, obtained by discounting of future cash flow.

Differences of the individual DCF methods pertain due to the volume of discounted cash flow, discount rate and regarding of capital structure change. Different characteristics of the individual processes are illustrated in table 1. It does not regard to the market value of property not used.

Table 1. Comparing of DCF methods

characteristics	Entity approach	Equity approach	Adjusted present value
Cash flow definition	Free CSF or total CSF	Flow of equity	Free CSF
Discount rate	Mixed rate of WACC or TCF from demand of owners rendition in indebted company and cost of foreign capital	Demand for owners rendition in indebted company	Demand for owners rendition in not indebted company

Determination of shareholder value	Market value of total capital (WACC) - market value of active foreign capital = shareholder value	Market value of own capital = shareholder value	Market value of not indebted company +value tax shield from foreign financing = market value of total capital (APV) -market value of active foreign capital = shareholder value
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Source: Raab, 2001

4. CONFRONTATION OF REVENUE METHODS AND DCF ACCESSES

In the following review there are concluded considerable characteristics of the revenue methods and DCF accesses (table 2). There are compared revenue methods according net cash flow of owner and *Entity-Approach* according *Free Cash Flow* as mostly used way of DCF processes expression. Comparison illustrates that different orientation of processes are made according the same evaluation methodology (capital value). Meanwhile in revenue methods there is subjective comparison of alternatives, made by discounting of individual alternative renditions; in DCF methods risk overcharges are used by derivation according theoretical model of capital market.

Method of real option

In present time accesses to the investment evaluation belong to the revenue methods, mainly represented by discounted cash flow. But in spite of their simplicity of calculation, such methods do not regard possibilities of strategic management of investment and that means also flexibility of the firm. During regarding of such possibilities to manage project flexibly, there is proper to identify such possibilities and to regard them proper during investment decision of the firm.

Due to the similarity of such possibilities, respectively real options, there are considered by certain analogue among financial and real options also models of financial options evaluation, mainly for example most known Cox-Ross-Rubinstein binomial model and Black-Scholesov model.

Table 2. Confrontation of revenue and DCF methods

	Revenue methods according net CSF, flowing to owner	Entity approach according free CSF
Conception	Individual comparing of alternatives	Orientation to the capital market
Methodology	Methods of capital value	Method of capital value
Discounted parameters	Net CSF, flowing to owners	Free CSF
Discount rate	Individual alternative rendition	Rate of balanced capital costs from demand of owners renditions
Risk regarding	Individual overcharge equivalent uncertainty (risk or of)	Deriving from theoretical model of capital market (CAPM)
Tax regarding	Firm's taxes	Only firm's taxes (in American basic model)

Source: Peemöller, 2001

5. CONCLUSION

In various countries there are used various methods and conceptions. But all methods have certain advantages, as well as disadvantages. Application of the individual methods can meet various limitations in various areas. In USA and Great Britain there are used mainly Discounted Cash Flow methods. With growing globalization and influence of Anglo – Saxon investors there is assumption that such methods will extend also to other countries.

But they are connected with certain shortages. Some shortages of revenue methods can be overcome by market methods. Here we can rank also market orientated evaluation by real options. Such methods are strongly connected with market environment and market value, market data predominate during their using over accounting data, and they fulfill criteria of flexibility. In comparison with revenue methods they are probably also more objective ones. But objectivity depends also on the experiences and intuition of advisor that make evaluation. Using of market values advantages is therefore linked up to the developed capital market, to many and transparent transactions with firms and sufficiency of reliable data.

Absence of developed capital market could be obviously obstacle during application of market methods in conditions of Slovak republic. Also new purpose of evaluation proves necessity to establish new methods to the evaluation practice. Such purpose can fill acquisitions, mergers that did not exist till present time in Slovak economy.

6. REFERENCES

- [1] T. Copeland, T. Koller, J. Murrin: *Stanovení hodnoty firem*. Victoria Publishing, Praha, 1994, ISBN 8085605414
- [2] J. Glova: *Hodnotová orientácia Economic Value Added - EVA*. Scientific Papers of the University of Pardubice. Series D. Vol. 10 (2006), p. 44-51. - ISSN 1211-555X
- [3] G. Mandl, K. Rabel: *Unternehmensbewertung – eine praxisorientierte Einführung*. Redline, GmbH, 2005, ISBN 3832309950.
- [4] V. Peemöller: *Praxishandbuch der Unternehmensbewertung*, Verlag Neue Wirtschaftsbrieft, 51 – 75, 263 – 360, Berlin, 2001, ISBN 3482511837.
- [5] H. Raab: *Shareholder Value und Verfahren der Unternehmensbewertung*, Verlag Neue Wirtschaftsbrieft, Berlin, 2001. ISBN 3482535213
- [6] R. Weiss: *Identifikácia rizika podnikania v cestovnom ruchu*. Vedecký seminár doktorandov 2009, ISBN 978-80-553-0310-9, Herľany, 2009.
- [7] R. Weiss, J. Zuzik: *Slovenský kapitálový trh*. Zborník príspevkov z vedeckej konferencie “Využívanie výsledkov doktorandského štúdia pre celoživotné vzdelávanie. Košice, ISBN 978-80-553-0353-6, Košice, 2010, p. 83-87.
- [8] T. West, J. Jones: *Handbook of Business Valuation*, New York, Wiley, 1999, ISBN 0471297879

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SERBIA'S PROSPECTS IN THE IT BUSINESS - KNOWLEDGE OF CULTURAL DIFFERENCES

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Abstract: The establishment of modern business means continuous improvement. This is being accomplished through the exchange of experiences with a numerous business people who originate from different parts of the world. In order to compete globally and collaborate with other nations, it is needed to the communications be adopted, to obtain the information about the characteristics of business communication of the country whom we entreat to co-operate with. The main purpose of any business correlation is the achievement of the profit to the mutual satisfaction, which is the result of the successful cooperation. Therefore it is important to explain the link between cultural heritage and corporate culture and communication. This research will be related to the culture of the Serbia and United States of America, likewise for making a parallel between them in purpose of better cooperation later. To understand the different cultures, it is necessary to resort to the dimensions of individual cultures. A matrix, through which the features of cultures of different nations may be broken, is created by comparison of the dimensions previously mentioned, as well as finding similarities and differences among them. This can be done by studying the components and dimensions of culture.

1. INTRODUCTION

Modern business systems tend to develop commercial activities at the international level. In addition to trying to find better business model of integrating into the global business cycle. Globalization offers many opportunities to the modern companies. There are numerous opportunities in expanding market, accessibility of material resources and cheaper labor force, availability of technological and managerial know-how. Globalization itself and the business benefits that globalization bring surpass geographical, political and cultural borders. The companies which engage in global business establish their offices in different parts of the world and thus employ members of different nationalities and cultures. Globalization and internationalization of the business mean that nowadays contemporary management confronts a various differences and the need to overcome the geographical, political, cultural and other barriers. Particular attention is drawn to the differences in national cultures because they have a large impact on the behavior of individuals and groups in the organization. More intense process of the globalization which affects all segments of social and business life no more asks the question whether to engage in globalization trends. It is now implied.

2. GLOBALIZATION OF BUSINESS

Global business requires a different way of practice of the managers. From contemporary managers, modern leaders, new skills are demanded. They must be capable of understanding and appreciation of cultural similarities and differences. Also, they must be able to manage differences between those countries where the company operates. Manager of international companies must have the ability to react rapidly to take advantage of the opportunities that other countries offer, and at the same time avoiding the dangers that threaten the global economy. They must respect the cultural differences of their associates. They need to identify the impact of cultural differences on the behavior of employees. This orientation of management is called multicultural orientation. This is a

characteristic of modern management. In addition, many believe that the multicultural orientation is of one of the most important sources to acquire and maintain competitive advantage for the organization.

It is only needed to find ways to help the existing diversity direct and subordinate to all common interests and goals of the company and its employees. Therefore it is considered that multiculturalism in business life is not an obstacle to performance, but on the contrary it is benefit that should be known how to use.

One of the most important goals is to find practical solutions to the new main issues that have appeared in numerous multicultural companies. Their managers are constantly confronted with the challenges of adapting to local cultures. It is also necessary to increase the efficiency of management practices in local units. Besides, it is also necessary to preserve the unique system of management, and organizational culture.

The importance of national culture has particularly increased during the eighties and nineties of the twentieth century. It was the beginning of the conflict of international managers with cultural distance and limited possibility of applicability of local business practices in different cultural conditions, ie. in different countries. Numerous studies in the field of intercultural management have been conducted. These studies were intended to identify causal relationships between specific dimensions of national culture and the specific characteristics of organizational behavior. So far, the impact of national culture on organizational behavior has been analyzed through a significant amount of researches.

Global way of doing business means increasing multiculturalism within the organizations themselves. Interactions between employees and managers from different cultures are becoming more common. It can be noted that the published domestic and foreign literature increasingly has common attitudes about the importance of respecting cultural differences in order to increase organizational efficiency and strengthen its competitive advantage. If cultural differences are properly managed the company can be led to higher levels of business performance and strengthen its competitiveness in the market.

Promoting tolerance for cultural diversity and respect for

attitudes of different cultures leads to greater openness and willingness of the company to accept new ideas and change in accordance with them. Regarding the acceptance of multiculturalism, if the company is successful in overcoming resistance to change, it will create an excellent position to successfully dealing with resistance of other kind of changes.

In order to successfully manage cultural differences and to understand the influences of national culture on the behavior of the members of the international companies a certain management quality and capability is needed. Among others things managers are expected to be well informed and to know the characteristics of another culture, to be tolerant and to respect different cultural values and to develop the ability to communicate. For successful communication with members of other cultures is not crucial only language skills but it is also important to have good knowledge of other cultural characteristics and dimensions.

National culture represents a determining factor in the behavior of individuals and groups in the companies. In multicultural companies successfully targeting organizational behavior is crucial. The very success depends on the characteristics of managerial knowledge of different cultures and the ways in which national culture shapes the behavior of individuals and groups in the workplace. Successful management of cultural diversity implies knowledge of other cultures and tolerance, appreciation and respect for their specificity. The main objective of cultural differences management is to turn the existing diversity within the company to its advantage and the potential to maintain position on the growing demands of the market and gain a competitive advantage in the marketplace..

3. CULTURAL DEBATES IN CONTEMPORARY CONDITIONS

Cultural debates with some cultures are more easily, and with some more difficult. Therefore, different business strategies are used. Debates of cultures depend on the understanding of time, space and context. Problems which need to be solved in debates of cultures vary from company to company.

Some theorists have tried to make a generalization, so we have a few fundamental principles of cultural debates: [5]

- Debates get more difficult if the context is higher
- Debates get harder if the complexity of the elements is larger
- Debates get more difficult if the cultural distance the larger,
- Debates get easier if the context is low

On the basis of their own knowledge and experience of a foreign culture, Halls dimensions of intercultural communication allow us to independently realize the basic structure of a particular culture. Knowing a foreign language is another skill that will help you to cope with the foreign culture.

High technology has the greatest impact on the changes in communication and in general to changes in lifestyle, understanding of culture and ways of doing business. The spatial boundaries as well as the traditional boundaries between people have been deleted. Now people are contented faster and more easily, and in a time of the connection they can be in different parts of the globe.

So, Edward Hall noted the five basic dimensions that are comparable to culture in communication. These are: the cultural context (high and low), space, time, information flow, cultural debates. [5]

In this way it is possible to easily understand the different cultures.

Cultural context - high and low

"The context includes information concerning one event and is a direct condition of it meaning. The elements that combine to produce a given meaning are presented in varying proportions depending on the culture."

The global business is one of the greatest challenges for managers and they need to find and to recognize the appropriate level of cultural context in any situation. If foreign cooperators are provided with too much information it can lead to their feeling of the need to adapt. But on the other side, if they are given too little information, it can confuse them. In every culture there are specific and different needs of context. To make communication easier, it is important to know whether the culture of a country is on the top or

bottom of the scale of the cultural context, because each person is influenced by the level of the context of their culture.

Cultural context may be: [5]

- High context
- Low-context

In cultures of high context, people rely less on verbal communication and more on the context of nonverbal actions and environments. Latin American, Asian cultures are high-context cultures. In these cultures, information contacts with family, friends, colleagues and clients are intensive. People are very involved in close personal relationships, small parts of communication are coded, or explicit part of the message. People learn from an early age to recognize situational signs and signals (gestures and voice), and how to react in certain ways. In these cultures overly comprehensive information are not necessary for most normal transactions in daily life. People are constantly informed about everything that has to do with people who are important in their life. People from high-context cultures are impatient and irritated when people from low-context cultures insist on information they do not need. This fact is very important for any kind of negotiation and later for further cooperation.

Low-context communication is the opposite of high cultural context. Low-context cultures are presented in the United States and in the northern European countries. The inhabitants of these countries rely more on verbal communication and less on non-verbal. In low-context culture people explain their own actions and give signs to the people they are talking to on what to do or what to expect. Members of low-context culture strictly separate the private life from business. Therefore, they need detailed comprehensive information whenever they interact with other people. So, again global managers have to be aware that members of low-context cultures are still in doubt when communicating with members of high-context cultures because they do not provide enough information.

Space

In different cultures space means different things concerning territoriality and personal space and proximity to the contact with each other.

Territoriality is highly developed at humans. It is an innate characteristic whose roots lie hundreds of millions of years in the past. Territoriality is strongly influenced by culture. It is characteristic for Americans, they tend to use the term "mine" for space. For Americans, the space is the power. Influential people in the company typically have offices on the corner. It is also a private office in any location is better ranked than the desk in the open space. The top floor is reserved for senior managers and executives.

Personal space is another form of territory. Each person has around himself "invisible bubble" of space, which expands and contracts depending on: the relationship with the people around, the emotional state of the person, the cultural heritage and the activities of his performs. Only a small number of people are allowed to penetrate into this territory. Changes in the "bubble" are caused by the narrowness of space or crowd, causing people to feel discomfort or aggression.

There are hundreds of physical signs and signals. People absorb the significance of these signs in the context of their own culture. This applies to personal boundary / distance. This is rarely thought of on a conscious level and it is modeled by culture. Foreign physical signs are almost always interpreted incorrectly, leading to bad emotions. Thus, it may lead to misunderstanding at people of other cultures. For example, if the business cooperator seems aggressive and intrusive, or distant and cold, it could mean that his / her spatial distance is different than yours. If these cultural differences are familiar to all participants the communication will be easier.

Time

For management there are two most important types of using time. These are: [5]

- Monochronic is the time when attention is paid and only one thing at a time can be done.
- Polychronic is the time when many things at once are involved.

Because of these two systems two cultures can be distinguished:

- Monochronic culture - the time is perceived and used in a

linear way. Monochronic time is divided into segments which enables people to concentrate on one thing at a time. Priority is always scheduled compared to all other things. For the people in monochronic culture time is money. The time is spoken of as something that can be saved, wasted, spent or lost. Time is observed as a system of classification and prioritization. Members of monochronic culture who are governed by the time do not like to be interrupted. So, to some extent we can say that monochronic time effectively isolates people.

• Polychronic culture – in the culture of polychronic, time is not considered like in monochronic. It cannot be insisted on adherence to schedule. It can be insisted more on the course of affairs than the compliance schedule. Business space often has the great reception where people can wait and there employee can discuss work with various clients and with colleagues. In polychronic culture private space is considered to impede the flow of information as it separates people. The exact opposite of monochronic culture, in polychronic culture the scheduled meetings are not sacred and can be moved even at the last minute in order to hold a meeting with someone more important in the hierarchy. It is not unusual that priority is given to family members rather than any of the business partners. Members of polycyclic cultures have many close friends and clients with whom they spend a lot of time. Close ties with clients and customers create mutual feelings of obligation and a common desire to help. In this culture, people share a lot of information. They strive to maintain ties with everything and everyone, regardless of whether it is business or personal contact.

The biggest stumbling block in intercultural understanding the are cultural differences of information flow. Contemporary international managers should be more aware of this fact and also need to know how to handle the information, and whether they flow easily through the company or they are limited to the narrow channels due to the division into sections.

Information aims to produce action. Length of travel time of a messages from one part of the organization to another and result with the reactions presents response rate of information flow.

For people who live in high-context cultures channels are rarely crowded because people are in constant contact. Wherever people are spatially engaged with each other, information flows freely. Information is expanding rapidly and moves as it has its own life. They put everyone in a context in order to achieve channels of information, determine whether the group can work together, and evaluate the chances of reaching an agreement in the future. Members of these cultures have a strong urge to stay in touch and be modern. These cultures are characterized by a high information flow.

People who use information as an instrument of "command and control" and who build their plans on controlled information, can experience cruel shock in cultures where people live in a sea of information. For people who live in low-context cultures information is extremely focused, divided into parts, controlled and therefore not prone to free flow. Organization where information flows slowly are close the Europeans from the north, because the low flow of information is associated with a low-context and monochronic time

These two countries, **Serbia and the United States** have different cultures, but in spite of that, there are some similarities. Serbia has had a turbulent history, and different cultural heritage compared to the U.S.. During the last twenty years in Serbia there have been lots of events, which affected its business ethos. If we look back at the history, that is, the socio-historical conditions of the formation of cultural forms in Serbia, we can logically explain Hofstede's results: [8]

- high power distance,
- expressed uncertainty avoidance,
- strong collectivism
- prevailing "feminine" values.

The former Yugoslavia, and thus Serbia is ranked in the cluster of Latin American countries. Serbia has a somewhat higher similarity with the cultures of Latin America (Chile, Mexico, Venezuela, Colombia), and lower with the Latin countries of Europe (France, Italy, Spain). What is common to Latin countries, and Serbia is a high power distance and uncertainty avoidance but also there are some big differences. Cultures of Latin countries are individualistic, whereas the Serbian national culture is largely collectivist. Unlike many cultures of the group of Latin American culture, Serbian culture has

feminine values. Serbian national culture has a unique combination of high power distance, high uncertainty avoidance, collectivism and femininity.

Table No.1.: Dimensions of Serbian culture [7]

Dimensions of national culture	index	rank
power distance	76 (11-104) ¹	122 ²
uncertainty avoidance	88 (8-112)	8
individualism	27 (6-91)	33-35
masculinity	21 (5-95)	48-49

Notice 1: The numbers in parentheses indicate the minimum and maximum index of 53 countries

Notice 2: Rank ranges from 1 to 53 how many were countries in the sample

Index of individualism in America is big and is 91 on a scale to 100 and those results indicate a society with individual attitude and a pretty weak connection with others. People are more independent. They care only about themselves and their loved ones.

Index of masculinity is a 62 on a scale to 100 and It is quite high compared to the average of 50. This points to the fact that in America there is a clear difference between the sexes. Men dominate much of the society and power structure. Therefore, women are more competitive-minded and wish to express their views strongly. They are also facing a male role model more than women.

Power distance is the 40th graduation (level), compared with an average of 55. This scale indicates a greater equality between societal levels, including government, organizations and even families. This orientation strengthens the cooperative interaction of power levels and creates a stable cultural environment.

Uncertainty avoidance is 46, on a scale of 100. Compared to the world average of 64, this low level of uncertainty avoidance, is typical for companies that do not have rules. Such companies have no intention to control all outcomes and results. Such companies also have a high level of tolerance for different ideas, thoughts and beliefs.

Table 2.: Dimensions of American culture[7]

Dimensions of national culture	index	rank
power distance	40 (11-104) ³	16 ⁴
uncertainty avoidance	46 (8-112)	11
individualism	91 (6-91)	50
masculinity	62 (5-95)	36

Notice3: The numbers in parentheses indicate the minimum and maximum index of 53 countries

Notice 4: Rank ranges from 1 to 53 how many were countries in the sample

4. SERBIA'S PROSPECTS IN THE IT BUSINESS

Internet enables the placement of IT products and services in the global market with minimal cost and minimal consumption of resources. Practically, all that is needed is a computer and internet connection. The Internet has enabled individuals from around the world to communicate in real time and work together on projects, like they are located in the same office or building. This advantage was used by IT companies in developed markets. This is all done in order to reduce costs, including: space, materials and taxes. Companies have hired workers from less developed countries and only communicate by sending funds through the Internet. In the country where outsourced service operates, this activity cannot even be registered.

It is estimated that in the Republic of Serbia currently 25% of local engineers work for software companies in this way.[18] This number is constantly growing. Given that local companies pay high taxes and regularly employed professionals, they can hardly compete with foreign companies. Also local companies are struggling to keep their employees whose education and training they have already invested in. This means that the total tax and benefits for employees directly affects the competitiveness of domestic software companies.

The Republic of Serbia is not currently in "Gartner's" of the 30 most wanted for investing in IT industry.

The necessary conditions to be met are: foreign languages - especially English language skills, training improvement of local experts and average structure of education - this is especially needed for IT. Besides, government support is also necessary, improving the quality of telecommunications infrastructure, reducing the amount of expenses (rent, travel), political and economic stability, cultural compatibility, legal security and data protection and privacy.

The major objections to the development of IT jobs in the Republic of Serbia are counted as: not enough top experts, the lack of state support, higher costs, and political and economic instability.

Educational workers are a source of economic power in contemporary social development. The laws of the market, i.e. the laws of supply and demand are present in education. In developed countries, education is the most profitable activity. All demands for improvement of methods and means of learning are increasing. The main question is whether a man is opened for changes and to which extent he will be able to follow them.

"In the field of education a tendency of linear models has been noticed, which tends to impose a monocultural education in societies characterized by cultural diversity. In schools, multiculturalism advocates for programs that include contents that belong to different cultures. It also calls for the organization of various religious and other ceremonies that foster an awareness of cultural diversity and at the same time encourage positive relationships among students." [21]

The basis for good governance, decision-making and the promotion of democracy, strengthening the capacity of individuals, groups is education. Education must ensure the integration of knowledge in sectors such as environment, economy and society, in order to ensure better quality of life. Moreover, education must adapt the labor market. Access to quality education for all citizens must be ensured. No less important is that educated people are trained in accordance with the changes in technology and changes in the labor market. In order to achieve this, local cooperation between schools, businesses, companies, etc. must be provided. As well as it should be provided at the international level between the relevant scientific and educational institutions.

Multinational companies have become a major factor in migration of highly qualified personnel. They often send their employees for training averagely from 6 to 24 months in the country and abroad. The main objective is the exchange of knowledge. This is a good example of the circulation of knowledge but, on the other side, migration from Serbia is still a weakness for further development in field of IT development.

Thesis about leaving the young and highly educated people abroad are published in public. It is frequently mentioned that 600,000 educated people left the country during the nineties. This assessment is excessive given that in Serbia, according to the census in 1991 there were 564 304 people with higher education. [10]

Unfortunately there is no generally accepted and standardized tool for monitoring and studying the migration of the highly educated. There is little information available both in the country of origin and the country of migration. It is a migration that is not fully transparent. Partly, this is due to the motifs of departure that can be educational or self-developing.

A distinction is made between migrations in Serbia during the nineties compared to the earlier migration. In the nineties, there was a mass exodus of a substantial portion of the population. Quite a large number of migrant during the nineties consisted of capable younger workers.

"Based on the research that, in 1993, in 1994. and 1995. was conducted by the Ministry of Science and Technology of the Republic of Serbia and the Institute for International Politics and Economy in the period since 1979 - in 1994. nearly 1,300 researchers (most graduates and PhDs in science) who were employed in research institutions went abroad." [20]

The analysis shows that the age structure of migrants in most cases is less than 40 years. [20]

Faculty of the Belgrade conducted research on the characteristics of migration in the period since 1994. up in 1999. year. It is estimated that during this period 5% of the total population moved. This is more than in previous decades. [20]

- According to the data from 1971. 2.5% of the population emigrated

- According to the data from 1981. 3.6% of the population emigrated

- According to the data from 1991. 3.9% of the population emigrated

According to the data obtained through the survey, which was conducted within the study of Philosophy, University of Belgrade, the majority (91%) consisted of younger people and middle-age people, under 40 years old. These were mostly students and people with high educational attainment. In 1994, 44% of migrants had higher education, i.e. more than 13 years of schooling. In 1999 48% of the respondents had more than 13 years of schooling. In the nineties, Serbia lost a significant portion of its best potential workforce.

From the former Yugoslavia, according to data from the UN Economic Commission for Europe in the period 1991-1993. between 800,000 and one million people emigrated. It is estimated that 2% of the population were highly educated.

"During 1993. the U.S. received 422 experts from the former Yugoslavia, and Canada in the same year issued more than 7,000 immigrant visas, and almost a quarter of that number are highly skilled people. Since 1992. by 2007, the United States issued 62,745 immigrant visas, Canada (1992-2006) 33,153 immigrant visas and Australia about 29 thousand immigrant visas to citizens of Serbia and Montenegro." [14]

More than 10% of the displaced persons were university graduates. In addition, many citizens of Serbia have a nonimmigrant visa that allows them temporary work and residence.

During the Fiscal Year 2002 – 2003, the U.S received a total of 454 persons from Serbia and Montenegro, who were temporary workers. H1B visa is issued to workers with particular occupations. That same year, among them there were 26 people who belonged to the category of workers with exceptional skills and achievements. In the same period, the U.S. issued 790 visas on the basis of exchanges and 1,535 visa students studying in this country. It's not a negligible figure, since it is known that student migration is a precursor of the brain drain. [14]

"Professor Vladimir Grečić quotes studies of high migration of other experts (Frédéric Docquier, Hillel Rapoport), according to which Serbia and Montenegro (data for 2005. while there still was the State Union of Serbia and Montenegro) had 149,065 displaced professionals, covering 24 . place on the list of countries with the largest number of displaced professionals." [4]

The analysis of World Economic Forum shows that the efficiency of the labor market in Serbia is very low. The biggest obstacles to the improvement of foreign economic cooperation between Serbia and the other countries are: corruption, political instability, access to finance and the inefficiency of the public administration.

In a survey of 133 countries in terms of efficient use of talent, Serbia is ranked 98th place. In assessing the efficiency four factors were taken into account:

- the relationship between wages and productivity
- leaning on professional management
- brain drain and the participation of women in the labor force

Some studies have found that professional management and Serbia is neglected, the state does not care about their talents and because of that they suffer from "chronic brain drain."

5. CONCLUSION

The application of computers and the Internet in education in Serbia is still at low levels. As the development of IT skills contributes to strengthening competitiveness and employment opportunities, hence there's the need to reform the education system. Of course, in order to make this possible, new investments will be needed. The problem which will be faced is of a financial nature.

Cooperation with companies engaged in the development of information technology can be one of the solutions. A complete and quality application of information technology in the organization of teaching requires fundamental changes. To begin changes implementation any subject can be taken. Teachers need to be trained and professionally perfected. They must be prepared for lifelong learning. They have to follow the trends and frequent changes in information technology. The application of information technology in education varies from state to state. There are two basic approaches

that use introduction of information technology in teaching content. One is the introduction of a specialist subject in the field of information technology. Another way is to use information technology as a tool in other subjects.

Also university should be seen as a place of learning, professional activity. University is a place that creates cultural and social development. It is therefore very important to develop a partnership of universities with industry and international institutions. Nowadays, higher education must develop and transmit knowledge through teaching and research work. It is necessary to develop key competencies and learning of foreign languages and education in the field of information technology. The importance of universities is to enhance the area of science, technology and mathematics. It is necessary to increase the mobility of students, teachers and linking universities to develop resources (technical, financial and human) in education, empowering individuals to personal development and well-being of society. First of all it must be done on the quality of education, because it is a basic requirement for trust and attraction.

In addition to all the above items that are needed, understanding of cultural diversity must be taken into account. Although we can conclude that there are great similarities between Serbian and American culture, practice has shown that in the course of cooperation more problems do not occur. Even more, it can be said that the cooperation itself in most cases runs very smoothly, despite the cultural differences. However, bearing in mind that in the U.S. expressed multiculturalism, which made it very tolerant of today's professionals related to cultural differences. Besides, American companies have recognized the benefits of multiculturalism in business, companies require managers, and often the employees at the lowest positions in the company, have a certificate of intercultural competence.

It is known that a large number of our experts is hired by U.S. companies. Unfortunately, as most of the experts are hired through intermediary agencies operating in the countries of Europe, or engaged by part time contract, we do not have the official statistics on the number of Serbian experts who work for American companies. Given the quality of education that IT professionals in Serbia can get, and the financial crisis that has lasted for a long time and that affects the low standard of living, what can we expect in the future is that with the development of IT, the number of such Internet engagements grows considerably.

Analysis of cultural differences clearly confirm proper orientation and full justification of the hypotheses. This can be considered as a significant reason for further monitoring and research in the field of intercultural management, especially in the field of information technology.

5. REFERENCES

- [1] Cox H.T., Blake S., Managing cultural diversity: implications for organizational competitiveness, Academy of Management Executive, Vol.5, No.3, 2001.
- [2] D.Lawson-Johnson C., Patel, S., The Effect of Cultural Differences on Software Development, Fountain Publishers, Kampala. 2009.
- [3] Docquier F. Rapoport H.: *Skilled Migration: The Perspective of Developing Countries*, World Bank Research Paper No. 3382, June 2007
- [4] Hall Edward T.: *Beyond Culture*, Garden City, Anchor Press/Doubleday, NY, USA, 1976.
- [5] Hofstede, G. Culture's consequences: Comparing values, behaviors, institutions, and organizations across nations. Thousand Oaks, CA: Sage, 2001.
- [6] Hofstede, G. National Cultures in Four Dimensions. A Research – based Theory of Cultural Differences among Nations“, (1983), страна 52
- [7] Hofstede, G., & ITIM.. Geert Hofstede cultural dimensions. from <http://www.geert-hofstede.com> Retrieved 30.12.2007.
- [8] Huang H., Trauth E. M., Cultural influences on temporal separation and coordination in globally distributed software development, The Pennsylvania State University (2008) ICIS 2008 Proceedings, 2008.
- [9] Jones M., Cultural Impact of information systems – through the eyes of Hofstede – a critical journey, University of Wollongong, Australia, Irit Alony, Central Queensland University, Rock Hampton, Australia, 2007.
- [10] Jovanović M., Langović Milićević A., Cvetkovski T.: Environmental Variable and Global Competition for Talent: The Case of Serbia East Asia: Comparative Perspective, Vol 11, No. 1, pg. 87-104 <http://ineas.donga.ac.kr> Printed by Sejong Printing Co. Ltd. ISSN: 1975-6135 The Institute for East Asian Studies, Dong-A University, 2012.
- [11] Jovanović M., Milićević Langović A., Cvetkovski T.: „Intercultural Management and Serbia“, pg. 548-551, 4th International Conference „Innovation in Management: the Cutting Edge of Business Education and Practice in an Epoch of Global Collaboration“, Poznan University, College of Business and Foreign Languages, Poznan, Poland, 21-22. May 2009. ISBN 978-83-925092-9-5
- [12] Lucas, H.C., & Spittler, V.: Implementation in a world of workstations and networks. Information and Management, 38, 2000.
- [13] Settler Arrivals 1991/92 to 2006/07. States and Territories, Canberra, Commonwealth of Australia, 2008; Facts and Figures. Immigration Overview. Permanent Temporary Residents, Canada, 2008; 2004 Yearbook of Immigration Statistics, U.S. Department of Homeland Security, 2005; 2007 Yearbook of Immigration Statistics, U.S. Department of Homeland Security, 2008
- [14] Sparrow, P., & Hiltrop, J. -M. European human resource management in transition. New York: Prentice Hall, 1994.
- [15] Srite, M. The Influence of National Culture on the Acceptance and Use of Information Technologies: An Empirical Study, dissertation, FSU, 2000.
- [16] Straub, D., Loch, K., Evaristo, R., Karahanna, E., & Srite, M. Toward a theory-based measurement of culture. Journal of Global Information Management, 10 enkatesh, V., Morris, M.G., Davis, G.B., & Davis, F.D. (2003). User acceptance of information technology: toward a unified view. MIS Quarterly, 27 (3) (1) 2002.
- [17] Terterov, M., Doing Business in Serbia, GMB Publishing Ltd & SIEPA, 2006.
- [18] Zlatko Langović, Brankica Pažun, Langović Milićević A.: The cultural impact of information technology, Zbornik radova sa naučnog skupa: Kulturna politika, uetničko stvaralaštvo i medijska praksa u funkciji održivog društvenog razvoja, Megatrend univerzitet, Beograd, 2012. str. 83-90. ISBN 978-86-7747-476-8; COBISS.SR-ID 195612940 Urednik Slobodan Branković – monografski zbornik- 31. Maj 2012
- [19] Гречић В., Кутлача Ђ., Матејић В., Микић О.: Миграције високостручних кадрова и научника из СР Југославије“, Институт за међународну политику и привреду и Министарство за развој, науку и животну средину, Београд, 1996; Исто наведено у: „Положај грађана СЦГ у европским земљама“, Марко Николић, Институт за међународну привредну политику, Београд 2005
- [20] Семприни А. Мултикултурализам, Париз 1997, страна 157

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BUSINESS OFFER ANALYSIS OF CONSULTING ORGANIZATIONS IN SERBIA

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Abstract: *This paper's aim is to find out quality and quantity of the consulting services in Serbia at this stage of its accession to Europe in this field. According to an objective state of the consulting in Serbia in the observed moment, there logically imposes a fact that the best offer is of those consulting services which refer to strategy and management, so this question has formed into a hypothesis: The biggest offer of the consulting services in Serbia is in the field of a corporative strategy and an operational management. That is to say, affirmation of market business in Serbia has imposed new rules in society and economy. Such changes are excellent precondition for the consulting sector development. Enterprises try to improve competitiveness through adoption of new products, technologies and services. A need for getting to know some business processes has initiated better consulting engagement. However, lack of information in enterprises on useful effects of the consulting services represents a significant obstacle for the consulting market development. Consequentially, this paper has pretensions to point out to many questions related to this problem, to start their solving, to inform those who should be interested in a role and a significance of the consulting, methods of their use – everything which could contribute to some interest and economy development, including also solutions proposals, resulted from the exact researches by logical conclusions, through the scientific methods application.*

1. INTRODUCTION

Accessing Serbia to the EU and development of market and market relations has affected the consulting development as a professional activity, which has specific methodological, conceptual, ethical and other performances. An assumption for successful consulting is a business integrity and business expertness of a consultant. On the other hand, a client should know the consulting market and business supply of the consulting organizations, in order to choose an adequate consultant for some business problem. Swiftness, quality, added value and reasonable solutions become key factors of the consultant's selection. The consulting services can differ from case to case, depending on goals which should attain, but a basic role is to increase a value and a company's - client's reputation through the consulting process [1]. In our terms, the consulting represents a necessity imposed by a new market business system, which forms in transition process [2].

Some of concrete characteristics of management consulting must accentuate at the very beginning of the paper.

First, the consulting (advising) is an independent role. It is characterized by engaging the consultant, where his supplement characteristic is at the same time his main role. But this independence means instantaneously that the consultants enter very complex relations with their client organizations and people who work in them. The consultant has no direct authority to make decision on changes and to apply them, but this does not consider as a fault. He has to improve a skill of profound consideration of changes, without abandoning his independence. Consequentially, he must provide the highest level of involvement in the client's work, so the final success would be the mutual one.

Second, the consulting is essentially a consulting service, which means that the consultants are not hired to manage the organizations or to make delicate decisions on behalf of „terrible“ managers. They are consultants (advisers) and their responsibility refers to quality and worthiness of advice they provide,

while the clients bear all responsibilities which appear. Surely, in the consulting practice, there are numerous variances and many „consulting“ levels. It is not only about providing a right advice, but providing advices timely and in right manner – those are basic consultant skills. In return, the client has to become skilful in acceptance and application of the consultant's advice.

Third, the consulting is a service which provides professional knowledge and skills important for practical problems of management. An individual becomes a management consultant, in the full sense of the word, by collecting the knowledge on different situations of management and organization, as well as by adopting necessary skills for solving the problems – for problems identification, finding out relevant information, analysis and synthesis (uniting and disuniting information), choosing the right solution when numerous are possible, communication with people, etc. The managers also must have specific skill types. What is special concerning consultants is that they pass through many organizations and trainings, during years, how to use their collected experience from previous tasks in new conditions. Besides, the professional consultants improve constantly concerning the management methods and techniques, including those which use at universities and research institutions, then carry over the experience to the clients and help them to apply it. They work as a connection between theory and practice in management.

Fourth, the consulting is not a service which provides a magical solution of excessively tough managerial problems. It would be misinterpreted to consider a consultant as a magician who can help in every situation. The consulting is hard, systematic and disciplined work, based on analysis of solid facts and research of all possible solutions. Powerful devotion of management in solving the organization problems and cooperation between a client and a consultant is of equal significance for the final results, as well as the consulting quality [3].

The managers would not see the reason for hiring the concrete consultants if they do not provide something which they miss in their

own organization. As a rule, the consultants hire for one or several reasons:

1. *Possess special knowledge and skills.* The consultants hire when there miss people in organization who can solve certain problem with the same chance for success. Here are often inevitable new techniques and methods which the consultant is familiar with, due to his professional expertise. In other cases, the problem which solves can be more common, if the organization wishes to achieve its main goals and to overcome a chasm in knowledge about the management general policy, planning, cooperation or leadership.
2. *Provide an intensive professional support on temporary basis.* Deep interest for big business problems, like firms organization or market policies, requires full attention and devotion of top managers in long-term. But daily job leaves little time and, what is worse, it is hard to concentrate simultaneously on operational and conceptual problems. The consultants are not just devoted to one problem type full time, but they will leave the organization once the job is done.
3. *Give independent opinion and judgement on problems.* Even the best people in the organization can be under great influence of their own prejudices and existing tradition and customs present in the firm, so they can be incapable to envisage a problem as it is, and therefore cannot suggest a real solution. As the consultant is independent from the client's organization, he can be neutral and right in all situations.
4. *Give the management arguments which justify predestined criteria.* From time to time, the firms hire the consultants requesting that they take some actions and submit reports, so the manager can justify his decision which basis on the consultant's recommendations. In other words, the manager can know exactly what he wishes and what his decision is going to be, but he wishes to get from the consultant also a report on facts which justify such decision. This is not a logical course of activities but, as a matter of principle and own interests, the professional consultants must be careful not to accept assignments in which their services will be possibly abused [4].

The mentioned reasons can exist to varying degrees and can be mutually connected, so the consultant faces very complex situations. Regardless to it, he has to have a clear insight in reasons due to which his service were requested, even if the initial reasons change or uncover some completely new. The consultant must dispose with numerous facts, in order to have as clearer picture as possible on a situation or a problem which considers in the firm. Also, management requires greater accountability for the consulting investment [5].

The consulting methodology is based on working tasks forming, which represents the consultant's activity plan [6]. Necessary facts for realizing a working task, the consultant identifies in cooperation with an ordering party or an ordering party's members, which are familiar with the enterprise's documents and other sources with necessary data. With recognition of the current state in the enterprise can get useful information, as well as through informing about experience, impressions, opinion and convictions of employees in the enterprise. The collected facts must analyze further on [7].

2. METHODOLOGY

Empirical research was done by a procedure, by which achieve relevant conclusions for science – researching data in the field, more concrete, by collecting appropriate data in the consulting organizations which work in Serbia. The survey of the consulting services supply in Serbia was done with help of three techniques: 1) telephone survey, 2) direct interview and 3) electronically. The analyzed sample comprises 35 surveyed units: private consulting organizations in Serbia, agencies for development of small and medium enterprises, scientific-research organizations, international organizations which provide the consulting services in Serbia, regional chambers of commerce, etc. Here was tried to comprise by

the sample as more representative units as possible, which significantly determine trends on the consulting services market in Serbia, such as: Economics Institute, KPMG, BC EXCEL, Appraisal Associates, NICEF, Konzit, Euro quality Group, Human Synergetics and others. A spatial distribution of this stratum was based on the results of desk research, which points out that the consulting organizations were concentrated, in significant number, in Belgrade. According to files of the Serbian Chamber of Commerce, of totally 973 consulting organizations, 773 of them were registered and do business in Belgrade. Accordingly, by the research was comprised around 80% of surveyed consulting organizations, located in Belgrade.

The empirical research comprises the consulting service lines after the FEACO (European Federation of Management Consultancies Association) classification of consulting activities in the following fields: 1) operational management – encloses operational aspects of organization, i.e. production management, acquisition and distribution, 2) information technology – refers to storing, organizing and using business information, 3) corporate strategy – focuses at long-term and strategic welfare of an enterprise, 4) human resources – main fields of this consulting service line are: research and selection, training and development, performances measuring (basic aim is to improve the organization's personnel), 5) outsourcing services – for many firms, these services of management consulting had become very significant with growth rate, as the higher in comparison with other service lines. The consulting services supply for small and medium enterprises will be also exposed to the empirical analysis, and will be perceived also validity and opportunities of networking small consulting organizations in Serbia. At the same time will analyze the consulting services, which are an integral part of clusters and business incubators in Serbia. Models of the consulting services payment in Serbia will be a subject of the empirical analysis, too.

3. RESULTS

3.1. Supply of the consulting services in Serbia

One of the questions meant for the consulting organizations, which have been sampled, was: *Name types of the consulting services that you offer.* Such question, put directly, could provide a real picture of the consulting services incidence in Serbia, a supply, placed at the disposal of enterprises. The answers of the surveyed consulting organizations can sublimely show in the following table:

Table 1. Incidence of consulting services service lines' supply in Serbia

Sub-category of consulting service line	%
OPERATIONAL MANAGEMENT	
Business plans	9,00
Investment program	4,00
Re-engineering	2,00
Operational services in enterprise's foundation	2,00
Consulting in the field of quality system	4,00
Total Quality Management	2,00
Integrated management systems	1,00
Operational support to business of SMEs	1,00
Environment protection	1,00
Influence assessment on the environment	1,00
Waste management	1,00
Total operational management	28,00
INFORMATION TECHNOLOGY	
IT consulting	2,00
Support in using information resources	2,00
Information systems and modelling	1,00
Total information technology	5,00
CORPORATIVE STRATEGY	
Revision of financial reports	3,00
Donations revision	1,00
Accountancy	3,00
Evaluation of capital value and property	8,00
Privatization programs	8,00
Financial consulting	6,00
Due diligence analysis	3,00

Certificates on done investments	1,00
Recapitalization	1,00
Financial consolidation of enterprise	1,00
Information on credits and government funds	2,00
Organizational changes and development	3,00
Programs of enterprises restructuring	2,00
Research of consumers' attitudes	1,00
Branding enterprise	2,00
Market positioning of products and services	2,00
Marketing and organization of fairs	1,00
Advising concerning competitive behaviour	1,00
Development strategy of some sectors	1,00
Total corporative strategy	50,00
HUMAN RESOURCES	
Business education and trainings	7,00
Training	2,00
Development of individuals and teams	1,00
Selection of personnel	1,00
Personnel management	1,00
Mentoring clients	1,00
Total human resources	13,00
OUTSOURCING	
Web designing and programing	4,00
Total outsourcing	4,00
TOTAL	100,00

Source: own

As it is obvious, the biggest supply of the consulting services in Serbia is in the field of corporative strategy (50%) and operational management (28%) and can interpret by mutual desire of the consultants and the clients to get, as faster as possible, to desirable results, which, in certain way, looks natural and logical (Table 1). However, if the process has not been followed by information technology and education – there achieves only temporary effect, and therefore, also false success. Exactly the supply of consulting houses in the field of information technology and education (although, according to answers to a matching question, this field affect the most at the consulting services development) is very poor (5%), only outsourcing is slightly poorer (4%), so there can conclude that there should work for the consulting organizations to increase and improve the supply in this field.

The data which could be got in this way unambiguously show that the supply of the consulting services in Serbia is not quite suitable to enterprises' needs. A fact that information technology and education have the greatest influence to the consulting services development, and they have been lacking in the supply – is a unique absurdity and it leads to a conclusion that the consulting organizations do not care for development of the consulting services in Serbia, so they do not undertake basic measures for own development. As such conclusion cannot be normal, we could rather say that the data show an immaturity of the consulting market in Serbia, even that the consulting organizations use a relative confusion of Serbian enterprises during an invasion of need for changes, need for the consulting services, so they offer those most profitable services. Of course, as a reason for such condition, cannot be neglected neither mutual desire for fast shift toward radical changes, i.e. success, although it is all of short-term and short-range.

Such condition partly allays the data, which were got by the empirical research. To a question *In what extent was present, so called, a process consulting in your work, which implies improvement of the clients' ability to solve business problems independently*, we got fairly calming answers:

- Significant – 48,57%;
- Occasionally – 37,14%;
- Never – 14,29%.

This form of education will surely not significantly increase demand for the consulting services, but will surely bring a significant interest from investments in the consulting. Previous experience shows that the consultants are mostly concentrated on enterprises in strategic crisis and success crisis. The consultants deal with enterprises with liquidity crisis poorly and those which already

succumb to insolvent regulatory rules. As a reason for these facts often states fear of loosing image or remuneration [8].

3.2. Structure of the consulting organization

In developed market economies, the consulting organizations have based their services' specialization on their clients' specialization. The oldest form of specialization was after the functional principle. It means that the consultants were specialized for some of management functions (managing production, finances, marketing ...). In time, its significance got the specialization by sectors: banking, small enterprises, transportation, construction industry, etc. [9].

The consulting organizations in Serbia are mainly organized by the functional principle, i.e. insufficient was the specialization by specific sectors. It is noticeable if perceives the supply of the consulting organizations, which has been directed to business problems of some functions enterprises- clients. Accordingly, development of the consulting services in Serbia is in initial phase, which is similar to the consulting beginnings in developed economies.

During the consulting organization structuring must take into consideration a great number of dependent variables, including also a character of people in managerial positions. Therefore, there is no strict structure of the consulting organization. Only can be noticed specific examples and common principles.

3.3. Models of payment for the consulting services in Serbia

Between the consultants and the clients should not exist a misunderstanding when it is a question of the consultant's fee, as well as the model of the consulting services paying. If an enterprise has a limited experience in using the consulting services, it is necessary that management asks from the consultant detailed explanation of suggested consulting fee. The clients should be sure that the consulting fee is proper and that they will get an adequate equivalent value for their money. If the enterprise has limited experience in using the consulting services, it is necessary that the management asks of the consultant the detailed explanation of the suggested consulting fee.

Generally, there is a growing trend of demand for the consulting projects, which ensure the results in short-term. The consultants use more methods for determination of fee and payment of services, where a spectrum of methods continuously increases. The selected method should suit both the consulting and the client organization, as well as to be appropriate for the concrete consulting project which performs.

Accordingly, in practice appear several models of the consulting services payment. The conducted research of current forms of the consulting fees on the consulting services market in Serbia points out to a fact that almost all forms are present, but phased payment is a dominant method of payment (Table 2).

Table 2. Forms of consulting fee

Payment model	% of consulting organizations which apply specific payment model
Payment in full	5,71
Payment by number of days	8,57
Payment by effect	14,29
Phased payment	40,00
Payment regulated by agreement on consulting services provision	17,14
Payment in full and by effect	2,86
Payment in full, by number of days and by effect	2,86
Free services and subsidized (Serbian Chamber of Commerce, Agency for SME, SIEPA, etc.)	2,86
Other	5,71

Source: own

3.4. Investments in marketing and managerial support

Totally 42.86% of surveyed consulting organizations invest in marketing (fairs, seminars, scientific journals, promotions, etc.). Thereby, 57.14% of surveyed consulting organizations do not invest in marketing, because they find they have a solid participation on the market and long-term relations with the clients. At the same time, an average grade of the clients' managerial support to the consultants, during work in the enterprise (client) is 3.74 (on a scale from 1 – minimal support to 5 – maximal support), which represents a solid support to the consulting interventions.

However, as we move away from the top management level, the situation is worse, i.e. there is an obstruction. In this regard, there are 2 types of barriers for learning in this context [10]. *Cognitive barriers* can arise to the managers as a result of a fact that the consultants use different and often complex concepts to define a problem. *Motivational barriers* refer to a resistance made when a way in which the problem is defined, requires an evaluation of previous performances.

In other words, members of the organization will probably hate and reject those problems definitions, which concern how they were accepted in the organization and which can jeopardize their future status. The consultant's position as outsider in organizational policy can help them to emphasize the problems, which insiders can hardly identify, but this does not make an issue less politically sensitive, so micro-policies can continue to block learning.

3.5. Terms and effects of small consulting organizations' networking

Taking into consideration the other markets, which have been substantially defined, the consulting market has been susceptible to continuous changes, which is natural regarding peculiarity of jobs it does and beyond need that constantly research new organization forms and to be ahead of practice [11]. In such conditions, network business connection has become a modern strategic need, new model of entrepreneurial behaviour and global mega trend, which bases exactly on searching the enterprise's key competence and efficiency of organizational-process network, and consists of making adaptable, synergistic and competitive organizational structure [12].

The key goal of business networking consists of their useful economic and organizational effects (direct and indirect). It explains in literature through its fundamental principle of forming and functional specific features of existence, which reflects in dynamic tendency of organizational development, permanent expansion and modernization aiming to realize as better positioning as possible and greater success on the market. In that sense, the business networking essentially represents a self-organized polycentric structure and target-oriented to the concrete tasks [13].

Accordingly, the analysis is directed to small consulting organizations networking in Serbia, as well as on their role and place in clusterization and business incubation processes of the local enterprises. The consulting organizations in Serbia are mostly concentrated in university centres, like Belgrade, Novi Sad, Kragujevac and Nis. Current state in the consulting services sector shows that it is inevitable to do decentralization of some ministries' consultative bodies and the Serbian Chamber of Commerce, by which would be made conditions for more adequate responses to enterprises needs, i.e. an opportunity for partnership approach in solving the business problems. Also, aiming to allocate resources efficiently, there is needed a regional experts exchange, which implies the consulting organizations networking in Serbia. According to the results of the conducted survey, 54.29% of the consulting organizations are networked. However, on the other hand, *business incubators and clusters* are still in „embryonic stage“ of development and sporadic character, so it is logical that their influence to the enterprise's performances in Serbia is negligible, for now.

3.6. Used consulting techniques and basic difficulties in work with the clients

According to the research results, the most often used consulting tools and techniques are:

- Methodology of enterprise's value evaluation in accordance with the International Accountancy Standards,

- The World Bank methodology for evaluation of enterprise value and business plans,
- Concept of the Boston Consulting Group,
- Internal methods (programs and projects), according to the clients' needs,
- Own consulting techniques, BSC (Balance Score Card) technique.
- Situational (contingent) approach,
- Consulting tools based on scientific analysis,
- Diagnosis of situation, 2. training, 3. Implementation and standardization of processes, 4. Internal control, 5. Corrective measures, 6. certification;
- Methodology for Resolving the Technical Problems,
- Quality system standards, creative workshops,
- Techniques and tools completely adjusted to client's needs,
- TQM, re-engineering, CPM and PERT techniques.

Thereby, difficulties, which the consultants have during the mentioned techniques application, can group in several categories: 1) insufficient acquaintance with the role and scope of the consulting; 2) bad communication and submitting internal documentation; 3) clients' lack of training and education and 4) other difficulties in consulting work.

4. CONCLUSIONS

Since 2000, the consulting has become very present in Serbia. Demand for the consulting services grows with objective needs, and is dictated by: privatization, evaluation of an enterprise's value, foundation of new small and medium enterprises as an assumption of faster development of market economy, new products, search for new markets, etc. Serbia, due to objective, but also subjective reasons, is late with transition, so with a view to keep pace with other countries, privatizes accelerative public property, often very clumsy, sometimes insufficiently controlled and under unclear circumstances. A side effect of those processes has been unavoidably a hasty development of the consulting services. It is natural that the consulting will be similar to what is happening in economy: intensive, aggressive, almost uncontrolled, and many times vulgar. The consulting until today, after so many years, has not been defined in statistical activities classification of Serbia, so its development analysis is made difficult.

In accordance with started economic reforms, the consulting services market development is directly dependant on the transition process and the local enterprises restructuring. At the same time, removal of external limitations and returning Serbia into international economic courses has caused a significant demand growth for new knowledge, experiences and expertises, including also those in form of the consulting services.

Special interest refers to rehabilitation programs and enterprises restructuring, but also to formulating and implementing development strategies and networking with economic actors on the international market, introduction of information technology, improvement of management performances with basic functions in enterprise, joint ventures, technological cooperation and similar. The enterprises privatization requires knowledge and creativity, which represents a significant area of the consulting organizations activity.

Introduction of market business in enterprises in Serbia represents a stimulus for the consultants to enlarge the consulting services assortment, especially as the clients must prepare to use rationally internal and external professional and creative potentials.

The research has shown that the biggest supply of the consulting services in Serbia is in the field of corporate strategy (50%) and operational management (28%), which can be interpreted as mutual desire of the consultants and the clients, to get desirable results as faster as possible, which, in certain way, looks natural and logical.

However, if the process has not been followed by information technology and education – there achieves just a provisional effect, and therefore, a provisional success. Exactly the supply of consulting houses in the field of information technology and education (although, according to answers to a matching question, this field affects the most at the consulting services development) is very poor (5%), only outsourcing is slightly poorer (4%), so there can conclude that there should work for the consulting organizations to increase and improve the supply in this field.

Resting upon the conducted research results, it would be suitable to determine basic messages for our enterprises management concerning managing and using the consulting services. The following are the most important:

- First, to contact the Serbian Chamber of Commerce and to lean on those consultants who are registered in the Serbian Business Registers Agency. That is to say, there are agencies which are called the consulting houses, but they do not have necessary reputation and professional experience. Also, to lean on business contacts aiming to choose an adequate consultant.
- Second, to make a comparison with enterprises which had similar business problems, and had used the consulting services, in order to select the adequate consulting service.
- Third, not to allow that the consultant's engagement ends with the specific project creation. In many cases is needed a maximal engagement of the consultant who should have control and corrective role during the project implementation. It is also necessary to track prices on the consulting services market, so the enterprise would not pay a price higher than a real market price.
- Fourth, to ensure the consultant free access to information on assets and business of the enterprise, in order to acquire real bases for the adequate consulting service.
- Fifth, the managers have to support to the utmost the consultants during determination and conduction of consulting interventions which concern the enterprise's business. The practice has determined that the consulting service success depends significantly on managerial support.

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5. REFERENCES

- [1] **B. Mihailović:** *Development of the consulting services in Serbia and their influence to enterprises' performances in agro-complex*, monograph, Institute of Agricultural Economics, ISBN 978-86-82121-93-0, Belgrade, 2011, p. 14.
- [2] **R. Pejanović, Nedeljko Tica, Stanislava Delić and Vladislav Zekić:** *Consulting in agribusiness*, Modern Agriculture, vol. 55, no. 1-2, 2006, pp. 69-75. ISSN: 0350 – 1205.
- [3] **M. Kubr:** *Management consulting – A guide to the profession*, International Labour Office, ISBN 9221011658 9789221011651, Geneva, 1976, p. 260.
- [4] **M. Kubr:** *How to select and use consultants. A client's guide*, International Labour Office, (Management Development Series, No. 31), ISBN 92-2-108517-1, ISSN 0074-6703, Geneva, 1993.
- [5] **J. Philips:** *The consultant's scorecard: tracking results and bottom-line impact of consulting projects*, McGraw-Hill Companies, Inc., ISBN 0-07-134816-6, Boston, 2000.
- [6] **N. Zivanović:** *Strukturiranje poželjne konsalting pomoći preduzećima u krizi*, Poslovna politika, jun, br. 6, 1994, pp. 30-40, ISSN 0350-2236.
- [7] **B. Mihailović, Jonel Subić and Drago Cvijanović:** *Metode i tehnici consultanță ca sprijin pentru managementul modern*, Conferința științific Internațională Modalități de eficientizare a managementului în condițiile economiei concurențiale, Chișinău, 5-6 octombrie 2007, Universitatea de stat din Moldova, Facultate de științe economice, Institutul muncii al sindicatelor din Republica Moldova, pp. 7-13. ISBN 978-9975-70-223-2.
- [8] **R. Senić:** *Krizni Menadžment*, Biblioteka Dijalozi, COBISS.SR-ID 50039564, Beograd, 1996.
- [9] **S. Blečić:** *International trade of consulting services*, master's thesis, Faculty of Economics, Belgrade, 2005, p. 33.
- [10] **J.A. Phillips:** *The Epistemology of Strategic Consulting: Generic Analytical Activities and Organizational Learning*, in Bertrand Moingeon & Amy Edmondson (eds.) *Organizational Learning and Competitive Advantage*. Sage. London, Thousand Oaks, New Delhi, 1996, pp. 202-223. ISBN-10: 0761951679.
- [11] **B. Mihailović, Drago Cvijanović:** *Organizations for providing the consulting services in Serbia*, Economics of Agriculture, (58) 4, 2011, Balkan Scientific Associations of Agricultural Economists, pp. 711-721. YU ISSN 0352-3462.
- [12] **V. Drašković:** *Network business connection as a mega trend and a new management strategy*, Economics of Entrepreneurship, no. 2, 2004, pp. 126-129. ISSN 14509695.
- [13] **M. Drašković:** *Clusterization as a component of global competition*, Montenegrin Journal of Economics, No 4, 2006, pp. 165-173. ISSN 1800-5845.

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ENERGY CONSUMPTION AND ECONOMIC GROWTH IN CHINA: EMPIRICAL EVIDENCE FROM PANEL DATA OF 30 PROVINCES

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Key words: energy consumption, economic growth, panel data, exergy, cluster analysis



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Abstract: *This paper tries to investigate the relationship between energy consumption and economic growth in China using panel data of 30 provinces. Firstly we analyze the status of each province in energy consumption and then classified those provinces into 5 classes by the method of cluster analysis. After that, panel data model are built to investigate the relationship between energy consumption and the economic growth in each class. With industrial GDP as dependent variable, three non-energy variables (inflation, labor, capital stock) and eight energy variables are employed in our models. To consider both the quality and quantity of energy, exergy is utilized instead of energy indicators. Estimate result within each class shows the energy which exerts a significant impact on economic growth differs from place to place, indicating that different energy policies should be taken in different provinces.*

1 INTRODUCTION

This paper tries to find out the relationship between energy consumption and economic growth in China. Energy is a key input to all societies. The development of economy calls for more and more energy while much kinds of it are exhaustible. Thus it is of much significance to research on the relationship between energy consumption and economic growth.

China is one of the countries that consume most energy all over the world. According to International Energy Agency, China consumes 7.9 percents of energy among all the countries in 1973 while the ratio become 17.3 in 2009, and the data continues increasing during this period [1]. The total energy consumption in China keep rising during our research period (1995-2009), published by China National Bureau of Statistics, from 1311.76 million tce in 1995 to 3249.39 million tce in 2009 [2], with a Cumulative growth rate of 147.12%, and an annual growth rate of 6.7%. Presently and in a long period, China would need more and more energy to meet the demand of rapid economic growth. Thus, China is very important when consider energy affairs.

Researchers have focused on the relationship between energy consumption and economic growth for decades. The research areas, methods and variables involved have been shaping and varying with the development of the methods and depth of the research. Regression analysis is widely adopted before 1996 to estimate the relationship between energy consumption and economic growth. However, John Ebohon, O.J. points out that regression analysis only conduct empirical analysis while fail to depict the critical causal relationships inbetween. He therefore begins to examine the existence and direction of the causal relationship between energy consumption and economic growth and finds that there exists a simultaneous causal relationship inbetween after a thorough investigation in Nigeria and Tanzania [3].

Thereafter a great many articles come out to explore the causal relationship between energy consumption and economic growth, most of which focus on one or more countries, employ unit root tests or Granger causality test to examine the causal relationship between one or more energy resources and some economic growth.

Hondroyannis, G. and his group survey the data of energy consumption and real GDP between 1960 and 1996 in Greece, and find that there exists a long-run causal relationship between energy consumption and real GDP [4]. Paul, S. and Bhattacharya, R.N. examine the different direction of causal relation between energy consumption and economic growth in India. Applying Engle-Granger cointegration approach combined with the standard Granger causality test on Indian data for the period 1950-1996, they find that bi-directional causality exists between energy consumption and economic growth [5]. Yoo, S.-H. and Jung, K.-O. investigate the short- and long-run causality relationship between nuclear energy consumption and economic growth in Korea by applying unit root tests, Granger causal tests during 1977-2002, they find that there is an unidirectional causality running from nuclear energy consumption to economic growth in Korea without any feedback effect [6]. Lee, C.-C. and Chang, C.-P. use aggregate as well as various disaggregate data of energy consumption, including coal, oil, gas, and electricity, employing the unit root tests and the cointegration tests and find that different directions of causality exist between GDP and various kinds of energy consumption so that energy conservation may harm economic growth in Taiwan [7].

Researches based on bivariate causal testing continues for a long time, among which stand out study on Asian newly industrialized countries and the U.S. [8], Turkey [9], 11 oil exporting countries [10], and 11 Sub-Sahara African countries [11]. However, Zachariadis, T. questions the method of bivariate causal testing. After a energy-economy bivariate causal testing in G7 nations, he finds implications to policy-making drawn from such a testing method less practical and suggests multivariate models based on a larger size of samples and a broader range of variables, which accommodate development mechanisms and causality channels in different countries and areas, better depict and understand real-world interactions between energy use and economic growth [12]. Following his lead, writings afterwards on relationship between energy consumption and economic growth begin to cover additional variables beyond energy and economics. Yuan, J.-T. and his group, using a neo-classical aggregate production model where capital, labor and energy are treated as separate inputs, tests the existence and

direction of causality between output growth and energy use in China at both aggregated total energy and disaggregated levels as coal, oil and electricity consumption. He found that there existed long-run cointegration among output, labor, capital and energy use in China at both aggregated and all three disaggregated levels [13]. In 2009, Wolde-Rufael, Y. re-examines the causal relationship between energy consumption and economic growth for 17 African countries in a multivariate framework by including labor and capital as additional variables. Using Granger causal tests, he finds that in 11 out of the 17 countries, energy is no more than a contributing factor to output growth and not an important one when compared to capital and labor [14]. Wolde-Rufael, Y. and Menyah, K. examines the long-run and the causal relationship between economic growth and energy consumption for South Africa for the period 1965-2006 in a multivariate framework which includes labour and capital as additional variables. They find a short-run as well as a long-run relationship between pollutant emissions and economic growth, a unidirectional causality running from pollutant emissions to economic growth, from energy consumption to economic growth and from energy consumption to CO₂ emissions all without a feedback [15].

Since 2009, panel data models are employed to examine the relationship between energy consumption and economic growth. For instance, Apergis, N. and Payne, J.E. examine the relationship between renewable energy consumption and economic growth for a panel of 20 members from the Commonwealth of Independent States over the period 1985–2005 within a multivariate framework. Using the method of panel cointegration and error correction model, they find out that there is a long-run equilibrium relationship between real GDP, renewable energy consumption, real gross fixed capital formation, and the labor force, and there is a bidirectional causality between renewable energy consumption and economic growth in both the short- and long-run [16].

Li, F. and his group apply panel unit root, heterogeneous panel cointegration and panel-based dynamic OLS to re-investigate the co-movement and relationship between energy consumption and economic growth for 30 provinces in Mainland China from 1985 to 2007. The empirical results show that there is a positive long-run cointegrated relationship between real GDP per capita and energy consumption variables. Furthermore, they investigate the east China and west China groups, and find that the economic growth in east China is energy-dependent to a great extent, and the income elasticity of energy consumption in east China is over twice that of the west China [17].

Sharma, S.S. uses dynamic panel data models to examine the impact of electricity and non-electricity variables on economic growth for a global panel consisting of 66 countries during 1986-2005. They also estimate this relationship for four regional panels. In total, they use six proxies for energy and other variables consisting of inflation, capital stock, labour force and trade. They hold the opinion that the results on the impact of energy are mixed [18].

To sum up, researches on the relationship between energy consumption and economic growth have developed from two variables and simple methods like linear regression to multi-variables and complicated methods like Granger causal tests and panel data models. The causal relation between the two varies in different countries and areas, which can be depicted as bidirectional, unidirectional, or non-existent. Energy policies are to be formulated based on a full understanding of regional features and a thorough analysis of the causal relation inbetween.

Based on the panel data consisting of 11 variables (3 non-energy and 8 energy) in 30 provinces of Mainland China (Since we have little information about Tibet, which is a great pity of this research, we take the rest 30 provinces here) between 1995 and 2009, this paper, using exergy analysis and dynamic panel data models, explores the relationship between energy consumption of 8 kinds of energy and economic growth in different classes of China with labor, capital and inflation as additional variables.

This paper uses exergy as an indicator to describe energy consumption. From the thermodynamics point of view, exergy is defined as the maximum amount of work which can be produced by a system or a flow of matter or energy as it comes to equilibrium with a reference environment [19]. Exergy's property ensures its wide application in resource accounting, economic analysis and other fields.

In 1977, Wall wrote his famous paper and pointed out exergy is a critical instrument in resource accounting as an indicator of the useful part of energy [20]. Chen, G.Q. and Chen, B. calculate the exergy value of energy in China, and deeply analyze the production and consumption of fossil fuels [21]. Valero, A.I. and Valero, A. makes an assessment of the exergy loss of the main minerals produced in the world throughout the 21st century, namely coal, oil, natural gas, iron, aluminum and copper. They then predicts the future depletion degree of mineral reserves with the help of five different scenarios [22].

Camdali, U. and Tunc, M. calculate energy and exergy efficiencies for Turkey's utility, transportation, industrial and residential and commercial sectors. After comparison, they find even though the utility sector is using the most energy and exergy, industrial sector has the highest energy and exergy efficiencies which are about 65% and 35% respectively [23].

Besides resource accounting and efficiency analyzing, exergy is also used as an indicator for economic researches. Caliskan, H. and Hepbasli, A. calculate and compare the energy and exergy prices of various energy sources in Turkey, such as coal, diesel fuel, electricity, fuel oil, natural gas, etc. They find that the costs of energy and exergy are inconsistency [24]. Ozturk, H.K. and his team calculate the petroleum exergy of Turkey, then estimate the petroleum exergy production in Turkey based on the gross domestic product (GDP) and the percentage of vehicle ownership figures in Turkey. For estimating exergy consumption, they build three forms of the model and then choose the best one [25].

In summary, exergy is an important indicator for measuring the quantity as well as quality of energy source, which is related with its environment and can be used for resource accounting, economic analysis, therefore has a great potential in application. Exergy, instead of energy is adopted as an indicator here to analyze the impact from energy source consumption on economic growth combining with China's specific energy source and environment cases.

2 CLASSIFICATION AND DESCRIPTION OF CHINESE PROVINCES IN ENERGY CONSUMPTION

China is so vast in territory that there is much difference between different provinces. Taking the regional difference into consideration, cluster analysis is employed to classify the 30 provinces based on their energy consumption during 1995-2009. Cluster analysis can automatically identify the optimal taxonomic group and thereby reflect regional differences in Mainland China to the greatest extent. Results of cluster analysis are depicted in Table 1.

Table 1: Five classes in China from cluster analysis

Classes	Provinces
Class 1	Sichuan
Class 2	Beijing, Tianjin, Jilin, Jiangxi, Guangxi, Hainan, Chongqing, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang
Class 3	Jiangsu, Zhejiang, Shandong, Guangdong
Class 4	Hebei, Shanxi, Henan
Class 5	Inner Mongolia, Liaoning, Heilongjiang, Shanghai, Anhui, Fujian, Hubei, Hunan, Guizhou

Features of each class are described below: The first class contains only Sichuan province, indicating the energy consumption of Sichuan is vastly different from that of other areas in China and

deserves singling out as an individual sample. The second class covers as many as 13 provinces. Areas in this class geographically cluster in the inland of China, namely in the central and western

China, and administratively contain three of China's four municipalities. The third class comprises 4 provinces, which are located in coastal areas and famous for their developed tourism industry in China. The fourth class is made up of 3 provinces of Henan, Hebei and Shanxi, which are near the capital of Beijing and characterized by rich resources and thriving industry. The fifth class consists of 8 provinces, among which 3 are located in the northeast and 5 in the southeast. No distinct shared feature for this class has been found yet.

Five classes are accordingly built up after cluster analysis. Mean energy consumption of each class during 1995-2009 are showed in Figure 1 (a)-(h), where we can see the feature of each class in energy consumption. Figure 1 (a) shows that Class 4 consumes most raw coal among 5 classes, followed with Class 3. In Figure 1 (b), we can

see that Class 4 consumes most coke among 5 classes, just like raw coal. The coke consumption of rest 4 classes are much lower than Class 4, especially after the year of 2000. Figure 1 (c), (d), (e) and (g) show that the consumption of crude oil, fuel oil, gasoline, and diesel fuel in Class 3 is the highest, and it is much higher than other classes. As to kerosene, Class 1 is the highest consumer according to Figure 1 (f). Figure 1 (h) shows the electricity consumption in Class 3 is the highest, followed with Class 4. Figure 1 (i) shows the average industrial GDP in each class during 1995-2009. It shows Class 3 always has the highest industrial GDP, and the tendency of Industrial GDP in other 4 classes is quite similar. Class 2 has the lowest Industrial GDP during that period.

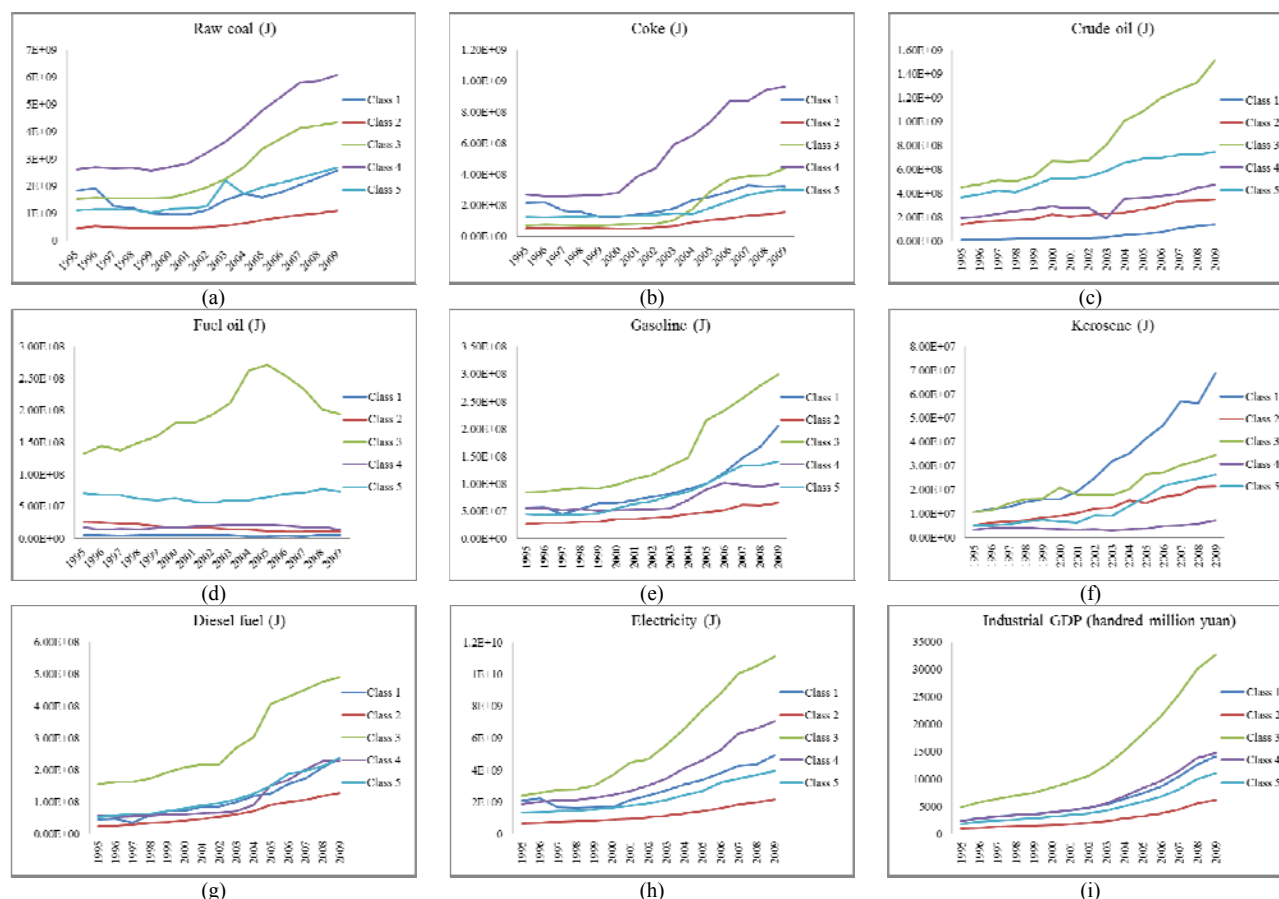


Figure 1: energy consumption of 5 classes in China during 1995-2009

3 EMPIRICAL ANALYSIS

3.1 Calculation of exergy content

The exergy content of each form of energy is figured by the formula printed in Technical Guides for Exergy Analysis [26], with reference to Chinese National Standard, which is expressed as follows:

$$e^0(\text{gasfuel}) \approx 0.950 \Delta h_h^0 \quad (1)$$

$$e^0(\text{liquidfuel}) \approx 0.975 \Delta h_h^0 \quad (2)$$

$$e^0(\text{solidfuel}) \approx 0.975 \Delta h_l^0 + 2438 \omega \quad (3)$$

Where e^0 represents the exergy content of fuel (J), Δh_h^0 represents the high heat value of the fuel, while Δh_l^0 represents the low heat value, ω represents the moisture content of the solid fuel. The above mentioned formulas coupled with the

low heat value described in China Energy Statistical Yearbook calculate the exergy content of 8 kinds of energy (See Table 2).

The low heat value of each fuel showed in table 2 is found in Appendix IV of China Energy Statistical Yearbook [27]. The high heat value is calculated with reference to Energy Statistics Manual [28] issued by International Energy Agency (IEA), which stipulate that the differences between low heat value and high heat value are typically about 5% to 6% of the high heat value for solid and liquid fuels. The moisture content is figured based on a combined consideration of the value given in Energy Statistics Manual [28] and the composition ratio of China's raw coal during 1995-2008, when moisture content of bituminous, anthracite and lignite is 35%, 15.5% and 20% respectively, while composition ratio is 76.61%, 16.25% and 7.15% accordingly [29].

Table 2: exergy content of different kind of energy

Energy form	Phase	Low heat value (KJ/Kg or KJ/m ³)	High heat value (KJ/Kg or KJ/m ³)	moisture content (%)	Exergy content (KJ/Kg or KJ/m ³)
Raw coal	Solid	20908	22125	0.155	21286
Coke	Solid	28435	30090	0.08	28679
Crude oil	Liquid	41816	44250		43143
Fuel oil	Liquid	41816	44250		43143
Gasoline	Liquid	43070	45576		44437
Kerosene	Liquid	43070	44577		44437
Diesel	Liquid	42652	45134.39		44006
Electricity		3596 (KJ/KWH)			3596 (KJ/KWH)

3.2 Theoretical model and data

There are 31 provinces in Mainland China, but unfortunately we have little information about Tibet and it is quite short for our research. Therefore, the rest 30 provinces are chosen as our study area.

Industrial GDP is employed as the proxy of economy in this

study because industry consumes 70% energy of total energy consumption in China [27]. As mentioned above, it is examined that multivariable models has higher accuracy than bivariate tests so that non-energy variables are accordingly taken into consideration. Table 3 summarizes variables used in the existing research on correlation between energy consumption and economic growth.

Table 3: variables used in existing research on relationship between energy consumption and economic growth

Year	Literature	District of research	Economic indicator	Non-energy variable	Energy variable	Results
2002	[4]	Greece	Real GDP	Inflation	Total energy	Long-run causality
2007	[30]	Iran	GDP	industrial value added	total energy, petroleum products	Variation in causality existence and direction with different variables
2009b	[31]	11 countries of the Commonwealth of Independent States	Real GDP	Capital, labor	petroleum products, natural gas, electricity, coal	Unidirectional causality in short run, bidirectional causality in the long-run
2009a	[16]	6 countries in central America	Real GDP	Capital, labor	Total energy	Unidirectional causality from energy to economic
2010	[32]	America	GDP	Capital, labor	Total exergy	Unidirectional causality from energy to economic
2010	[15]	South Africa	GDP per unit of energy use	Capital, labor	Total exergy	Unidirectional causality from economic to energy
2010	[18]	66 countries	GDP	Capital, labor, inflation, trade openness	Total energy, electricity, fossil fuel	Different influential variables in different countries

Table 3 shows some consensus on variables affecting economic growth, non-energy variables involving capital, labor, inflation, and other variables like industrial value added still to be ascertained. As a result, the first three variables considered to have impact on economic growth are studied in this research: capital, labor and inflation.

Table 3 also depicts that energy variables include total energy consumption, energy consumption per unit of capital and consumption of specific energy form. Exergy content of energy, as a measurement of energy consumption in this research, is related to the component of the form of energy. Specification of energy sources and clarification of energy content consequently facilitate an accurate calculation of exergy. As an instance, to calculate the exergy of row coal and coke respectively is far more accurate and reliable than calculate the exergy of coal. Therefore, a most specific classification in energy statistics is employed, dividing energy source into 8 forms: raw coal, coke, crude oil, fuel oil, gasoline, diesel, kerosene and electricity.

So far, variables for panel data models have been carefully chosen, including industrial GDP, capital stock, labor, inflation, consumption of 8 energy forms like raw coal, coke, crude oil, fuel oil, gasoline, diesel, kerosene and electricity.

Concerning data availability, the labor comes from the annual number of employed persons, while inflation is indicated by consumer price index (CPI) in each province. Lack of exact statistics of capital stock in China, annual average balance of net value of fixed assets of all industrial enterprises reported in Statistical Yearbook of China [33] is used as a reliable proxy for growth of capital stock (following [34-35]).

Model proposed in this research takes the following form:

$$\text{Industrial GDP} = f(\text{CPI}, \text{LABOR}, \text{ABNVFA}, \text{ENERGY})$$

(4)

Where CPI represents regional consumer price index, Labor represents number of the employed persons, ABNVFA represents annual average balance of net value of fixed assets of all industrial enterprises, Energy represents the consumption of 8 kinds of energy in China.

Modern econometrics has proved, panel data model has its advantages compared with time series data and cross-sectional data when dealing with the affairs that cross different regions. On one hand, using panel data exceeds the assumption of homogeneity in studies about general amount. On the other hand, panel data models greatly increase the number of samples, expanding the ability of statistical model for obtaining the information, and thus ensuring the reliability of the conclusions of the study to some extent. Thereby, this paper uses panel data models to investigate the relationship between agricultural fiscal expenditure and agricultural economic growth, where equation (4) can be written as:

$$\text{Industrial GDP}_{i,t} = a_0 + a_1 \text{CPI}_{i,t} + a_2 \text{LABOR}_{i,t} + a_3 \text{ABNVFA}_{i,t} + a_4 \text{Energy}_{i,t} + e_{i,t} \quad (5)$$

Where all variables in equation (5) are transformed into its growth rate, and the subscript i represents provinces (here, $i=1\sim30$), the subscript t represents time (the time frame is 1995~2009).

3.3 Empirical results

Dynamic panel data model is applied to the five panels from cluster analysis, involving 3 non-energy variables (inflation, labor, capital stock) and 8 energy variables (consumption of raw coal, coke, crude oil, fuel oil, gasoline, diesel, kerosene and electricity). Each model contains the 3 non-energy variables and one energy variable, coefficient and significance of the 4 variables are calculated to estimate the relationship between them and Industrial GDP. The results are showed as below.

Table 4: Estimate results for panel of class 1

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
CPI	0.11 (0.048)	0.09 (0.103)	0.04 (0.397)	0.02 (0.743)	0.11 (0.062)	0.13 (0.047)	0.12 (0.135)	0.14 (0.049)	0.10 (0.174)
LABOR	0.06 (0.900)	-0.41 (0.473)	-0.93 (0.070)	-0.39 (0.382)	0.06 (0.903)	0.34 (0.574)	0.08 (0.873)	0.31 (0.588)	-0.11 (0.875)
ABNVFA	0.38 (0.246)	0.40 (0.219)	0.66 (0.026)	0.53 (0.080)	0.39 (0.284)	0.45 (0.217)	0.37 (0.309)	0.28 (0.442)	0.40 (0.270)
Raw coal	—	0.28 (0.184)	—	—	—	—	—	—	—
Coke	—	—	0.58 (0.001)	—	—	—	—	—	—
Crude oil	—	—	—	0.34 (0.034)	—	—	—	—	—
Fuel oil	—	—	—	—	-0.02 (0.860)	—	—	—	—
Gasoline	—	—	—	—	—	-0.28 (0.452)	—	—	—
Kerosene	—	—	—	—	—	—	-0.04 (0.878)	—	—
Diesel	—	—	—	—	—	—	—	-0.12 (0.423)	—
Electricity	—	—	—	—	—	—	—	—	0.12 (0.743)

Model 1 in Table 4 shows that CPI and LABOR among the non-energy variables have statistically significant impact on economic growth in class 1 areas. In model 2, we use the

consumption of raw coal as a proxy for energy and find that it has statistically insignificant effects on economic growth. Statistics from other models reveal that the consumption of coke and crude oil exerts statistically significant impact on the economic growth.

Table 5: Estimate results for panel of class 2

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
CPI	1.19 (0.000)	1.21 (0.000)	1.09 (0.000)	1.34 (0.000)	1.22 (0.000)	1.18 (0.000)	1.16 (0.000)	1.20 (0.000)	1.13 (0.000)
LABOR	0.55 (0.013)	0.54 (0.014)	0.54 (0.011)	0.51 (0.012)	0.53 (0.016)	0.54 (0.013)	0.53 (0.015)	0.58 (0.009)	0.48 (0.026)
ABNVFA	0.02 (0.576)	0.03 (0.522)	0.03 (0.443)	0.08 (0.126)	0.03 (0.534)	0.03 (0.520)	0.02 (0.601)	0.05 (0.289)	0.03 (0.462)
Raw coal	—	-0.01 (0.496)	—	—	—	—	—	—	—
Coke	—	—	0.06 (0.001)	—	—	—	—	—	—
Crude oil	—	—	—	-0.02 (0.157)	—	—	—	—	—
Fuel oil	—	—	—	—	-0.01 (0.203)	—	—	—	—
Gasoline	—	—	—	—	—	0.02 (0.600)	—	—	—
Kerosene	—	—	—	—	—	—	0 (0.433)	—	—
Diesel	—	—	—	—	—	—	—	0.03 (0.158)	—
Electricity	—	—	—	—	—	—	—	—	0.23 (0.023)

Notes: "0" means the coefficient is less than 0.004.

With regard to class 2 areas, CPI and LABOR are significantly related to the regional economic growth, consumption of coke and electricity is statistically significant at the 5% level (Seen in Table 5).

Table 6: Estimate results for panel of class 3

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
CPI	0.88 (0.000)	0.61 (0.008)	0.75 (0.001)	0.75 (0.001)	0.84 (0.001)	0.87 (0.001)	0.89 (0.000)	0.78 (0.001)	0.73 (0.006)
LABOR	0.64 (0.068)	0.22 (0.511)	0.45 (0.168)	0.66 (0.048)	0.69 (0.055)	0.55 (0.124)	0.61 (0.088)	0.68 (0.048)	0.65 (0.062)
ABNVFA	0.39 (0.000)	0.33 (0.000)	0.32 (0.001)	0.38 (0.000)	0.39 (0.000)	0.35 (0.001)	0.43 (0.000)	0.33 (0.002)	0.38 (0.000)
Raw coal	—	0.33 (0.001)	—	—	—	—	—	—	—
Coke	—	—	0.09 (0.002)	—	—	—	—	—	—
Crude oil	—	—	—	0.15 (0.012)	—	—	—	—	—
Fuel oil	—	—	—	—	0.03 (0.456)	—	—	—	—
Gasoline	—	—	—	—	—	0.06 (0.217)	—	—	—
Kerosene	—	—	—	—	—	—	0 (0.448)	—	—
Diesel	—	—	—	—	—	—	—	0.07 (0.063)	—
Electricity	—	—	—	—	—	—	—	—	0.103 (0.171)

Notes: "0" means the coefficient is less than 0.004.

According to Table 6, in class 3 areas non-energy variables like CPI and ABNVFA, and energy variables like consumption of raw

coal, coke and crude oil have statistically significant impact on the regional economic growth.

Table 7: Estimate results for panel of class 4

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
CPI	1.40 (0.001)	0.96 (0.012)	0.96 (0.000)	1.03 (0.000)	0.97 (0.000)	0.93 (0.000)	0.95 (0.000)	0.96 (0.000)	0.86 (0.000)
LABOR	-0.39 (0.583)	-0.18 (0.780)	0.52 (0.000)	0.49 (0.000)	0.52 (0.000)	0.50 (0.000)	0.51 (0.000)	0.52 (0.000)	0.44 (0.001)
ABNVFA	0.63 (0.001)	0.51 (0.004)	0.10 (0.000)	0.15 (0.000)	0.11 (0.000)	0.11 (0.000)	0.10 (0.001)	0.13 (0.000)	0.10 (0.000)
Raw coal	—	0.55 (0.004)	—	—	—	—	—	—	—
Coke	—	—	0.01 (0.566)	—	—	—	—	—	—
Crude oil	—	—	—	0.01 (0.278)	—	—	—	—	—
Fuel oil	—	—	—	—	-0.01 (0.202)	—	—	—	—
Gasoline	—	—	—	—	—	0.05 (0.061)	—	—	—
Kerosene	—	—	—	—	—	—	-0.01 (0.293)	—	—
Diesel	—	—	—	—	—	—	—	0.05 (0.001)	—
Electricity	—	—	—	—	—	—	—	—	0.16 (0.002)

Table 7 shows that CPI and ABNVFA, consumption of raw coal and diesel have significant impact on the economic growth in Class 4 areas, while the rest variables are less influential.

Table 8 shows the correlation of the 13 variables and the regional economic growth in Class 5 areas, among which all the 3 non-energy variables and consumption of coke are of much significance.

Table 8: Estimate results for panel of class 5

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
CPI	0.63 (0.001)	0.63 (0.001)	0.54 (0.003)	0.54 (0.008)	0.62 (0.001)	0.54 (0.004)	0.63 (0.001)	0.60 (0.001)	0.56 (0.003)
LABOR	0.61 (0.015)	0.61 (0.017)	0.56 (0.025)	0.67 (0.001)	0.63 (0.013)	0.58 (0.021)	0.60 (0.017)	0.59 (0.021)	0.55 (0.033)
ABNVFA	0.26 (0.000)	0.26 (0.000)	0.25 (0.000)	0.28 (0.000)	0.26 (0.000)	0.27 (0.000)	0.27 (0.000)	0.26 (0.000)	0.26 (0.000)
Raw coal	—	-0.01 (0.530)	—	—	—	—	—	—	—
Coke	—	—	0.07 (0.017)	—	—	—	—	—	—

Crude oil	—	—	—	-0.05 (0.305)	—	—	—	—	—
Fuel oil	—	—	—	—	0.02 (0.526)	—	—	—	—
Gasoline	—	—	—	—	—	0.07 (0.084)	—	—	—
Kerosene	—	—	—	—	—	—	0.01 (0.259)	—	—
Diesel	—	—	—	—	—	—	—	0.04 (0.273)	—
Electricity	—	—	—	—	—	—	—	—	0.09 (0.196)

4 DISCUSSIONS AND CONCLUSIONS

This paper attempts to find out the relationship between different kind of energy and economic growth in different areas of Mainland

China. The results from dynamic panel models of the five classes of areas show the impact of 3 non-energy variables and 8 energy variables on the regional economic growth. Table 9 lists all the significance in a more clarified way.

Table 9: significance of each variable in each panel

Classes	CPI	LABOR	ABNVFA	Raw coal	Coke	Crude oil	Fuel oil	Gasoline	Kerosene	Diesel	Electricity
Class1	*				*	*					
Class2	*	*			*						*
Class3	*		*	*	*	*					
Class4	*		*	*						*	
Class5	*	*	*		*						

Variables of inflation, the energy consumption of coke and crude oil have significant impact on economic growth in Class 1 areas. More emphasis should be laid on inflation control rather than on labor or capital input for their regional economic growth. Less significant impact of labor and capital on economic growth from the research is not justified theoretically, which may be explained that Chongqing's independence from Sichuan Province in 1997 caused a sudden drop in the province's labor and capital stock during 1995-1998 and that Wenchuan's earthquake in 2008 also interrupted labor and capital's natural impact on economic growth. Their significantly influential energy reflect the regional key industries like the metallurgical industry, steel industry (where coke exert as main energy source) and primary petroleum industry. Additional attention is to be paid to the above industries and restriction policies on coke and crude oil consumption should be carefully laid down.

Variables having significant impact on economic growth in Class 2 areas refer to inflation, labor, the consumption of coke and electricity, which indicates that economic development there requires effective inflation control, adequate labor input and proper restriction policies on coke and electricity consumption.

Inflation, capital stock, consumption of raw coal, coke and crude oil are significantly influential on the economic growth in Class 3 areas. From a non-energy perspective, proper capital input apart from effective inflation control is needed to boost the regional economy. From an energy perspective, the significance of raw coal, coke and crude oil indicates the critical position of primary energy industry there, and restriction policies on consumption of the 3 energy sources should be accordingly cautiously laid down to ensure a sustainable development in those related fields and industries.

Inflation, capital stock, and the consumption of raw coal and diesel have statistically significant impact on the economic growth in Class 4 areas. Accordingly, effective inflation control, proper capital input and carefully-made restriction policies on raw coal and diesel consumption are in need to promote the regional economy.

Variables significant for economic growth in class 5 include inflation, labor, capital stock and the consumption of coke, which indicates that proper labor and capital input along with effective inflation control is indispensable for a boost in the regional economy. Consumption of coke exerting its unique significant impact on economic explains that heavy industries like metallurgical industry and steel industry play an important role in the regional economy. Thereby adequate attention should be paid to those industries and restriction policies on coke consumption carefully formulated.

From another point of view, we find that the main energy resources which are consumed most and those energy resources

which have significant impact on economic growth do not necessarily match.

Figure 1 (a) shows that Class 4 consumes most raw coal, followed with Class 3. Table 9 shows that raw coal has a significant influence on economic growth in Class 4 and Class 3. These two findings together show that raw coal is an important energy for Class 4 and Class 3 and it is right used in these two classes.

Figure 1 (b) shows that the coke consumption in Class 4 is far more larger than other classes, especially after the year of 2000. However, table 9 shows the coke consumption has significant influence on economic growth in Class 1, Class 2, Class 3 and Class 5, except of Class 4. This conclusion, which need further study, may attribute to factors other than this model, or the consumption of coke in Class 4 is not wise.

Figure 1 (c) shows Class 3 consumes most crude oil, followed by Class 5. Table 9 shows crude oil consumption is significant to economic growth in Class 1 and Class 3, while insignificant in other areas. Therefore, crude oil is an important energy in Class 3 since Class 3 consumes most crude oil and it has a significant influence on local economic growth. In Class 5, the crude oil consumption is large while it has no statistical significant influence on local economic growth. In contrast, Class 1 consumes little crude oil while crude oil consumption has significant influence on local economic growth.

Table 9 shows the consumption of fuel oil is insignificant for economic growth in all of 5 classes. This may be due to little consumption of fuel oil, accounting for only about 2% of the total energy consumption. Thus, the fuel oil is not main energy with little influence on economic growth. This conclusion keep true to gasoline and kerosene.

As to diesel fuel and electricity, the classes which consume most of them and the classes where they has a significant impact on economic growth is quite different. Take diesel fuel as an instance. Diesel fuel consumption is significant to economic growth in Class 4 while Class 4 consumes little diesel fuel compared to other classes. This result is somewhat strange and thus need further researches.

To conclude, this paper uses cluster analysis, exergy analysis and dynamic panel data model to survey the relationship between energy consumption and economic growth in 30 provinces of China. Despite all thorough and considerate work, limitations still exist in the research. Firstly, the specific environment difference of each province and municipal fails to be considered in the calculation of exergy, which is actually an environment-related indicator. Calculation of specific exergy of different regions would definitely add accuracy and value to the research results. Secondly, the approach of energy variable selection in dynamic panel data models is relatively simple, with one energy variable together with 3 non-energy variables put into each model.

REFERENCES

- [1]IEA (Information Energy Agency) (2010). Energy Statistics Manual. available at http://www.iea.org/stats/docs/statistics_manual.pdf. Last accessed on 5 December 2011.
- [2]CNBC. China National Bureau of Statistics. <http://www.stats.gov.cn/tjsj/>.
- [3]O.J. Ebohon: *Energy, economic growth and causality in developing countries A case study of Tanzania and Nigeria*, Energy Policy, vol.24, no. 5, (May. 1996), page numbers (447-453) ISSN 0301-4215.
- [4]G. Hondroyannis: *Energy consumption and economic growth: assessing the evidence from Greece*, Energy Economics, vol.24, no. 4, (Jul 2002), page numbers (319-336) ISSN 0140-9883.
- [5]S. Paul, R.N. Bhattacharya: *Causality between energy consumption and economic growth in India: a note on conflict in results*, Energy Economics, vol.26, no. 6, (Nov 2004), page numbers (977-983) ISSN 0140-9883.
- [6]S.H. Yoo, K.O. Jung: *Nuclear energy consumption and economic growth in Korea*, Progress in Nuclear Energy, vol.46, no. 2, (2005), page numbers (101-109) ISSN 0149-1970.
- [7]C.C. Lee, C.P. Chang: *Structural breaks, energy consumption, and economic growth revisited: Evidence from Taiwan*, Energy Economics, vol.27, no. 6, (Nov 2005), page numbers (857-872) ISSN 0140-9883.
- [8]S.Z. Chiou-wei, et al: *Economic growth and energy consumption revisited-Evidence from linear and nonlinear Granger causality*, Energy Economics, vol.30, no. 6, (Nov 2008), page numbers (3063-3076) ISSN 0140-9883.
- [9]M. Balat: *Energy consumption and economic growth in Turkey during the past two decades*, Energy Policy, vol.36, no. 1, (Jan 2008), page numbers (118-127) ISSN 0301-4215.
- [10]M. Mehrara: *Energy consumption and economic growth: The case of oil exporting countries*, Energy Policy, vol. 35, no. 5, (May 2007), page numbers (2939-2945) ISSN 0301-4215.
- [11]A.E. Akinlo: *Energy consumption and economic growth: Evidence from 11 Sub-Sahara African countries*, Energy Economics, vol.30, no. 5, (Sep 2008), page numbers (2391-2400) ISSN 0140-9883.
- [12]T. Zachariadis: *Exploring the relationship between energy use and economic growth with bivariate models: New evidence from G-7 countries*, Energy Economics, vol.29, no. 6, (Nov 2007) page numbers (1233-1253) ISSN 0140-9883.
- [13]J.T. Yuan, et al: *Energy consumption and economic growth: Evidence from China at both aggregated and disaggregated levels*, Energy Economics, vol.30, no. 6, (Nov 2008), page numbers (3077-3094) ISSN 0140-9883.
- [14]Y. Wolde-Rufael: *Energy consumption and economic growth: The experience of African countries revisited*, Energy Economics, vol.31, no. 2, (Mar 2009) page numbers (217-224) ISSN 0140-9883.
- [15]Y. Wolde-Rufael, K. Menyah: *Energy consumption, pollutant emissions and economic growth in South Africa*, Energy Economics, vol.32, no. 6, (Nov 2010), page numbers (1374-1382) ISSN 0140-9883.
- [16]N. Apergis, J.E. Payne: *Energy consumption and economic growth: Evidence from the Commonwealth of Independent States*, Energy Economics, vol.31, no. 5, (Sep 2009b), page numbers (641-647) ISSN 0140-9883.
- [17]F. Li, et al: *Energy consumption-economic growth relationship and carbon dioxide emissions in China*, Energy Policy, vol.39, no. 2, (Feb 2011), page numbers (568-574) ISSN 0301-4215.
- [18]S.S. Sharma: *The relationship between energy and economic growth: Empirical evidence from 66 countries*, Applied Energy, vol.87, no. 11, (Nov 2010), page numbers (3565-3574) ISSN 0306-2619.
- [19]I. Dincer: *The role of exergy in energy policy making*, Energy Policy, vol.30, no. 2, (Jan 2002), page numbers (137-149) ISSN 0301-4215.
- [20]G. Wall: *Exergy—a useful concept within resource accounting*, Institute of Theoretical Physics, Göteborg, Sweden, Report no. 77-42, (1977).
- [21]G.Q. Chen, B. Chen: *Resource analysis of the Chinese society 1980–2002 based on exergy—Part 1: Fossil fuels and energy minerals*, Energy policy, vol.35, no. 4, (Apr 2007), page numbers (2038-2050) ISSN 0301-4215.
- [22]A. Valero, A. Valero: *A prediction of the exergy loss of the world's mineral reserves in the 21st century*, Energy, vol.36, no. 4, (Apr 2011), page numbers (1848-1854) ISSN 0360-5442.
- [23]U. Camdali, M. Tunc: *Energy and exergy efficiencies for society*, Journal of the energy institute, vol.81, no. 2, (Jun 2008), page numbers (118-122) ISSN 1743-9671.
- [24]H. Caliskan, A. Hepbasli: *Energy and exergy prices of various energy sources along with their CO₂ equivalents*, Energy Policy, vol.38, no. 7, (Jul 2010), page numbers (3468-3481) ISSN 0301-4215.
- [25]H.K. Ozturk, et al: *Estimating petroleum exergy production and consumption using vehicle ownership and GDP based on genetic algorithm approach*, Renewable and Sustainable Energy Reviews, vol.8, no. 3, (Jun 2004), page numbers (289-302) ISSN 1364-0321.
- [26]AQSIQ (General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China)(1994) Technical guides for exergy analysis. Gb/T, 14909-94.
- [27]CESY (1995-2010) China Energy Statistical Yearbook. China Statistical Publishing House, Beijing.
- [28]IEA (Information Energy Agency) (2010) Energy Statistics Manual. available at http://www.iea.org/stats/docs/statistics_manual.pdf. Last accessed on 5 December 2011.
- [29]CCiy (2008) China Coal Industry Yearbook. Coal Information Institute, Beijing.
- [30]M. Zamani: *Energy consumption and economic activities in Iran*, Energy Economics, vol.29, no. 6, (Nov 2007), page numbers (1135-1130) ISSN 0140-9883.
- [31]N. Apergis, J.E. Payne: *Energy consumption and economic growth in Central America: Evidence from a panel cointegration and error correction model*, Energy Economics, vol.31, no. 2, (Mar 2009a), page numbers (211-216) ISSN 0140-9883.
- [32]B.S. Warr, R.U. Ayres: *Evidence of causality between the quantity and quality of energy consumption and economic growth*, Energy, vol.35, no. 4, (Apr 2010), page numbers (1688-1693) ISSN 0360-5442.
- [33]SYC (1990-2001) Statistical Yearbook of China. China Statistical Publishing House, Beijing.
- [34]J.C. Jin, E.S.H. Yu: *Export-led growth and the US economy: another look*, Applied Economics Letters, vol.3, no. 5, (1996), page numbers (341-344) ISSN 1350-4851.
- [35]J. Shan, F. Sun: *Export-led growth hypothesis for Australia: an empirical re-investigation*, Applied Economics Letters, vol.5, no. 7, (1998) page numbers (423-428) ISSN 1350-4851.

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ARGUMENTS IN FAVOR OF INVESTMENTS IN ENERGY CULTURES VERSUS INVESTMENTS IN MICRO HYDRO POWER PLANTS. CASE STUDY: ROMANIA

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Key words: Investments, biomass, environmental protection

Abstract: *The results of the research in this paper aim to present the main arguments in view of Romania's supporting investments in biomass energy cultures. Their high advantages are presented from an ecological, economic perspective, due to the possibilities of multiple energy recovery possibilities, possibilities of long term storage compared to the energy obtained in micro hydropower plants which cannot be stored. The latter is dependent upon the level of rain, which aggressively modifies ecosystems in the long run, being a profitable resource just for investors.*

1. INTRODUCTION

The integration into the European Union also brought many obligations for Romania, together with benefits. Thus, the national energy policy must be correlated with the European one so as to observe Directive 2001/77/EC on energy renewable sources, according to which, in 2020, 20 % of the EU's energy consumption must come from renewable energy.

According to the weather and geographical conditions of Romania, in the energy balance on medium and long term the following types of sources of renewable energy (SRE) are taken into account: solar energy, wind energy, water energy, biomass and geothermal energy [1]. In 2007, Romania drafted its Strategy on biomass and production of biofuels for the period 2008-2020. This strategy presents the Main Objective – "Energy safety" and the Specific objectives increasing the availability of biofuels within transport fuel: long lasting, competitiveness, economic efficiency and the social and economic development of rural areas. The arable area cultivated for obtaining the biomass is below 7.5 %, much lower than the arable area left outside the provisions of Romania's EU accession agreement (25,4 %) or which is not currently used due to the fact that the new EU provisions among which the non-payment of the 45 Euros/ha for energy cultures from the EU which considered that the areas established at European level for biofuels were performed. Furthermore, Law no. 220/2008 establishes new objectives concerning the weight of the electric energy produced from SRE in the gross final consumption of electric energy for the years 2015 and 2020 – namely 35% and 38%, respectively. At the same time the law regulates the mechanism of promoting the production of energy from SRE, which consists of applying the system of mandatory rates, combined with the transaction of green certificates. According to Eurostat, Romania is ranked 3 at European level with respect to energetic independence (20% of energy resources are imported) after Denmark and Estonia. The production of energy from renewable resources accounts for 27% of the total production. Actually, our country fulfills the conditions imposed by the EU concerning the percentage of energy obtained from renewable resources. Investors in the production of renewable energy produced in micro hydropower plants, wind parks and photovoltaic parks are attracted precisely by the aid scheme, one of the most generous in Europe; for the time being, they are the only winners, all consumers who refund green certificates and a large part of the industry are the losers, as well as the next generations who will refund the invoices of the ecological imbalances of micro hydropower plants.

The main research methods used are: quantitative and qualitative analysis, comparison, SWOT analysis. The input base of the research consists of statistic data published by national, international bodies, the research and works in the field published in the country and abroad, information offered by the National Institute of Statistics, the relevant Ministries and Companies, certain undertakings.

2. THE SITUATION OF INVESTORS IN RENEWABLE ENERGY AT INTERNATIONAL LEVEL AND IN ROMANIA

We can see that investments in renewable energy are among the few which increased in the last years due to the decrease of natural resources and increased concerns regarding the environment.

A United Nations report published recently shows that global investments in renewable energies reached the unprecedented level of 227 billion dollars in 2011, 17% more compared to 2010 and 94% more than in 2007, the year before the global financial crisis [2].

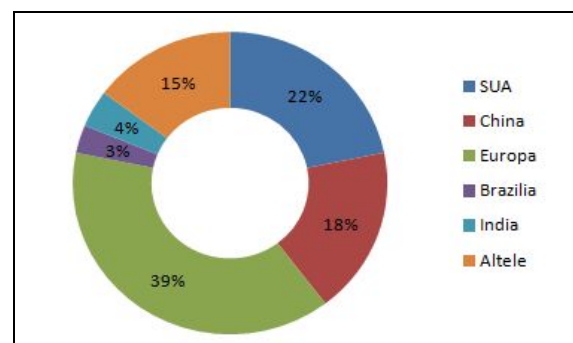


Fig.1. Regional investment in renewable energies in 2011. Source: Bloomberg New Energy Finance (bnf.com)

In 2011 in China investments in renewable energies increased by only 1% compared to 2010, and in the USA by 33%. In China investments reached a total of 47.4 billion dollars in 2011 and in the USA 55.9 billion. In Europe investments increased by 3% reaching 100.2 billion dollars. This increase is due to the construction of photovoltaic parks especially in Germany and Italy, respectively new wind parks in the North Sea area. In India investments increased by 52% reaching a total value of 10.3 billion dollars. Brazil appears for the first time individually in these statistics, the increase compared to 2010 being 15% with a total value of 8.2 billion dollars.

As regards the value of the investments for each renewable resource, this is shown in the chart below.

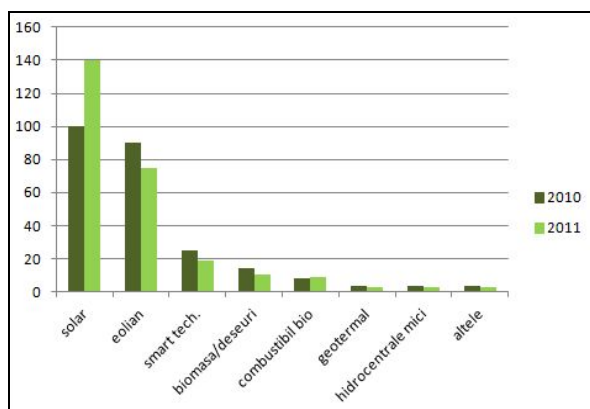


Fig. 2. Investments in renewable energies 2010-2011 (billion US\$). Source: Bloomberg New Energy Finance (bnf.com)

We notice that, the first place is occupied by investments in solar energy, followed by investments in wind energy, and the third place by investments in smart technologies – that is in smart technologies for storing, transporting and the efficient use of electric energy. In this field 19.2 billion dollars was invested and in the production of energy from biomass / waste 10.8 billion dollars. In using geothermal energy 2.8 billion dollars was invested and in small hydropower plants 3 billion dollars. Apart from the investments in solar energy the only field which really recorded an increase namely 5% was biofuel, which in total had investments of 9 billion dollars.

The evolution of global investments in renewable resources is favorable. According to the report Bloomberg Renewable Energy Market Outlook, in the following 18 years we will witness an accelerated growth of investments in renewable energies.[3]

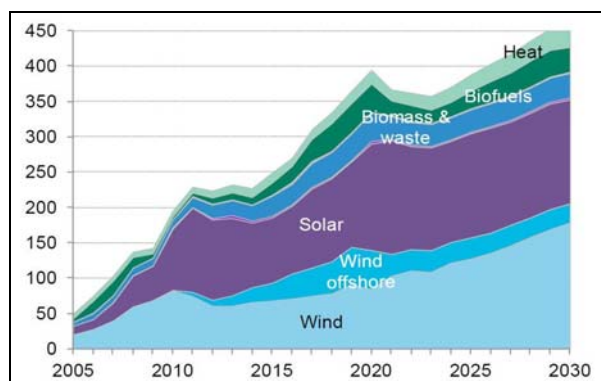


Fig. 3. The evolution of global renewable investments. Source: Investeam <<http://investeam.ro/blog/energia-verde---un-model-pentru-viitor-art476>>

As regards Romania, it is ranked seven among EU member states with respect to the weight of the energy obtained from renewable sources in the gross final consumption in 2010, recording an increase of over 6% (from 17.1% in 2006 to 23.4% in 2012), show the data presented by the European Office of Statistics (Eurostat) on June 18 2012, Romania is placed after countries like: Sweden, Latvia, Finland, Austria, Portugal, Estonia. Romania's objective is to obtain a percentage of 40% by 2020.

The reason is the fact that Romania can develop system for producing all types of renewable sources, depending on the characteristics of each geographical area in the country. Further to the studies conducted in Romania, the potential in the field of producing green energy is 65% biomass, 17% wind energy, 12 % solar energy, 4% micro hydropower plants and 2% voltaic and geothermal. According to the map drafted by the National Administration of Meteorology Romania's energy potential is distributed by areas as follows:

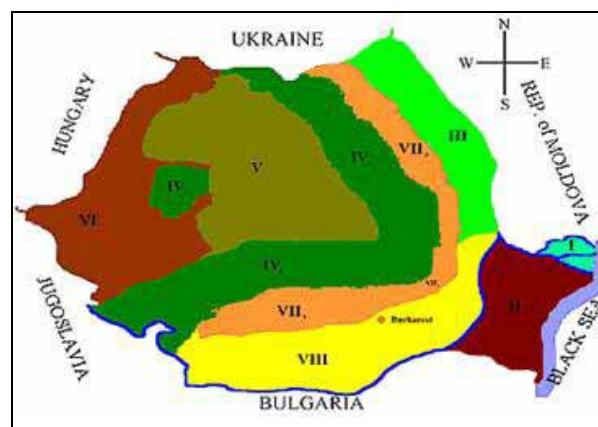


Fig. 4. Map of available renewable energy by regions. Legend: I. Danube Delta (solar power); II. Dobrogea (solar and wind power); III. Moldova (plains and plateaus - micro hydro, wind power and biomass); IV. Carpathian Mountains (IV1 - Eastern Carpathians, IV2 - South Carpathians, IV3 - Western Carpathians (biomass, micro hydro); V. Transylvania Plateau (micro hydro); VI. The Western Plain (geothermal energy); VII. Subcarpathians (VII1 - Getic Subcarpathians; VII2 - Curvature Subcarpathians; VII3 - Moldovan Subcarpathian: biomass, micro hydro); VIII. The South Plain (biomass, geothermal and solar energy). Source: MEF - 2007

This explains the massive investments made in Romania in the field of renewable energies; our country remains one of the most attractive markets in the world for renewable energies, according to the new report Country Attractiveness Indices, launched by Ernst & Young. The general index, which includes the scorings for all categories of renewable energy- wind, solar, geothermal and biomass – continues to place Romania among the first 15 countries at international level concerning the attractiveness of the local market for the development of energy projects in all these fields.

3. ROMANIA'S POTENTIAL OF BIOMASS FROM ENERGY CULTURES, POSSIBILITIES OF USE

Biomass is for Romania a source of renewable energy extremely promising, both from the point of view of its potential and from the point of view of the possibilities of use. This type of non-polluting energy tip is practically inexhaustible on a medium and long term, its costs being much more reduced (by approx. 40% compared to sources of conventional energy). With an arable area of 9,379,331 ha (62 % of the country's total area) to which are added forests and other lands with forest vegetation of 6,728,600 it is estimated that Romania has a potential evaluated by specialists at approximately 7594 thousands tons equivalent oil (toe) or 318×10^9 MJ/year. The pedoclimatic conditions offer the possibility of cultivating a wide range of energy cultures for producing biofuels without affecting the necessary of food or other fields. Research in the past years has shown that the solar energy stored in biomass can represent a renewable and non-polluting source of energy, being a good alternative to fossil fuels. The biofuel obtained from various species of plants (beetle juice, potato, reed, milo, cereal, fodder, wood etc.) through different technologies based on fermentation processes, used as such or in combination with classical fuels can substitute the use of classical fuels. In the world there were and there still are various concerns related to the obtainment and use of alternative fuels. These are especially used as adding to classical fuels for internal combustion engines with the purpose of reducing greenhouse effect gas emissions, but there are farms which ensure the necessary energy (electrical, thermal) by using the biofuels resulted from the processes of fermentation of the biomass produced by plants.

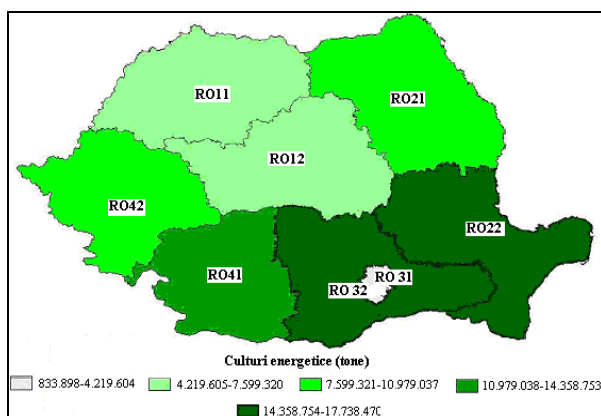


Figure 5 Energy cultures distributed per territorial national units. Source: Biogazul-ghid practic, 2010.

A field on which Romanian research concentrated in order to find new sources of non-polluting and renewable resources was also the one regarding the adaptation of new breeds of plants called "energy" plants such as: rape, reed, energy grass and different species of trees such as acacia, poplar and willow. Apart from biomass, some forest species can be cultivated on refuse heaps containing cinder or ashes from thermo power plants, in this category we find *Miscanthus* and *Phalaris* and the species *Hippophae salicifolia*. Other species, such as: underbrush, acacia, contribute to the stabilization of the soils, the willow *Salix Viminalis* Energo is resistant to various climate conditions especially on soils with high humidity, in Romania there are thousands of such hectares [4]. The biomass from energy cultures can be used in multiple directions or fields: heat, pharmaceutical products, electricity, human and animal food, as fertilizer, for the production of biofuels. The technologies used in the conversion of biomass are: biomass combustion; mechanical extraction by cold pressing in order to obtain pure vegetal oil from oil plants; Extraction by cold pressing, of oil, purification, in order to obtain biodiesel; Hydrolysis and fermentation from beetle juice, sugar cane, cereal for obtaining bioethanol; Pyrolysis and gasification for producing gas and hydrogen.

We notice that biomass cultures can be advantageous solutions for the ecological reconstruction of soils with various types of degradation; also, biomass can be used in a wide range of products: biofuels, electricity, biohydrogen, it can be preserved and transported, which recommends it as a main energy resource in our country. Besides, after an evaluation made in 2011 the barren agricultural area reached 1 million ha. The diversity of the biomass species imposes the cultivation with priority of the most performing ones, which do not affect the soil, biodiversity, food and environment and whose cost is more reduced than that of non-renewable energies. All the advantages of biomass cultures have not convinced Romanian authorities to support investments in energy cultures, more than that, this type of energy receives the smallest number of green certificates, two /1MW, compared to other types of energy which receive more.

4. MICROPOTENTIAL OF INTERIOR RIVERS, POSSIBILITIES OF USE

The rigorous determination of the technical micro potential is made based on drafting harnessing schemes, which take into account local conditions (land surveying, geological, hydrological, ecological), climate changes, the situation of communication means, the requirements of water for other use, the technical performances of hydroaggregates. The size of the technical hydro energetic potential is estimated between 32 and 36 TWh/year, and of the economic one, between 23 and 30 TWh/year [5]. The harnessed micro potential at 1.01.2005 had a total of 380 MHC (micro hydropower plants) and CHEMP (small power hydroelectric plants) with an installed power of 501 MW and project average energy 1504 GWh/year [6].

Although the hydro energetic potential of interior rivers is not updated as provided by GEO 3/2010 and the Water Management and

Harnessing Scheme, Romania supports only investments in hydroelectricity through policies in the field of renewable energy, and on the other hand, through stimulating programs which offer facilities for funding the use of microhydropotential in order to answer the requirements of the European Union Directive on renewable energy sources, without taking into account the disadvantages on the long term concerning the ecological performance of micro hydropower plants and the country's huge biomass potential. Currently, due to the created facilities, more and more Romanian and foreign companies are getting involved in the production of electric energy from renewable sources and within them, the hydro energy is the most important, it is considered the energy provided by hydro energy units with installed power < 10 MW (that is *small hydroenergy* obtained in micro hydro power plants). The environment permits were granted by authorities without observing a main principle of sustainable development namely the principle of precaution because the following aspects which are extremely important were not taken into account: all C+M works severely affect the underwater ecosystem, due to the large quantities of matters in suspension, the use of explosive materials and the performance of works with machinery and equipments directly in the river's bed the banks deteriorated, the areas for the reproduction of trout are affected, in many cases works were also made along the water flow and dams for the accumulation of water were built in the rivers' bed, and in the future such dams must be preserved by the current investors, the risk of breaking these concrete dams upon future floods generated also by massive deforestation was not established; the impact of the micro hydro power plant on the biodiversity in time and space was not quantified; the current hydroenergetic potential has not been updated since 2005, and in between the following factors intervened which impose a reevaluation: the modification of the rivers' flow, climate changes and the impact of hydro technical harnessing on environment; the decisions are based only on the technical and financial aspect of the investor.

5. SWOT ANALYSIS ON THE INVESTMENTS IN ENERGY CULTURES AND MICRO HYDRO POWER PLANTS

Based on the research made, we drafted a SWOT analysis in order to emphasize the pros and cons arguments concerning the investments in the two forms of renewable energy. The most important arguments are listed below.

Arguments in favor of investments in biomass cultures:

- Biomass can be preserved, stored and transported;
- It contributes to the maintenance of the state of maximum fertility of the soil, by maintaining it covered with vegetation;
- From biomass all sorts of energy and other ecological derivatives are produced: pigments, fertilizers, pharmaceutical products, etc;
- It can be cultivated on ecologically degraded lands: refuse heaps, cinder, soils with high humidity, soils on which other cultures cannot be planted;
- Does not affect the environment, on the contrary it contributes to making the soils ecological and it stabilizes them, degraded soils can be recovered and used to their full extent;
- Contributes to the protection of the environment through the cultures on refuse heaps air, soil and water pollution is diminished
- Contributes to the creation of jobs for the people in rural areas;
- Romania has a high potential of area and pedoclimate conditions for providing biomass from a wide range of energy cultures without affecting the necessary amount of food or other fields.

Arguments against the investments in biomass cultures:

- Inconsistency of politicians in the financial support of biomass producers and biofuel users;
- The lack of programs concerning the structure of cultures for the biomass destined to biofuels;

Arguments in favor of investments in micro hydro power plants:

- Water is a free resource;

- b) For each MWh generated by a new micro hydro power plant the producer receives three green certificates, which are paid guaranteed for 15 years after the start of the production the value of the certificate appears in the invoice of the end consumer;
- c) The investments are supported by a double subsidy – grants from the environment fund and green certificates.

Arguments against investment in micro hydro power plants:

- a) We do not have performing systems for “storing energy” due to the discrepancy between the moment and the place of the production of energy and the moment and the place of its consumption as well as due to the high fluctuations in the rivers’ flow. This imposes the increase of pollution due to the taking over of the task by thermo power plants which upon their turning on they pollute more;
- b) The construction of the micro hydro power plant severely affects ecological and scenery diversity of underwater ecosystems [7,8];
- c) The invoice for ecological disturbances will be paid by end consumers;
- d) The projects cannot be ecologically grounded due to the lack of studies for establishing the hydro energy potential in order to establish the best location;
- e) The impact on the environment does not justify the quantity of energy produced.

6. CONCLUSIONS

Investments in micro hydro power plants are profitable only from the point of view of the investor. The impact of each micro hydro power plant on the environment does not justify from an ecological, economic point of view this type of investment which is not sustainable. In addition, the risk that these may not be functional in a few years is quite high due to the climate changes on rivers, namely the minimum debit might not be ensured. The solving of the green energy problem through this type of investment creates big

problems to the environment, much bigger than thermo power plants. For the investments in biomass cultures, problems occur which can be solved as they are related to bureaucracy: organizational, economic, legislative and normative problems from biomass cultivators to biomass users. Our attention must be focused on the management of cultivating energy cultures for the production of energy. This management must be treated and created as an integrated management which must include problems related to environment, soil and biodiversity protection. Investments in this type of cultures are sustainable and performing from an ecological point of view.

7. REFERENCES

- [1] Raport Anual Hidroelectrica 2011
- [2] Alice Proti, 13 iun 2012, la adresa <http://energielive.ro/investitiile-in-energiile-regenerabile-au-crescut-in-2011/>
- [3] Daniela Vasile, Energie verde – un model pentru viitor, 9 dec 2011, la adresa <http://investeam.ro/blog/energia-verde---un-model-pentru-viitor-art476>
- [4] Proiect 22082, Utilizarea in scopuri energetice a culturilor instalate pe haldele de steril, Coordonator: Institutul de Cercetari si Amenajari Silvice (I.C.A.S.)
- [5], [6] INHGA, Sinteza studiilor de fundamentare a schemelor directe de amenajare si management ale bazinelor hidrografice componenta plan de amemajare, 2011, pg. 30-33.
- [7], [8], F. Bran, I. Ioan, C. Trica, *Eco-economia ecosistemelor si biodiversitatea*, Editura ASE, Bucuresti, pg. 24-38, 2004, ISBN 973-594-468-5.

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A TEMPORAL FRAMEWORK EMBEDDED IN DECISION MAKING SYSTEMS, SPECIFIC CASE OF IRON AND STEEL INDUSTRY

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Key words: Temporal framework, Extended Fuzzy Logic System, Decision Making Systems, Economic Intelligent Systems, Materials Engineering

Abstract. In today knowledge-based economy the value of goods, services and companies is created mostly by assets based on effective usage of knowledge and therefore knowledge management. The technical performance of modern Information and Communication Technologies (ICTs) has significantly changed not only the organisational structure of work but also individual work profiles. In this transformation process, the new wave of technologies is oriented to



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Semantic Technologies. From this perspective, the development of Distributed Knowledge Management Systems (DKMSs) that incorporate the human imprecision is a very important effort, especially from a dynamical view. This paper shows that the influence of knowledge on new forms of work organisation can be described as mutual relationships. Different changes in work organisation also have a strong influence on the increasing importance of knowledge of different individual and collective actors in working situations. After that, we characterize a piece of basic formal system, an Extended Fuzzy Logic System (EFLS) with temporal attributes, to conceptualize future DKMSs based on human imprecise for distributed just in time decisions. The approximate reasoning is perceived as a derivation of new formulas with the corresponding temporal attributes, within a fuzzy theory defined by the fuzzy set of special axioms. In a management application like the prototype REF2, the reasoning is evolutionary because of unexpected events which may change the state of the DKMS. In this kind of situations it is necessary to elaborate certain mechanisms in order to maintain the coherence of the obtained conclusions, to figure out their degree of reliability and the time domain for which these are true. These last aspects stand as possible further directions of development at a basic logic level for future technologies that must automate knowledge organizational processes. Materials technologies development has to be considered, too.

1. INTRODUCTION

Work organisation is a complex concept used in a variety of ways in different disciplines, research traditions and language contexts. It encompasses the technical, functional and social structures of work within the workplace and beyond. Usually the term refers to the ensemble of task structures, divisions of labour, forms of control and co-ordination, and forms of co-operation. Often the concept also includes the deployment of personnel in functional, temporal and social dimensions and the use of skills. Economic and social life became dependent on knowledge, so it is essential to accurately explore and understand the significance of the real processes and phenomena and their consequences. One consequence is the growing importance of knowledge. It is discussed more than ever on intelligent products, knowledge-based services, intelligent systems (connectionist systems, fuzzy systems, multi-agent systems, systems for evolutionary computation, hybrid systems) expert systems and / or knowledge based systems, intelligent enterprise, intelligent houses, workers who use knowledge, organizations based on intensive knowledge, continuously learning organizations, knowledge economy, etc. All these are related to the fact that the products, services and all social activities will include increasingly more knowledge in order for problem solving, process development, decision making etc., to take place supported by the newest technologies. For some processes, knowledge (fuzzy or temporal) is the very basic raw material, subject to creation, storage and transfer. Information Society has revolutionized the work making it an intellectual work, where efficiency needs more and more knowledge. This explains why appeared competent users or new disciplines specialized in knowledge processing. One of them is called knowledge engineering and aims to disseminate the analysis and development methodology of knowledge-based systems, intelligent information systems, and to train such systems' developers or cognitions. In organizations with intelligent behavior, the role of personnel, of knowledge pieces, learning and innovation, and internal operations of the departments are conducted in accordance with a specific logic. Knowledge engineering is one of the newest and most fascinating disciplines of information society. This discipline evolved from the art of developing expert systems, knowledge-based systems and information systems that integrate expert systems. In its work, it is known that the organization relies on a fundamental resource - knowledge, for which all its defining elements such as learning, innovation, creation and efficient updating of the knowledge pieces, etc. fall under the auspices of knowledge management. Whole staff

knows that based on this foundation has permissiveness, motivation, opportunities and capacities to act intelligently.

Currently, in information technology the focus is especially on data storage, at the expense of means of transforming data into useful information for decision-makers. Under these conditions, managers are often forced to spend time browsing thousands of data sources of enterprises looking for the information they need, rather than analyze them. Often, efforts are directed to IT departments which are forced to reduce the time spent maintaining and improving systems. Difficulties in accessing information are: (1) obtaining data takes too long and is generally late; (2) the analysis adversely affect the performance of transactions; (3) necessary information appears in an inadequate format; (4) information is rarely consistent and constantly subject to change; (5) ad-hoc queries are difficult. AI tools have been subject to major changes in recent years, from their original meaning, becoming the new core technology for customers analysis based on e-commerce, information portals and other. These instruments have an increasing number of users.

This paper has as scientific objective to analyze the impact of our temporal framework on the synthesis of intelligent systems in economy. To this end, an intelligent system in economy was considered any system that incorporates operational knowledge, often inaccurate, which can be formalized, represented and used rationally within KMS, which includes FKBS. An intelligent organization is defined by its strategy. If an organization is focused clearly on its objectives, then there is no need for centralized planning and control systems. Organization will be able to advance through continuous interactions between its members which, through trial and error, will find the best organization for their environment and will be able to adjust it according to environmental changes. An intelligent organization cannot lose its goal, because the organization itself is re-creating continually through intellectual cooperation. The goal guides the organization, not vice versa. The use of knowledge and communication is the central objective of section 2, because already exists a long debate about the transformation of fuzzy temporal knowledge into technical and standardised working procedures or operational knowledge. Section 3 presents some contributions from logical perspective, characterizing an Extended Fuzzy Logic System with Temporal Attributes for Distributed Knowledge Based Systems, and in section 4 are presented concluding remarks.

2. THE USE OF KNOWLEDGE AND COMMUNICATION

The intention of this section is to show that the influence of knowledge on new forms of work organisation can be described as a mutual relationship. It is not only the case that the content and structure of knowledge change the organisational patterns of working activities; conversely, different changes in work organisation also have a strong influence on the increasing importance of knowledge within the production processes as well as on the social and cultural expectations of different individual and collective actors in working situations [1,2]. One of the central advantages of modern ICTs is that they bridge both time and space, which traditionally have been key barriers to information and knowledge exchange. ICTs enable rapid communication across geographical space and organisational boundaries [3]. It is no longer necessary to combine all competences and resources in the same place. Because of the networked character of these technologies, people from all over the world with different expertise can work together to resolve specific problems. This ability to overcome geographical limitations together with the rapidity of transmission can be seen as the major ways in which modern ICTs can facilitate further acceleration of the innovation process. The communication and storage capacity of network technologies enables the creation of innovation as well as the production of knowledge. In this respect, it seems very important that modern ICTs support the exchange of both codified and tacit knowledge. The codification of knowledge on the one hand reduces transaction costs and on the other hand makes it possible to establish information bases and electronic networks for enterprises. Modern ICTs are the first global technology with the potential for international codification and transferability of intercultural communication. Knowledge is from this perspective a non-rival good. It can be shared by many people without diminishing in any way the amount available to one of them. Without taking this important issue into account, the new possibilities of worldwide communication, the models of networking and the creation of new social and cultural perspectives through ICTs cannot be considered seriously. At the firm level, ICTs contribute to the creation of new knowledge which can accelerate different learning and innovation processes. They radically transform both intra- and inter-firm communication which is of particular importance in the daily operation of intensively co-operating company networks [4,5]. ICTs can also radically transform communication between firms and their clients. The possibility of direct communication with clients (who are becoming one of the most important sources of knowledge) opens up new paths to company level learning. As well as technical access to modern ICTs, specific skills and routines are needed to use the technologies, which are also strongly connected with the capability to generate non-formalised communication. From this perspective, the emphasis is on their potential to reinforce human interaction and interactive learning and ways that companies can support and mobilise tacit knowledge [6,7,8].

The most important impact of ICTs is that they move the border between tacit and codified knowledge. The attention to increasing skill requirements and the growing knowledge-intensity of jobs related to ICT and to the structural transformations they bring about in the economy, also results from the incompleteness of the codification of knowledge and the growing relative importance of the remaining tacit knowledge components. Other researchers also agree on the growing importance of generic skills because of the limits of codification and automation [9,10]. In particular in knowledge work it is now assumed that precisely the remaining tacit knowledge part will embody the main value of the activity and that work relies to an important extent on tacit knowledge (creativity, talent, experience), that by definition requires more autonomy and discretion in the job. With respect to the tacit *versus* codified skills debate it is important to note that the interaction between both kinds of knowledge (tacit and codified) should be acknowledged. Knowledge creation or learning is 'an accumulative process whereby tacit knowledge is transformed into codified knowledge and new kinds of tacit knowledge are then developed from close interaction with the new piece of codified knowledge. Such spiral movement is at the every core of individual as well as organisational learning. Huws describes this dynamic relationship between tacit and codified knowledge and the concurrence of upgrading and deskilling in the processes of innovation and technical division of labour. Codification and deskilling are counterbalanced by tasks that require different kinds of (new) skills related to new emerging tasks, such as creative tasks, but also relational, communication or commercial tasks (Perret, 1995). The implications of a - proportionally - growing knowledge-intensity of jobs, can be considerable. If knowledge-intensive

jobs can be defined as those jobs where the active and independent acquisition, processing and development of knowledge and information plays a dominant role, this implies that these jobs are by nature complex and non-routine, because of the importance of non-codified knowledge in this process. The assumption is that a so-called 'knowledge worker' can easily access complex knowledge, is continuously learning and is qualified to use formal, abstract and complex information. The work organisation of such work will have specific characteristics, notably these workplaces will be characterised by non-routine, non-standardised jobs, requiring autonomy and opportunities for learning and intensive interaction and collaboration with others (inside and beyond the firm) in view of problem-solving requirements. The question remains what is the spread of such knowledge-intensive jobs in firms and organisations and to what extent and under what conditions knowledge work, is becoming a more dominant type of work in Europe to the detriment of routine work.

Related to the debate on knowledge work and increasing knowledge-intensity, in recent years a growing body of research has emerged from studies in computer science and organisational studies focused on knowledge management systems within organisations and beyond. In order to manage knowledge, knowledge and information is codified and standardised. Some approaches to knowledge management prioritise structural models and IT systems whereas others focus on processes, communities of practice and dialogue. The main problems knowledge management aims to solve, *i.e.* the generation, representation, storage, distribution and application of knowledge, are of particular importance in networked organisations and with distributed work [11]. While advanced databases greatly support co-operation over distance, recent trends in the debate on knowledge management emphasise implicit knowledge and the role of communities of practice [12,13]. Research on various forms of work indicates that neither higher levels of codification of knowledge, increased planning, nor a more intensive use of technology can fully replace tacit forms of knowledge in the light of increasing complexity and critical situations. Likewise, the more information is codified and stored in ICT, and retrievable from it, the more important tacit knowledge becomes in selecting, combining and applying knowledge [14]. With respect to distributive teams, it is however worth making a distinction between the uses of ICT in 'task-orientated' *versus* 'space-time dependent' forms of distributive virtual teams. In task-oriented teams, the ICT support is more useful for efficient co-ordination (management of workgroup inter-dependencies) in comparison with space-time dependent teams. This distinction is especially important in the case of use, transfer and sharing of so-called diffused knowledge (tacit skills) in comparison with codified knowledge. It is anyway crucial to understand the impact of new forms of work organisation on the opportunities for the acquisition, mobilisation and utilisation not only of explicit, but also of implicit knowledge [15].

The restructuring of value chains is, next to ICT, a second important 'driver of change' which is of interest in relation to the introduction structural changes in the skills structure of organisations. In this respect the emergence of the so-called networked organisation is especially relevant [16]. The impact of ICTs on knowledge and communication is a crucial factor in globalised corporate restructuring, implying an increased externalisation of activities through outsourcing and subcontracting, a considerable change in transaction costs and - thus - a growing importance of market-led forms of control and management of businesses functions. A number of authors describe this transformation from the traditional bureaucratic organisation to a networked organisation. It is argued that organisations are disintegrating and networked forms of co-ordination of economic transactions are emerging. Several recent studies focus on the different forms these networked organisations can take and what implications this can have on different aspects of the employment relationship and on the social dialogue. Without describing in detail the different forms of 'multi-employer' environments networked or boundaryless organisations, it is obvious that such new organisational models will have huge implications for the way skills acquisition and development are organised in firms [17].

The evolution towards distributed organizations seems to be inevitable once everyone has access to collaboration systems that allow horizontal, crisscross interactions. Organizations that remain too hierarchical may soon crumble under the pressure created by these systems. This trend started with phone, fax, and now with the Internet which has exploded. Central coordinating items appear and disappear when making successive adjustments in response to environmental change. Companies wishing to increase their collective intelligence,

must therefore make a priority from implementing collaborative intranets. We do not refer here to an intranet for information or communication, but one that provides real cooperation. A collaborative intranet allows information to flow through individual horizontal interaction, rather than a top-down central coordinated communications company. Information finds its way to right individuals, on appropriate levels. They do not need the same information level at the same time to produce collective intelligence. What matters is that information must be distributed. This information may reach to someone in the organization who really needs it, without requesting it. Note that there is no absolute ideal organization, only for a specific culture, a specific environment and specific context. Therefore, an organizational structure will always be relative and contextual. Schematically, the company consists of four elements: strategy (which provides the vision, concept, direction), an organization (that structures the power, the relations), systems (e.g. Information, management, control, allowing operation of the organization) and operations (all objectives, activities, tasks). A sale is a transaction between two brains, and the sale instruments are: the commercial thinking matrix, cognitive brain, info-exchange, mental maps (very close to neuro-genetic models), compass of the sale. This approach supports the use of the brain in an increasingly large proportion, namely its extraordinary creative ability.

During the last decade, there was a transfer from data-based information systems to information systems based on processes. Business Process Management includes methods, techniques and tools to support design, use, management and analysis of operational business processes involving people, organizations, applications, documents and other sources of information. Business Process Management can be considered an extension of classical systems based on workflow management. A *business process* is a set of activities that follows a logical flow, resulting an output. A business process is to specify the tasks to be fulfilled to achieve a business objective. Inputs and outputs may be facts and / or information, and the transformation can be performed by human actors, machines, or both. Although an organization's business processes can be tracked separately, by integrating them is obtain value-added which, long term, leads to positive results, a good control over the resources involved and over the environment in which it operates. Petri networks are tools of business process modeling. One of the advantages of using Petri networks for modeling workflows is access to many analysis techniques based on Petri networks. Accuracy, applicability and efficiency of business processes supported by systems based on workflow management are vital to any organization. It is important to review the definition of a process through network flows before applying it in practice. In theory, there are three types of analysis: (1) *validation*, testing whether a workflow behaves as expected; (2) *verification*, determining the accuracy of the network flow; (3) *performance analysis*, evaluating the ability to meet the requirements, taking into account the time, levels of work and resources. Validation can be done through interactive simulation: are analyzed a number of cases to see if the system behaves properly. For verification and performance analysis, are used advanced analysis techniques specific to Petri networks, such as invariants, reachability trees, coverage graphs analysis, etc. The multitude of available analysis techniques shows that Petri networks can be seen as an independent environment (solution) between the design of a process' definition through workflows and the analysis of the resulted workflow.

Another important direction in the synthesis of intelligent KMS systems in economy is the development of heterogeneous computing environments, in which one can develop adaptive algorithms for planning and resource allocation using genetic algorithms and evolutionary computation technology [18]. Heterogeneous computing environment is a suite of processing units, high-speed interconnections, interfaces, operating systems, communication protocols, and programming environments. It provides a variety of architectural options and skills that can be adapted to perform an application in accordance with different execution requirements.

Different parts of an application task often require different types of calculation. It is generally impossible for a single architecture along with the compiler, operating system and associated programming tools to equally meet the computational requirements in such an application. In the heterogeneous computing environment considered, an application task can be decomposed into subtasks, each subtask being computationally homogeneous (appropriate, indicated for a single

processing unit) and different subtasks may have different architectural requirements. These subtasks may have data dependencies between them. If the application task is decomposed into subtasks, the following decisions must be taken: subtasks' distribution on different processing units and scheduling, ordering subtasks' execution for each processing unit, as well as planning data transfer between processing units. In this context, the aim of heterogeneous compilation is to obtain a minimum duration of execution, i.e. the minimum total execution time of the application task in the suite of processing units. It is well known that such an allocation and planning problem is generally NP-complete. It was proposed a large number of approaches to different aspects of this problem. This chapter proposes an approach based on genetic algorithms to solve the problem of concurrent allocation and planning in heterogeneous systems from the computational point of view. It decides the subtasks' allocation to processing units, orders the execution of the subtasks allocated to a processing unit and coordinate the data transfer between subtasks. The characteristics of this approach include: separation of allocation and planning representation, the independence of chromosomes' structure from communication subsystem's details and an assessment of the coverage degree and overlap between all communications and calculations that meet the precedence constraints of subtasks.

3. CHARACTERIZING AN EXTENDED FUZZY LOGIC SYSTEM WITH TEMPORAL ATTRIBUTES

The approximate reasoning refers to creating new rules of inference and translation. It is a mathematical instrument used for modeling the human reasoning based on imprecise knowledge. The theory suggested by Zadeh is based on intuitive rules and leads to operations with fuzzy relations, obtaining thus very useful applications [19]. This perspective has the advantage of demonstrating that the fuzzy logic is a generalization of bivalent logic, replacing the discrete feature of the latter with a continuous one. If in the case of bivalent logic there are used methods that clear up every possibility of evaluation according to the interpretation function, when we refer to fuzzy logic this are no longer possible. The formalism of the first-degree fuzzy logic represents the mathematical basis for the general theory of approximate reasoning. A special feature of the human thinking is the effective use of natural language even within the process of logic reasoning. According to this observation, we can conclude that the mathematical model of the way in which man thinks (acts) in a management position and at a certain level of synthesizing decisions, could be based on the fuzzy logic, combined with modal temporal features. I will tackle next the formalism of first-degree fuzzy logic, highlighting the structure of truth values, the extended syntax and the semantics of this formal logic system. I will underline in this way the connections between fuzzy logic and approximate reasoning, which is further analyzed through the possibility reasoning, which is considered useful by the inference engine of the expert management system SECOMBCF [19].

The *structure of truth values* is a residual lattice written $L = (L, \vee, \wedge, \otimes, \rightarrow, 0, 1)$ where the 0 and 1 values are the smallest respectively the biggest elements, $\vee$ and $\wedge$ are the supremum, respectively infimum operators, $\otimes$ is the isotone product operator for both variables, $(L, \otimes, 1)$ is a commutative monoid, and $\rightarrow$ is the residuation operator. Furthermore, $a \otimes b < c$ only if $a < b \rightarrow c$ ($\forall$) $a, b, c \in L$. For $L = [0, 1]$ the logical connectives are $\vee = \max$, $\wedge = \min$, $a \otimes b = 0 \vee (a + b - 1)$ and $a \rightarrow b = 1 \wedge (1 - a + b)$. If we consider, for instance, $a \otimes b = \min(a, b)$, then the only corresponding residuation operator is the Gödel implication operator. The *syntax* of the basic language of the extended first-degree fuzzy logic with modal temporal operators consists of: $(x, y, \dots)$ variables and $(c, d, r, \dots)$ constants seen as elements that describe the set of states of an expert management system $X^{SEC} = X^{SE} \cup X$, $(f, g, \dots)$ functional symbols of n arity, a set of symbols for the truth values $\{a: a \in L\}$, predicate symbols of n arity, a binary connective $\Rightarrow$, a $\{o_i: i \in J\}$ set of connectives of m arity, a symbol for the $(\forall)$ quantifier, the o modal temporal operators (the following moment in time), $\square$ (for all present or following moments in time), $\diamond$ (for a present or following moment in time) and punctuation marks. The terms are classically introduced. The *formulas* are defined as follows: **i)** an a symbol for a $(a \in L)$ truth value is an atomic formula; **ii)** if $t_1, \dots, t_n$ are terms and p a predicate symbol of n arity, then $p(t_1, \dots, t_n)$ is an atomic formula; **iii)** if $A, B, A_1, \dots, A_m$ are formulas and o_i is a connective of m arity, then $A \Rightarrow B, o_i(A_1, \dots, A_m), (\forall x)A$ are formulas. The $\neg A$

formula is an abbreviation for $A \Rightarrow 0$. There are similarly defined the ($\vee$) disjunction, the ($\wedge$) conjunction, the ($\Leftrightarrow$) equivalence, $A \& B$, ($\exists x$) A , $A^k = (A \& A \& \dots \& A) / k \text{ times}$; **iv**) The $x^{SE} \in X^{SE}$, $x \in X$ variables are formulas, and if g is a formula, then og , $\square g$, $\diamond g$ are formulas, too; **v**) Any application of the above-mentioned rules for a certain number of times, determines a formula. Given a J_1 language of the extended first-degree fuzzy logic with modal temporal operators, the set of all terms will be noted M_{J_1} , and the set of all formulas will be noted F_{J_1} . If t is a term and A is a formula, then $A_x[t]$ is the formula obtained by substituting of the t term whenever the x variable appears freely in A . $g_s = (x_1 \vee x_2 \vee \dots \vee x_n)$ and $g_0 = (x_{01} \vee x_{02} \vee \dots \vee x_{0n})$ are given fuzzy formulas. The $g_0 \rightarrow \diamond g_s$, $g_0 \rightarrow \square \diamond g_s$, $g_0 \rightarrow \square \diamond g_s$ relations are formulas too, and they allow expressing certain qualitative management conditions.

The semantics of the first-degree fuzzy logic is defined as follows. A structure of the language of the fuzzy logic J_1 , is characterised by $\bar{D} = (D, p_D, \dots, f_D, \dots, u, v, \dots)$ where D is a set, p_D, D^n are relations of n arity assigned to each p n -ar predicate symbol and, f_D are n -ar functions in D assigned to each functional symbol of n arity, whereas $u, v, \dots \in D$ are elements assigned to each $u, v, \dots$ constant of the J_1 language. Take $\bar{D}$ a structure for the J_1 basic language. The interpretation function of the formulas in $\bar{D}$ is a $\tilde{D} : F_{J_1} \rightarrow L$ function, which assigns a truth value for any formula from F_{J_1} , as it follows: **i**) $\tilde{D}(a) = a$, $a \in L$; **ii**) Take $t_1, \dots, t_n$ terms without variables and p an n -ar predicate symbol. Then $\tilde{D}(p(t_1, \dots, t_n)) = p_D(\tilde{D}(t_1), \dots, \tilde{D}(t_n))$, where $\tilde{D}(t_i) \in D$ is an interpretation of the $t_i \in M_{J_1}$, $i=1, \dots, n$ term; **iii**) $\tilde{D}(A \Rightarrow B) = \tilde{D}(A) \rightarrow \tilde{D}(B)$, highlights the fact that A and B are closed formulas; **iv**) $\tilde{D}(o_1(A_1, \dots, A_n)) = o_1(\tilde{D}(A_1), \dots, \tilde{D}(A_n))$; **v**) $\tilde{D}(\square x A(x)) = \bigwedge_{d \in D} \tilde{D}(A_x[d])$, where d is the name of the $d \in D$ element; **vi**) $\tilde{D}(A(x_1, \dots, x_n)) = \bigwedge_{d_1, \dots, d_n} \tilde{D}(A_{x_1, \dots, x_n}[d_1, \dots, d_n])$. Take $Y \subseteq F_{J_1}$ a fuzzy set of formulas. The fuzzy set of semantic consequences of the Y fuzzy set (where $Y(B) \in L$ represents the truth degree of B in Y) is: $(C^{sem}Y)A = \bigwedge \{ \tilde{D}(A) : \bar{D} \text{ is a structure for } J_1 \text{ and (for each } A \in F_{J_1}), (Y(B) \leq \tilde{D}(B)) \}$. If $(C^{sem}Y)A=1$, then for any fuzzy set of Y formulas the following relation occurs $\models A$ and A is a tautology, and C^{sem} is the closing operator in L .

Lemma 1. **a)** $\models A \Rightarrow B$ only if $\tilde{D}(A) \leq \tilde{D}(B)$; **b)** $\models A \Leftrightarrow B$ only if $\tilde{D}(A) = \tilde{D}(B)$, for any $\bar{D}$ structure. This result is used in the derivation of tautologies. It is allowed the introduction of a set of fuzzy axioms to support the derivation of new formulas.

A logical inference is a $B_1, \dots, B_m$ sequence of formulas, each of them being either a logical and special axiom, or a formula derived from other formulas, using a rule of inference. The rules of logical inference can be schematically written under the form $A_1, \dots, A_n / B$ where $A_1, \dots, A_n$ are known formulas, and B is a derived fact ($A_1, \dots, A_n, B \in F_{J_1}$). The rules of inference preserve the truth values after the inferential process.

The theory of approximate reasoning, as a methodology of exploitation of imprecise knowledge with respect to the state of the expert management system (noted with $x^{SEC} \in X^{SEC}$ and represented as distributions of possibility), allows that, given certain logical inferences, strict characterizations of the values of linguistic variables to be obtained from the structure of the x^{SEC} state, compliant to the management purpose. The X^{SEC} set can be defined as a Cartesian product $X^b \times X^{int} \times X$, in which $x^b = [x_1^b \ x_2^b \ \dots \ x_{k_1}^b]^t \in X^b$. For instance, the X_1^b component marks,

through its values, possible command events for the process, $x_i^b \in U^{(i)}$, $i=2, \dots, k_1$ where $U^{(i)}$ are the universes of discourse attached to the linguistic variables $X^{(i)}$ (chosen in order to characterise the $x^{SE} \in X^b \times X^{int}$ state), X^{int} represents the set of internal states of the engine of inference, and X refers to the set of the states of the process.

Types of Knowledge Specific to a Real-Time Expert Fuzzy System

Creating certain efficient reasoning algorithms, within expert management systems, demands for a corresponding analysis of the type

and signification of knowledge from the structure of the involved models. The elements presented in the next section of the paper refer mostly to the logical aspects regarding fuzzy inference, without paying too much attention to the semantics of the fuzzy rules. From this point of view, the implication and the multi-evaluated extensions can correctly express the problem of the semantics of the fuzzy rules, hardly investigated in literature. There are put forth three types of fuzzy rules „if..., then...” according to the paper [19] and these will be further presented in this paper: **i) Rules to qualify certainty.** These rules are expressed like “the more $u \in A$, the more sure $v \in B$ ”, which are translated by the relation $(\forall) u, \mu_A(u) \leq g_t(B)$, where $g_t(B)$ evaluates the degree of reliability of the statement $v \in B$ when $x=u$. The g_t function can be any occurrence of the kind necessity, possibility, and probability; **ii) Gradual rules** (or rules to qualify truth) expressed by: “the more $u \in A$, the more $v = f(u) \in B$ ”, i.e. there is a $f : \text{Supp}(A) \rightarrow \text{Supp}(B)$ function so as $f(A) \subseteq B$. This condition can be written down again as $(\forall) u \in A, \mu_A(u) \leq \mu_B(f(u))$, a relation as a definition of the fuzzy function in the paper [8]. This last relation can be relaxed by replacing the f function with the R fuzzy relation, and thus resulting the inequality: $(\forall) u, v, T(\mu_A(u), \mu_R(u, v)) \leq \mu_B(v)$, where T is a triangular norm. We can create this type of statements of the kind “the more $u \in A$ and the more u is in relation with v , the more $v \in B$ ”. In this situation, the degree of truth of the antecedent restricts the degree of truth of the consequent; **iii) Rules to qualify possibility** expressed by: “the more $u \in A$ the more possible $v \in B$ ”, which represents a partial description of the R relation between u and v . In this case, the inclusion $A \times B \subseteq R$ takes place, and this further implies that $\mu_R(u, v) \geq \min(\mu_A(u), \mu_B(v))$. This type of rules is used in the fuzzy decision/control process.

The interpretation of the semantics of fuzzy rules is important, since it allows the selection of certain ϕ -operators to match with the significance of the rule. In the case of gradual rules, Yager's principle of minimum specificity is satisfying in order to obtain the distributions of possibility implied by these rules. For instance, the R relation from the gradual rules definition is a relational fuzzy equation with unknown μ_R . Applying the minimum specificity principle leads us to the definition of the distribution of possibility $\pi_{xy}(u, v)$, which expresses the semantics of the rule as a maximum solution in the $\mu_A(u) \leq \mu_B(f(u))$ relation, i.e. $\pi_{xy}(u, v) = \sup \{ \alpha \mid T(\mu_A(u, \alpha) \leq \mu_B(v), (\forall) u, v \}$. This result offers to the R - implications semantics of representation of gradual rules. The minimum specificity principle is not sufficient in order to solve the above-mentioned inequality, especially when B is fuzzy. This last problem demands the use of a qualification of α -certainty applied to B . The above-mentioned aspects entail possible domains of application of the various types of fuzzy rules, compared to their semantics for different kinds of reasoning: uncertain, interpolative, by analogy. In the case of the expert management system REFK2 prototype, the inferential subsystem based on fuzzy logic uses the scheme of inference generalized modus ponens. The knowledge-based reasoning represented as certain distributions of possibility, uses the notion of similarity defined as complement of distance.

The DKMSs can entail also the temporal reasoning. In this situation, we attach temporal descriptors like DT_p , to rules which can be punctual ($\alpha=p$) or interval ($\alpha=i$). These temporal descriptors can be modeled with the help of certain distributions of possibility, so as to attach the fuzzy statements of temporal features. The attachment of the temporal fuzzy descriptors is specific to artificial intelligence techniques, but from the point of view of automation, this idea is equal to the fuzzification of the moments of time within the discrete events systems theory, a class of systems which the expert management system developed in this paper is part of. So as to elaborate an actual model for an expert system, in which to make possible the development of the temporal possibilistic inference, we will refer to the structure of the expert system based on the fuzzy inference. The temporal descriptors are operators that characterize the temporal properties of a P fuzzy statement and these can be:

i) punctual $DT_p \left(P, \int_t \frac{\mu(t)}{t}, u \right)$; **ii) of interval type**

$DT_i \left(P, \int_t \frac{\mu_1(t)}{t}, \int_t \frac{\mu_2(t)}{t}, u \right)$, in which P is a fuzzy sentence,

$\int_t \frac{\mu(t)}{t}$ is a T-number that describes the point on the axis of time at

which statement P takes place, and μ represents the membership function of the moment of time associated to P .

Similarly, the T -numbers $\int_T \frac{\mu_1(t)}{t}$, $\int_T \frac{\mu_2(t)}{t}$, that represent the

moments of emergence and extinction of the event described by the P statement are also interpreted. The available information about a certain moment in time will be represented within the model by a possibility distribution.

Due to the change of values of the variables in a dynamic way within the problem domain, the evolution of the $x^{(i)}(t)$ specimens can engender dynamic corresponding symptoms in the fact base. Moreover, the basic rules describe the dependences between the numerical values of the symptoms by means of fuzzy sentences P_j , $j \in M_k$, $M_k \in M_0$, and the temporal relations between these symptoms by using the DT_j associated temporal descriptors.

In the case of the REFK2 system, this kind of knowledge does not interfere, since the temporal aspect appears only as real time, and not as the reasoning concerning time also. In fact, this last aspect of time is adequate in the artificial intelligence systems with applications in diagnosis. An important feature of time in expert systems in order to manage processes is represented by their real-time behavior, capable to guarantee a satisfying response time. By introducing certain real-time restrictions inside an expert system, we provide the system with features like: **i)** reasoning is evolutionary and non-monotonous because of the dynamic aspect of the application; **ii)** unexpected events can change the state of the expert management system. There is a series of additional problems if we take into account the temporal characteristics, associated both to the model and to the evidence system that reflect the state of the process at a certain moment in time. These problems can be summarized as it follows: **i)** The filtering of a temporal fuzzy rule demands that, beside the numerical filtering, to adequately solve the temporal filtering also, i.e. the temporal attributes attached to the motives within the structure of the fuzzy temporal rules R_i , $i=1, \dots, n$, must filter the temporal attributes formed by the corresponding dynamic symptoms from the fact base in a fuzzy sense. It is also necessary to determine a method of numerical temporal filtration, so as to evaluate the degree of filtration between R and X^b ; **ii)** the way in which the conclusion can be inferred (i.e. the result of the inference and the corresponding degree of reliability) and which is the domain of time associated to it. The model associated to the filtering stage from the structure of a temporal fuzzy reasoning system based on intervals, must satisfy a series of conditions presented in above example. From the filtering point of view, we can obtain various situations, by choosing a corresponding window of filtration in the $U^{(i)} \times T$ bi-dimensional space. Figure 1 presents a similar type of filtration. The filtering window can be a point or a rectangle, depending on how the temporal attribute attached to the P_i sentence is: punctual or interval. In the fact base, the evolution of values afferent to the $X^{(1)}$ and $X^{(2)}$ variables, generates certain manifestations or specific situations, which are determined for the x^b state of the expert system. Meanwhile, the rules in which the $X^{(1)}$ and $X^{(2)}$ variables appear (implicitly attached to the P_1 and P_2 sentences), highlights the presence of some temporal descriptors that define the temporal relation between P_1 and P_2 .

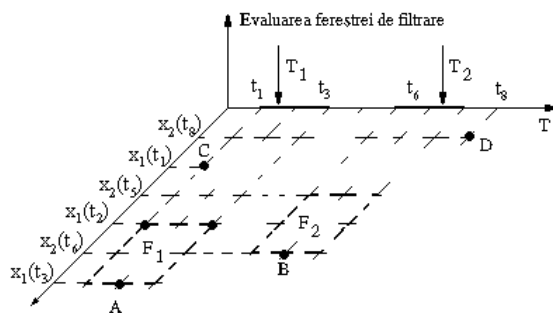


Figure 1. The bi-dimensional filtering space

This way, we can give top priority to numerical filtering by choosing $x_1(t_3)$ and $x_2(t_6)$ to be filtered with P_1 and, respectively P_2 . We obtain a good result of the numerical filtering, but the temporal filtering offers

weak results instead. We can give priority to the temporal filtering as compared to the numerical filtering. The results may favorably change for the temporal filtering compared to the first case (for example, we choose $x_1(t_3)$ and $x_2(t_8)$ or $x_1(t_1)$ and $x_2(t_6)$ in order to filter with P_1 , respectively P_2). It is obvious the fact that there are other choice possibilities also in the $U^{(i)} \times T$ space of the window filtering position.

The unsolved problems from a practical point of view represent the means by which the width of the filtering windows is determined (F_1 , F_2), their best possible positioning within the $U^{(i)} \times T$ ($i=1,2$) space, the summary inside the filtering windows of the evolutions afferent to the $X^{(1)}$ and $X^{(2)}$ variables in values that can be further undergo a numerical filtering with P_1 and P_2 , by assessing the consistency of the filtering phase on the whole. The advanced stages in order to obtain the reasoning strategy are: determining the time domain, temporal and numerical filtering. Once these properties have been mentioned, we may continue the development of the advanced model for the effective DKMS.

4. CONCLUSIONS

In the present paper we also analyzed the formal aspects of the reasoning corresponding to an expert management system as a decision making system that includes imprecise knowledge and time variables. With this aim, I extended a first-degree logic fuzzy system with temporal modal operators that allow the justification of the synthesis of certain linguistic process management models. The process of modeling the approximate reasoning assumes the definition of certain fuzzy sets of evaluated closed formulas, which are actually fuzzy subsets of certain sets of special axioms. The description of some models that include also attributes like temporal descriptors, we highlight the fact that the specification and synthesis of fuzzy management models is marked, from a logical point of view first of all, by the presence of the possible and the necessary. The temporal precedence relations can appear especially in diagnosis applications, where the introduction of time is made from the exterior and these types of applications allow symptoms classification. The formulas from the extended first-degree fuzzy logic domain with temporal modal operators can be used in order to model various management strategies. For instance, take $g_s = (x_1 \vee x_2 \vee \dots \vee x_n)$, where $x_i \in X_s \subseteq X$ and take $g_0 = (x_{01} \vee x_{02} \vee \dots \vee x_{0n})$ in which x_{0i} are initial states for the state variables of the $(1 \leq i \leq n)$ process. Take $X^b \subset X^{SE}$ and $g_b = (x_{b1} \vee x_{b2} \vee \dots \vee x_{bn})$ in which $x_{bi} \in X^b$. The $g_0 \rightarrow \Diamond g_s$ formula can be seen as an admission condition. The formulas: **i)** $g_0 \rightarrow \Diamond g_s$ (if the process starts from one of its initial states, then, after a certain number of moments of time its state will always be found in X_s); **ii)** $g_0 \rightarrow \Box g_s$ (if the process starts from one of its initial states, then it will be in X_s for an infinity of times); **iii)** $\Box g_b \rightarrow \Box g_s$ (if the inputs of the process are always in a X^b set, then the states of the process will always remain in X_s set), characterizes properties which can be thought of as the equal of the stability demands. The temporal logic is a particular type of modal logic and provides a formal framework which allows the description of the way in which certain systemic properties can be specified, and it is useful in a more profound understanding of the state of the systems. It is very important to know these facts when we refer to the expert management systems of technological processes, in order to analyze the time evolution of the states and events sequences, to implement and verify the system itself. We can more adequately specify the behavior of the management system within the temporal logic formalism, since this kind of specifications have a greater expressivity in comparison to the classical logic specifications. The temporal logic properties cover many of the dynamic behavior aspects of the knowledge-based management systems. That is why we consider that the logic formalism presented above is important for the creation of the REFK2 system, since it is an attempt of including both fuzzy and temporal attributes.

Performance of an organization should not be measured by the number of restrictions placed upon its data, but by the number of high quality connections created between people, and how fast and fluid are these connections. Risk of information to be stolen is real. But precautions taken to protect information against fraudulent people must not destroy the organization as a whole, slows down intellectual collaboration for the sake of protecting against a potential risk that may never happen. This endangers the long-term success of the company rather than opening the door to the unscrupulous. Only rarely individuals outside a company are trying to spy and steal information from there. In 80% of cases, people who steal information are people from the inside! Truly confidential information (strategic, sensitive)

should not even be included in information systems, but to be specially handled. All of the information protection systems have a crack: overthrow. An employee leaving the company to work for its competitors damages the company more than any pirate in the computers would ever do, because he leaves with a lot of information, some of which are not capitalized and thus lost forever. The best way to protect our information is to gain employees' loyalty and to encourage knowledge capitalization and sharing. Recently implemented in organizations, KM essentially has three functions: (1) decision support by increasing the quality and quantity of knowledge, by facilitating the emergence of new ideas; (2) their identification, validation and conversion in projects; (3) production optimization (recurring processes), by implementing best practices, reducing errors and re-using knowledge and skills.

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5. REFERENCES

- [1]. **M. Alavi and D.E. Leidner**: Knowledge Management Systems: Issues, Challenges, Benefits, *Comm. Of AIS*, vol. 1 (7), 1999.
- [2]. **M.M. Appleyard**: Cooperative knowledge creation: the case of buyer-supplier co-development in the semiconductor industry, Working Paper No. 98-06, Darden Graduate School of Business Administration, 1998.
- [3]. **T. Bui, A. Gachet**: Web Services for Negotiation and Bargaining in Electronic Markets: Design Requirements and Implementation Framework”, Proceedings of the 38th Hawaii International Conference on Systems Sciences, 2005.
- [4]. **T.H. Davenport, L. Prusak**: Working Knowledge: how organizations manage what they know. Harvard Business School Press, Boston, p. 34-87, 1988.
- [5]. **E. M. Awad, H. M. Ghaziri**: Knowledge Management, Int. Edition, Pearson Education, ISBN 0-13-122784-X, 2004.
- [6]. **N. Foss**: Strategy, Economic Organization, and the Knowledge Economy. The coordination of firms and resources. Oxford University Press, 2005.
- [7]. **G. Alaa, G. Fitzgerald**: Understanding and Modelling Factors of Emergence in Turbulent Business Environments, School of Information Systems, Computing and Math, Brunel University, UK, 2005.
- [8]. **L. Tesfatsion**: Notes on Learning, Department of Economics, Iowa State University, USA, 2006.
- [9]. **R. Lindgren, O. Henfridsson, U. Schultze**: Design Principles for Competence Management Systems: A Synthesis of an Action Research Study, *MIS Quarterly* Vol. 28 No. 3, pp. 435-472 September, 2004.
- [10]. **L. F. Luana-Reyes, A. M. Cresswell, G. P. Richardson**: Knowledge and the Development of Interpersonal Trust: a Dynamic Model, Proceedings of the 37th Hawaii International Conference on System Sciences, Universidad de las Americas, Center for Technology in Government, Rockefeller College of Public Affairs and Policy, Mexico, 2004.
- [11]. **M. von Mevius, R. Pibernik**: Process Management in Supply Chains – A Petri-Net Based Approach, Proceedings of the 37th Hawaii International Conference on System Sciences, Institute of Information Systems, Department of Supply Chain Management, School of Business and Economics, Goethe-University, Frankfurt, Germany, 2004.
- [12]. **I. Nonaka**: A Dynamic Theory of Organizational Knowledge Creation, *Organization Science*, February, pp. 14-37, 1994.
- [13]. **I. Nonaka, H. Takeuchi**: The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, Oxford University Press, New-York, 1995.
- [14]. **K. E. Sveiby**: A knowledge-based theory of the firm to guide in strategy formulation. *Journal of Intellectual Capital*, 2(4), 344-358, 2001.
- [15]. **L. Tesfatsion**: Agent-Based Computational Economics, Department of Economics, Iowa State University, ISU Economics Working Paper no. 1, p. 1-30, 2003.
- [16]. **A. Tiwana**: The Knowledge Management Toolkit, Second Edition, Pearson Education, ISBN 0-13-0092248X, 2002.
- [17]. **M. K. Wiig**: People-Focused Knowledge Management: How Effective Decision Making Leads to Corporate Success, Knowledge Research Institute, Inc. Elsevier Butterworth-Heinemann, 2004.
- [18]. **V. Mazilescu**: An Enterprise Control Support System for Economic Growth, The 10th WSEAS International Conference on Applied Informatics and Communication (AIC'10), Taipei, TAIWAN, August 20-22, Conference ID 647-307, p. 365-370, 2010.
- [19]. **V. Mazilescu**: Fuzzy Modelling in the Emerging Field of Knowledge Management Systems, The 9th WSEAS International Conference on Artificial Intelligence, Knowledge Engineering And Data Bases (AIKED'10), Cambridge, UK, 2010.

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INTEGRATING INFORMATION AND KNOWLEDGE IN INTELLIGENT ECONOMIC SYSTEMS.SPECIFIC SITUATION OF METALLURGICAL INDUSTRY

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Key words: Knowledge Distribution, Intelligent Economic Systems, Competency Management, Knowledge Management Systems, Materials Engineering.

Abstract. Knowledge is based on the accumulation of facts, procedural rules or heuristics. Knowledge is supported by both formal and informal processes and structures in their acquisition, sharing and applications. Workers and employees communicate and assimilate values, procedures, rules and data from the beginning of their activity in an organization, and hypothetically should begin to be increasingly willing to share what they know as their length of service increases. This paper presents a deep analysis of knowledge, as the basic pillar of the intelligent enterprise and of many other Intelligent Economic Systems. In this respect we emphasize that it is essential to realize that Knowledge Management is both a cultural and a technological provocation. Our work demonstrates the main aspects and strategic advantages of knowledge representation, processing based mobilisation and distribution in the long process from integrating information and applications to automate knowledge worker functions. Developing systems that incorporate knowledge within organizations differs significantly from other systems, because it is absolutely necessary to associate operational interpretations with the information, in order to transform them into knowledge useful in various acts of decision. Understanding, defining and using knowledge can be based on a number of many approaches, such as the synthesis of Knowledge Management Systems, Knowledge Agents, Knowledge Discovery and Data Mining, Organizational Semantic Webs. In this respect the contribution of materials engineering is very important.



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1. INTRODUCTION

Creating and sharing knowledge are intangible activities, that can neither be led nor monitored, and people cannot be required to do these. Knowing is apparently rooted in people's minds, through their experiences and skills. While some knowledge is explicitly acquired in electronic format or traditional documents, most do not reside in such sources. This share forms the tacit aspect of knowledge. Any part of knowledge formalized, captured and explained can be easily converted in different forms that allow searching and reusing it. Much of knowledge organization is created during an act of collaboration and action, so that the collaborative efforts are essential in a Knowledge Management (KM) initiative. Knowledge has the highest value in terms of human contribution and the highest significance in various decision acts. They are very difficult to manage because their source is the human brain and mind. There are differences between information and knowledge also with technological implications. Technological implications imply that computer systems can handle electronic information, but not electronic knowledge. Business systems are loaded with information, but not with knowledge, whereas the latter are information combined with experience, are contextualized, interpreted and reflected. A higher form of reasoning embodied in action is the wisdom, characterized by knowledge combined with learning. Managers and experts must use and understand a series of knowledge in order to reach some information or data. One of the reason why knowledge-type resource is a difficult concept is that the processes involving knowledge are usually recursive in development, dynamic and often discontinuous. In knowledge acquisition, encoding and transfer of all processes for which are created systems that incorporate knowledge (business processes, technical, economic, diagnosis applications etc.) there are a number of cycles [1,2,3]. Defining and understanding knowledge can be based on a number of approaches, ranging from the philosophical and ending with a pragmatic one, the synthesis of Knowledge Management Systems (KMSs) [4,5,6].

Most economists and business theorists appreciate knowledge as a vital resource for competitive advantage of the modern business [7]. The key link between information and knowledge is based on the observation that knowledge is actionable information. If it can be used for doing what we intend, then the information becomes knowledge. Knowledge are unclear, partially structured or unstructured, vague, intuitive, hard to communicate and difficult to articulate in words or different illustrations, and a large part of them are not stored in databases, but in the minds of the people working in

the organization. We find them in connections, conversations between people, insights based on experience, in people's kindness to compare situations, problems or solutions. Only a tiny part of the tacit knowledge comes to be formalized in data, books, documents or presentations, the rest remain in people's minds. There is nothing wrong in this situation, except that if a person leaves, the knowledge leaves with it (more or less). By contrast, information remains whether or not a person leaves. Much of knowledge organization is created during an act of collaboration and action, so that the collaborative efforts are essential in a KM initiative, like in Knowledge Based Systems (KBSs) development and implementation.

Theoretical knowledge is build up of empirical knowledge through analysis and synthesis, deduction and induction, generalization and particularization. Knowledge does not exist outside of an agent. In this way, they are the result of a cognitive process, set in motion by the inputs of new stimuli. We can assert that the information is converted into knowledge if it is processed in the mind of an agent (human or artificial), and knowledge becomes information if it is synthesized and presented as text, graphics, words or other symbolic forms. A major implication of this view on knowledge says that, in order to reach a certain comprehension of the data or information, an agent must manage a certain amount of knowledge [8,9,10]. Another significant implication of this manner to define knowledge is that the systems designed for knowledge integration and management within the organization must be recognized as different from other types of computer systems, by relating them with various semantics and appropriate processing mechanisms. In order to define the concept of knowledge mobilization, important for the development of Intelligent Economic Systems (knowledge-enterprises, virtual organizations, KBSs), we will present some knowledge characteristics, as they occur in practice, in the synthesis and use of Organizational Knowledge Management Systems (OKMS). Knowledge consists of concepts available in information processing and in controlling various activities of social action [11,12]. They can be of various types: meta-knowledge (assumptions on which are based different knowledge from research, gained through observations and experimentation), practical or operational (characterize the work methods), actions (specify the manner in which are done certain things), descriptive (who, what, when, where), strategic (characterizing the whole context of action), learning (between people and about problems). A very important example is a Business Process Management System that includes methods, techniques and

tools to support design, use, management and analysis of operational business processes involving people, organizations, applications, documents and other sources of knowledge. Business processes prescribe the order in which activities have to be executed. On top of that, there are many other business rules that should be met by the execution of business processes. Business rules can be required by any stakeholders, such as management, government (by law), shareholders and business partners (clients and suppliers). Business Process Management can be considered an extension of classical systems based on workflow management. A business process is a set of activities that follows a logical flow, resulting an output, to specify the tasks to be fulfilled to achieve a business objective. Inputs and outputs may be facts and / or information, and the transformation can be performed by human actors, machines, or both. Although an organization's business processes can be tracked separately, by integrating them is obtain value-added which, long term, leads to positive results, a good control over the resources involved and over the environment in which it operates. Petri networks are tools of business process modelling. One of the advantages of using Petri networks for modelling workflows is access to many analysis techniques based on Petri networks. Accuracy, applicability and efficiency of business processes supported by systems based on workflow management are vital to any organization. There are three types of analysis: (1) validation, testing whether a workflow behaves as expected; (2) verification, determining the accuracy of the network flow; (3) performance analysis, evaluating the ability to meet the requirements, taking into account the time, levels of work and resources. Validation can be done through interactive simulation: are analyzed a number of cases to see if the system behaves properly. For verification and performance analysis, are used advanced analysis techniques specific to Petri networks, such as invariants, reachability trees, coverage graphs analysis etc. The multitude of available analysis techniques shows that Petri networks can be seen as an independent environment (solution) between the design of a process' definition through workflows and the analysis of the resulted workflow [13].

This paper is organised in five sections. After the research motivation presented in the current section in connection with other relevant papers in this area, we analyse knowledge representation solutions in Section 2. This is a very important topic in development of any KMS. In this context, knowledge can be defined as a reflection of the real world essence and the objective (economic, social) relationships of the reality, based on the capacity to process and analyze some important features. Section 3 defines the concept of knowledge mobilization as an effective organisational tool to manage knowledge and to create competencies. The competencies are strongly related to knowledge, and the extent to which new knowledge becomes expertise is an important element for the increase of the competencies. Whatever the other possible knowledge definitions and interpretations are, from our perspective, the main purpose is to understand what knowledge represents within the organization and their associated processes and products. Section 4 point out that without knowledge distribution there can be no organisation. The fundamental condition of organizations' existence is the relentless knowledge accumulation and dissemination. The knowledge processes or cognition are activities that support the self-perpetuation of the organizational networks [14]. Section 5 presents some short conclusions and after, the references.

2. KNOWLEDGE REPRESENTATION SOLUTIONS IN DEVELOPMENT OF KMSs

Knowledge representation can be considered as a relation R , in the form $a R b$, which establishes a link between an identifier symbol a , which is the name of the represented entity, and an expression b articulated in the KBS representation language, which describes the entity's features and its structure by means of some primary terms, the meaning carriers of the language. The expression b will be called the *representation* of the entity a , or the cognitive system's *knowledge piece* a . To establish the conceptual orderliness, basis on which can be developed the effective knowledge representation method, it is necessary to highlight the following issues, related to the knowledge pieces, as primitive objects of the formal system: 1) establishing the *meta-representation system* that provides methods of

representing knowledge for both the world model and the artificial intelligence system's components, 2) establishing the *classification system*, i.e. the grouping and ordering in classes, following the criteria resulted from the analysis of the employed features' relevance, in order to characterize the objects for which are created, by representation, the knowledge pieces 3) establishing the *organizing system*, i.e. the grouping and ordering of the elements and classes in order to ensure the fulfilment of certain fundamental processes of the intelligent programs: access, search, mail, substitution, deductive inference and inductive inference, grouping and regrouping, ordering and reordering, structuring and restructuring, protection. It is possible to use in an application a single representation (for simplicity) or hybrid representations (heterogeneous representation), by using several knowledge representation languages, in order to increase the representativeness of the problem's characteristics. Any KBS must make a compromise between the simplicity of knowledge representation and difficult computational issues, specific to exploiting heterogeneous and distributed knowledge. In the followings, we briefly present the most important knowledge representation methods, together with their characteristics [15].

Logics provide, first of all, a mean of expressing the assertions and a formal framework for performing inferences. A knowledge base consists solely of a set of formulas that describe the features of a system within a discourse area. A major concern in using logic is the chance to obtain new results, by using the inference rules: modus ponens, resolution, modus tollens etc. Logic allows a relatively natural expression of facts, without ambiguities. Modelling knowledge in first-order logic is not always easy. Logic is a formal system that has semantic rigor and clarity. These advantages are also disadvantages, since the man is not so rigorous, his reasoning being supplier. There is no organizing among the various elements that compose the knowledge base. The manipulated objects do not have their own representation; they exist only through the features disseminated in the knowledge base. This is a feature of the relational formalism, contrary to the object based approach. As it increases, the lack of organization in the knowledge base generates problems in terms of consistency and use. In order to address these anomalies and to expand the applicability of classical logics, it has been developed non-monotonic logics; especially multi-valuate logics, modal logics and logics of uncertainty or fuzzy logics.

Semantic networks. Knowledge representation using networks emerged as a consequence of trying to capture, through an appropriate tool, highly complex relational structures that occur as a result of the formal expression of information about entities in the real world. The graph aspect of the knowledge representation is just a notational alternative of the features highlighted by the knowledge representation in the first-order predicate calculus language. The *nodes* (structural abstractions for concepts, events, states and other support objects of the relational system) and the *links* or *arcs* (abstractions of the proper relations) are the primitive elements on which are build the networks. These primitives are used for representing data structures in superior level languages, in the form of memory areas called *cells*, interconnected by *pointers*, as for example, the LISP language. Such networks do not provide facilities for representing all the key features of knowledge, having only the form of data structures that can be considered structural primitives for a knowledge representation system. The correlation of some symbols and values with these data structures, allowed the expression of certain meanings, and consequently, the approach to the requirements of the knowledge representation systems.

The first representation model based on networks has been entitled *semantic network*, because it aimed, by using this formalism, to capture the objective part of the meaning that people assign to the natural language's words, in order to use this representation in making judgments that involve the understanding of these meanings. This name is justified by the fact that it reproduces conceptually the semantic structure of explanatory dictionaries: the nodes contain concepts represented by words and the arcs represent their relationships with other concepts, within a structure that reproduces the very definition of the concepts involved in the network. Nowadays, the term of semantic network is assigned to a class of representation methods based on the network model, but the attribute "semantic" does not fully match the qualities of these methods. The

associative feature brings the semantic networks closer to the supposed model for human memory. The term of semantic network is very common in the literature. It includes a variety of methods that use the network structure to build knowledge bases for systems, aiming to achieve some of the effects of the understanding process' characteristics. All these methods have as common feature the structure of a conceptual graph. Modelling both the syntax and semantics, the networks provide an adequate formal tool to represent languages. Therefore, we can talk about a network's language through which we express concepts, events, states, episodes and relationships between them. For a semantic network's language it is necessary to delimit a number of symbols which the network's interpreter is programmed to understand, and with which are constructed all the other entities, by applying the language's grammar rules. These symbols, known as semantic primitives, have a default interpretation, which allows, by combining these primitives under the rules of the language, to obtain expressions which are the real significance of the non primitive elements generated by the language's grammar. The variety of methods for knowledge representation in the semantic networks category is in fact due to the selecting criteria for the semantic primitives. These determine different interpretations of the networks, because the only thing they have in common, namely the network structure, remains at the physical level of the cognitive system mechanisms. The structural configuration of a knowledge piece represented through semantic networks depends on how it is conceived the description through which we define the constituent entities of the knowledge pieces and their relations.

An informal or formal description refers to the entity's properties and structure, made in terms of certain constituents of the knowledge piece that can be described in the same way, until are reached the elements that represent themselves, being primitive. The description is done both as intentional formal objects, called concepts, and as extensional objects, called instances. The relationship between concepts and instances, called instantiation, has an extensional epistemological character, while the relationship between instances and concepts, called conceptualization, is intentional. An instance can represent a real world object, or another concept. If the Y instance is another concept, then it may also have instances. This way it is conceived a conceptual hierarchy, consisting of several levels. The *highest* level is a concept called *generic concept*. The generic concept is any concept whose instances are also concepts, but less general than the generic concept. The *basic* level of a conceptual hierarchy, also called the *lowest* level, is always an instance that represents a real world object. Between the highest and the basic level can be defined intermediate levels, which are generic concepts, excepting the level immediately above the basic one, which must be an *individual concept*. An individual concept is defined as any concept whose instances are individuals. In a conceptual hierarchy, extension and intension relations are transitive, so that a concept located on a given level is an intension for any object located on the lower levels, and vice versa, an object located on a given level is an instance for any concept located on higher hierarchical levels, if they are located on the same epistemic chain. Like any object with a structure, it consists of formal entities called concepts and of the relations between them. The nature of the components depends on the concept, it can be the same with the one of the concept (e.g. the part of a whole object), or different, representing attributes of different objects (e.g. colour), the objects' roles in different actions (e.g. an instrument of the action) etc.

Production rules. Knowledge representation using production rules is a part of a problem-solving method, widely used in Artificial Intelligence, encountered under the name of *production systems*. We separate the common calculation components, in order to be properly handled in the processes in which are involved. This is the underlying idea of this method. Knowledge in a productions system has a procedural nature and is divided into the following components: *declarative or factual knowledge*, representing knowledge pieces created in the form of data structures stored in a collection called *context*; *procedural knowledge* in the form of condition-action pairs called *production rules*, which are stored in a set called *rules base*; *strategic or control knowledge*, in the form of rules supporting decision on the action sequences, namely on the solving process. The whole system is built around the concept of

production rule, whose structure is as follows: <condition-part> → <action-part> (if the condition is satisfied, then it can be performed the action). The condition specifies those criteria that must be met for the rule to be applied. The production rules mechanism has been borrowed from the formal language theory and appears in the grammars' definition as following: a grammar G, is a quadruple (N, T, S, P) where: N is a non-empty, finite set of symbols called *non-terminals*; T a non-empty, finite set of symbols called *terminals*; S is a distinct symbol from the non-terminals set N, called *initial symbol*, which is the symbol from which starts application of the production rules; P is a finite set of ordered pairs (x, y), usually written as $x \rightarrow y$; x and y are strings from V^* ($V^* = (N \cup T)^*$ is G (grammar's vocabulary)), specifying that the application of the rule $x \rightarrow y$, is rewriting the string y, provided that x must contain at least one non-terminal symbol. The set V^* contains inclusively the word of zero length, called "empty word".

Frameworks. A framework is a collection of attributes (slots) that describe an object. Each attribute can be loaded with a value, with a different framework or with procedures. Embedding procedures in a framework (or in other declarative structure) is called procedural attaching. An attribute of a framework is equivalent to a relationship (link) from a semantic network. In this way, the frameworks and the semantic networks are mutually convertible. The reasoning mechanisms specific to a framework are selection, instantiation, inheritance, procedural attaching. Representation through frameworks is natural for structured objects, being more efficient and more malleable than the logic-based objects. The reasoning specific to the frameworks are decidable, unlike the logical reasoning (such as the non-monotonic reasoning) which can be semi-decidable or undecidable. Representation through frameworks has certain disadvantages, such as lack of semantic clarity, and expressivity limitations in knowledge representation.

Object languages. Object languages do not use only the object-oriented representation, like the frameworks, they also define computational objects. The objects are active, with characteristics similar to data and programs. The methods are associated with objects and are invoked by sending messages. The advantages of this approach include the modularity and encapsulation, and as disadvantages we mention the lack of clear semantics and the weak ability to model events.

Qualitative knowledge. The term of quality refers to the description, in form of symbols, of the values for the specific parameters of a given system and the functional relations between them. The real set of a variable is quantified in a set of discrete intervals, corresponding to qualitative values. Qualitative reasoning on continuous parameters requires a certain quantification of knowledge in form of discrete symbols sets.

3. THE MOBILIZATION KNOWLEDGE PROCESS AND CREATING COMPETENCIES

The principles that guide human activity, starting with the research and ending with the discovery of viable social actions, are: knowledge lie in people's minds, with effects that relate to subjectivity, temporality, space, transformation, knowledge inherently have a mobilizing capacity for the person who creates them and therefore all those who interact with it, mobilizing knowledge creates value and allow people to obtain results, knowledge use leads to their enrichment, collaboration and participation mitigates some differences between knowledge through employment, the used knowledge creates responsibilities, their use having a number of implications. The mobilization process is based on the following activities [16,17]:

- identification of the situation (problem, case, opportunity);
- obtaining information (about situation and the associated context);
- understanding the situation (using concepts required for information processing);
- developing a theory (associating a content to the context);
- practical use of the knowledge thus obtained (how to use what we learned);
- action (the actual implementation);

- obtaining, interpreting and correlating results (for application in possible new situations);
- analysing feedback information (to observe if it is necessary to resume the activities, specifying some adjustments etc.).

3.1 Important challenges for the acceptance of OKMS

The OKMS' acceptance is a very difficult problem, since these systems are often abandoned or, in other cases, partially exploited and do not lead to the organizational performance expected. Some of these knowledge management challenges have a sociological nature and influence how people perceive and use a number of deployed systems. The literature related to KM mentioned many times that the effectiveness of KM processes and systems is strongly influenced by the organizational culture [18]. The organizational culture, like the culture in general, is revealed by the common use knowledge, accepted behaviours and values developed within the organization. It is reported many times that a series of adopted OKMS are based on architectures and methods that enhance the old practices (usually inadequate to current requirements), instead of creating new and beneficial dynamics within the organization. This analysis demonstrates the need for analysing the current features of the organization, in terms of habits and values, for the purpose of proposing a solution that reflects the changes. One of the most debated issues regarding the knowledge distribution is the fact that organizational environments leans more towards competition than towards cooperation. Consequently, a series of OKMS, involving collaboration in their design and their use, will fail because personal knowledge pieces, required for collaboration, are blocked inadequately and premeditatedly. The fear of making mistakes is another obstacle in the process of knowledge exchange. In general, people feel they can better explain certain things when talking directly to the person who needs that knowledge. People also fear that a static description of their expertise may be poorly made, because knowledge has a dynamic character and are difficult to transfer in many situations. This is a challenge for OKMS developers in their attempt to allow certain knowledge pieces to be correctly contextualised and linked with a range of previous knowledge and experience. The organisations should create environments that stimulate learning and should be tolerant to mistakes. The latter is the true key element that stimulates the creation of new knowledge. There have been highlighted significant examples in this respect. Large companies have managed to achieve important successes only by learning from mistakes [19]. There are also permanent suspicions regarding improper and unethical knowledge use, which is an intellectual property asset. It is a situation characterized by the lack of trust and leading to a behaviour that blocks knowledge transfer and communication. This concern is increasingly better managed and resolved through the development of environments that allow social interaction, based on network-type structures, in the form of practice communities. Lack of time is another serious reason which prevents the acceptance, implementation and operation of OKMS. This leads to inherent reruns and great efforts in terms of accessing and achieving suitable knowledge for situations that are not really new. All these demonstrate that reaching effective solutions basing on KM, in terms of processes and systems, can be achieved step by step, based on real cases, after clearly understanding the current organizational culture and its entire system of values. These are just some of the challenges that KM is facing in its attempt to adopt, as well as it can, certain technological solutions [20].

3.2 Knowledge mobilization process and its role in the synthesis of OKMS

Knowledge mobilization is a process whereby personal and professional knowledge in a particular problem area of an organization are capitalized, shared, developed and implemented as an OKMS [www.sacyhn.ca]. Such an environment for the knowledge mobilization is built on a network-type structure, and must be able to support distributed knowledge processes. In this way, it allows the network members, on the basis of several projects for planning, development, implementation and refinement of certain initiatives (based on research results and practice) to mobilize and increase their capacity to meet the needs initially settled. There is a series of conflicts between group knowledge processing and the technologies able to support such processes. These conflicts concentrate on the

following remark: the effective knowledge creation and sharing are deeply embedded in interpersonal contexts, strongly dependent on the face-to-face character, while the technologies created to support these distributed processes are often created to support mobile knowledge, but not so compatible with the interpersonal context outlined above. It's exactly the problem of *modelling knowledge distributed processes in order to generate strategic alliances*. This is a topic to be discussed, as an essential problem in developing intelligent OKMS. The feasibility of such systems, based on knowledge mobilization, is real with the emergence and hybridization of some advanced approaches of the management in the private sector, with the technology innovation and the development of processes for communication and creating alliances. Knowledge mobilization should be viewed from the perspective of combining the external knowledge with the internal ones, in order to create new knowledge that users / customers would better agree. It thus highlights the need for innovation based on building relationships or partnerships, a practical reformulation of the collective intelligence. From this perspective, the knowledge mobilization is the solution accepted and developed in this work for creating intelligent organizations, KM-intensive organizations, distributed technologies and human resources' competencies within and outside the organization [21].

An example may be the *Supply Chain Management (SCM)* for a more efficient organization management and for synchronizing its abilities with the ones of other organizations, for a virtual integration, which brings great competitive advantages. SCM is a concept that extends the operations perspective from one organization to the entire supply chain. It is an increasingly hot topic and it is approached by many companies. SCM is applied to a number of issues and business practices. In essence, SCM is a set of practices to manage and coordinate the entire supply chain, from the raw materials suppliers to the final consumer. The objective is to develop a synergy along the entire chain, rather than focusing on a specific organization. SCM is an expansion of internal programs like TQM and streamlined production. Often they have brought substantial improvements by removing barriers between departments and by efficiently managing the business processes. Therefore, it is reasonable to consider the improvement potential that allows an overall view and managing the entire supply chain. It is assumed that there are significant synergies to be acquired by managing the complete supply and delivery chain. The objective of the synergy development is achieved by reducing costs and increasing the offered value. The most commonly mentioned benefit of SCM is the reduction of the costs. A typical example is the reduction of the stock. It is less common for companies to increase the value provided through the chain. Some companies are trying new methods of products and services clustering to increase the value for the end customer. Typically, the supply chain can be viewed as an aerodynamic pipeline that processes the raw materials, transform them into finished goods and delivers them to the final consumer. The best practices for SCM can be described as a set of interrelated processes that function as a whole. This is *virtual integration*, contrasting with the traditional vertical integration. The idea is to get the benefits of the vertical integration and, at the same time, to avoid the related costs, ever larger (for example, additional levels of managers and reporting systems). However, virtual integration raises problems related to economic unit's boundaries, which are not well defined. Given these SCM practices, the units have more reasons to connect their processes in this way. The major driving forces can be classified into three categories, which are the basis for developing the synergy in a supply chain: reduce costs, enhance the value, competition within the network. SCM is a set of practices for the entire chain management, from the raw materials suppliers to the final consumer. The basic constructive elements are the organizations (business units), rather than the companies. Here are some typical characteristics: the reduction and consolidation of suppliers and customers bases, stock coordination and price policies, information transfer, networked computer systems, cooperative problem solving and internal positions at the client's premises to represent the supplier. SCM is not a traditional vertical integration. It is driven by opportunities to reduce costs, increase value and by the competition within the network. When choosing their partners, companies must consider the potential of the economic entities. To integrate

marketing, sales and services, CRM requires a strong integration of the business processes involving consumers. These sales departments of the CRM-based processes are unstructured and non-transactional. CRM processes can therefore be regarded as knowledge-oriented processes with the following strongly correlated characteristics: knowledge intensity: CRM-based processes require knowledge of heterogeneous sources, not necessarily computational sources, to meet the process' goals; complexity of the processes: CRM-based processes have particularly a complex structure, or no clear structure. This implies a need for a high degree of knowledge for executing a process. The most important concern is to collect, store and distribute only useful knowledge and not wasting time and effort in collecting and storing useless knowledge. In order to integrate the various CRM-based processes, there are often developed projects. These projects promote the process models that can form the basis for an analysis of knowledge flows in the CRM processes. The origins of CRM can be traced in the Marketing Relationships concepts. Marketing Relationships are an integrated effort to identify, build and maintain a network of consumers, and to continuously strengthen this network, for the mutual benefit of both parties, through interactive, individualized and valuable contacts, added throughout a large period of time. Marketing relationships have largely a strategic nature. Although business processes are important, there is a lack of a holistic vision for business processes connected to Marketing Relationships. On the other hand, Customer Relationship Management was influenced by several information systems concepts, focusing on different areas of applications. In the processes integration flow, these systems continue to merge into CRM integrated systems. Typically, CRM-based business processes require not only transactional data that can be automatically collected and stored in relational databases, but also a significant amount of knowledge. Also, CRM processes are complex and structured only to a certain extent. For this reason, they can be considered intensive knowledge processes. More than developing an integrated approach to CRM processes, it is, therefore, essential for the system to address the KM flow from and to the consumer, regarding all the communication channels, such as being able to use knowledge about consumers.

3.3 Creating competencies in the context of knowledge mobilization

All knowledge-based organizations have a common goal, namely to increase employees' competency and implicitly their performance. This way, they benefit of personal knowledge and build, step by step, more efficient business processes. To achieve these objectives, organizations follow different strategies that can be classified into two categories, oriented towards: 1) knowledge codification, involves developing knowledge repositories that can be reused in the future, e.g. KBSs; 2) inter-personal contacts, through the processes of access, communication and sharing of expertise, knowledge, information (also called personalization strategies). At first sight, the difference between these two approaches is important: knowledge codification is characterized by the reuse of old knowledge, while personalization strategies particularly put emphasis on knowledge creation and innovation. In our work we are equally interested in both strategies. While the first strategy will be used for the synthesis of subjective knowledge models, re-usable in a certain sense, as currently perceived and used in different logical decision-making processes, the second strategy is particularly important for the development of organizational initiatives to allow the employees, on the one hand, a high degree of autonomy, and secondly an active and constructive participation in generating new knowledge, involved in developing new products, new services bundles or new business processes. Organizations have always been oriented towards accumulating and transferring knowledge in order to create economic value and competitive advantage. In this context, knowledge must be visible and tangible. The ambiguous character, the intangible nature of tacit knowledge, as well as their permanent importance, make the KM research and application more challenging.

There were identified several important trends related to the business environment strongly based on competition. According to some researchers, these trends will lead to dramatic changes in productivity and in structural and functional approaches of the companies or organizations of any kind. The combinations between

production cycles reduction, increasing diversity of the products oriented towards services bundles, rapid development and increasing complexity of the technologies with strong orientation towards intelligent technologies, markets globalization, frequent changes in demand, business environment's uncertainty and strong competition are the trends of the economic context. The knowledge within the companies or organizations are stored in the employees' minds, or are implicitly encoded and used in various organizational processes, services or systems. They are the reunion of the experience, expertise and operational information (in action), at the individual or work group level, used in performing certain tasks. Solving problems within companies is a complex activity, fundamentally based on knowledge. It requires making decisions in a dynamic business environment, using various sources of information. It is widely recognized that organizational knowledge management contributes, as a decisive factor, to the effectiveness of the business processes. We call such an organization the Organization Intensively based on Knowledge (OIK). In the context of an OIK, the tasks that persistently and permanently use knowledge, such as those of abstraction, representation and processing the uncertainty or imprecision, decision making in the absence of information, recognition of certain forms and characteristics of organization's development etc., involve an effective combination of company's competencies and an aggregation of the responsibilities. The groups within the OIK must effectively manage its skills and create mechanisms to generate innovation and new ideas. For this purpose, it is required the development of practice groups, based on organizational learning (organizational process that can take an individual form, a group form based on communication, and the learning based on the use of information repositories). The purpose of organizational learning is to enhance its knowledge, in order to build an organizational culture and a more coherent understanding of the knowledge assets' value, in direct relation with different business processes. To examine more deeply the relationship between KM and organizational memories, it is required a classification of the knowledge, data and available and useful information, according to the organization's needs.

Increased competitiveness, frequent teamwork in communities of practice, as a result of the great changes in terms of technology, have increased both the importance of human capital within organizations and the knowledge resources sharing, in order to obtain a competitive advantage. The human capital of the employees is one of the most complex resources for the organization's control. This capital has a high financial value and can be accumulated based on certain learning processes, processes that are essential in the organization's struggle for existence. The managers concerned with the strategy and the industrialists identified the organizational learning as a basis for achieving competitive advantage on the local or international markets, since 1990. The competencies are generally perceived as unique resources, based on knowledge, and that lead directly to a competitive advantage. They are created by continuous knowledge refinement, both explicit and tacit knowledge. The term of competence was originally developed by the organizational psychology. From this perspective, knowledge can be interpreted as ingredients (personal confidence and information that enhance an individual's ability to take decisions or to effectively perform an action) or products (the direct results of organization's members actions, usually embedded in private practices or in different outputs of the organization) of the daily activity within the organization. KM is based on various practices and technologies that enable the knowledge exchange so that knowledge can be replicated and expanded for the use in all actions undertaken within the organization, and Fisher and Ostwald [Fischer & Ostwald, 2001] define it as a cyclic process composed of three fundamental activities: creation, integration and dissemination.

Knowledge Creation – (KC) is the conscious activity of the organization of generating new knowledge. The theory on creating new knowledge is based on the idea that the knowledge resource inherently includes human values and ideals. In this way, the creation process cannot be described as a normative causal model because human ideals and values are subjective and the concept of truth depends on all these. *Knowledge Integration* (KI) refers to all activities based on which an organization identifies, acquires and uses external knowledge. As long as the development of new

products or services is a crucial aspect of any company, KI is a complex process which is not very well known both in research and practice. For this purpose, it is necessary to develop systemic models to support the identification, explanation and solving problems specific to KI. *Knowledge Dissemination (KD)* allows the access to some specific knowledge for the employees and the units who need to apply this knowledge. Teams are the cornerstone for the effectiveness of KM application. Working in a distributed context, based on strong social interaction, has profound significance for KC and KD. New ideas can occur through dialogue and discussions. This dialogue can often involve strong interactions and conflicts, but right these conflicts can motivate the organization members to obtain answers to a series of fundamental questions, using experience in various new ways. Consequently, these interactions often lead to changing personal knowledge into knowledge of the organization. There are a number of authors who emphasized the role of the teams and communities of practice in the knowledge distribution, something which will be subsequently analyzed [].

At the individual level, knowledge is created on the basis of cognitive learning processes, while at the social systems level (i.e. groups) knowledge is generated based on collaborative interactions. Factors participating in the KC may be internal or external to the organization. KC is the process of transforming raw data into information. During this process, the KC uses various technologies to classify knowledge. Competencies, as an abstraction of a relevant work and constantly adapting to the organization's strategies, are a promising concept for applying the management theory, in the case of human skills and knowledge, in the context of a large number of applications. From the management perspective, the competencies provide a more accurate possibility to approximate human knowledge, than the notion of knowledge according to the classical KM approaches. To be competent is more than to know, as it is closer to the action and its rational results. The competency is defined as a function that depends on intelligence, education, experience, ethics and interest. From the perspective of human resource management (HRM), the concept of competency can be practically understood as a minimum capacity that an employee must have to perform different tasks at a certain quality standard. The competencies consist of four components: knowledge, skills, attitude and capability. When discussing competencies, is imperative to know the competency levels, such as: (1) practical competency (an employee has demonstrated the ability to perform a specific assignment or task), (2) key competency (an employee must demonstrate that he understands what and why he does a certain thing), (3) reflexive competency (the ability of an employee to integrate actions with their understanding - this way, he learns from the actions and adapt them to future action which differ from the previous ones), (4) applied competency (an employee has demonstrated the ability to perform many tasks, which he understood and reflexively applied). In the recent years, many authors have suggested a number of approaches related to competency modelling and management within organizations. These approaches have in common the concentration, throughout the organization, to develop tools that unify the human resources with their tasks.

They define the competencies in certain ways, develop a general framework and establish certain procedures for implementing this approach in the specific context of an organization. The competencies refer to a series of individual and organizational characteristics. At the individual level, we find the technical knowledge and individual capabilities that lead to performance. Although the technical skills (knowledge of related disciplines, research knowledge) are obviously very important for the scientific success, the literature on R & D highlights the importance of communication skills and teamwork skills as a source for productivity growth within the organization. The central competencies refer to a set of skills and technologies that enable the organization to provide the customer with a particular advantage and thus be more competitive. The firms must have necessary competencies and specific competencies (differential). The necessary competencies are those which support the value creation, and the specific ones are those that confer the organization or group of organizations a competitive position.

3.4 Enhancing the connection between individual and organization by using the concept of competency

Competency Management (CM) aims a deeper connection between the individual and the organization through the concept of competency. Due to unprecedented dynamics of the business environment, the strategic planning based on static views is not longer satisfactory, companies are forced to build a series of competencies and transfer them between different business units. Understanding how these resources (knowledge, competencies) must necessarily be developed and managed is imperative for every manager. CM is defined to include all the tools and methods within an organization that allow a systematic evaluation of the current and future competencies, involved in different work processes or employment. The competencies are defined from different perspectives: cognitive (knowledge and skills), affective (attitudes and values), behavioural or motivational and characterize a person's ability to perform certain tasks in a proper way. CM is becoming increasingly important, because it is the only competitive advantage available in the organization and which cannot be easily imitated. CM studies how organizations can achieve higher performance, for a certain period of time, or how organizations can get a mix of resources. By resources, we understand all the elements, tangible or intangible, that an organization can use to develop new products or services. But what are the firms' most important resources? Many researchers and particularly managers considered a unique response to this question "the knowledge and skills of all the people working within that company". CM is also a solution to control these resources, and, in addition, allows an appropriate match between individual capabilities and the current / future needs of the organization within various business units. CM is an approach adopted very quickly. CM is an effective way to use employees' skills within the organization and is closely related to HRM, meaning that CM may be a way to align HR processes (selection, development) with the job requirements and organizational strategy. There are two different approaches related to CM highlighted in the literature. The first approach, called functional, considers two functions within the organization. These two functions are KM and HRM and are somehow distinct, in relation to the central interest element: one focuses on staff and the other on ICT. However, KM developments, in terms of human resources, have become increasingly important, and HRM uses intensively ICT (e.g. e-Learning). The second approach is based on the notion of processes. The implementation of a CM initiative is based on a number of processes (the analysis and identification of a goal, defining organizational competencies, competency assessment, selecting and evaluating some models, using models). The organizations need knowledge to obtain information about the environment wherein they operate. The organizations need to systematically focus their behaviour on certain purposes and provide the optimal conditions for satisfying the specific requirements for achieving goals. But why organizations would need goals? Because they are open and complex systems, that are designed and built to self-replicate and grow, using, for this purpose, resources "extracted" from their environment. This question and answers reveal that all communication processes within organizations have a deep cognitive motivation, organizations' behaviour being modified by teleological restrictions, resulting from the orientation towards certain goals. The organizational communication's mission is to cognitively support both the realization of the goals and the whole process of self-maintenance and replication of the organization.

Therefore, in order to survive and expand, the organization develops certain specific ways of identifying and pursuing particular goals. For example, economic organizations have financial goals, commercial, technological etc., aiming the rate of profit, the sales volume, the market share, the costs level, processes reliability, launching new products etc. The orientation towards clear-cut objectives defines the type of knowledge necessary for such an identification and tracking. The imperative to obtain this knowledge pushes the organization to detect and systematically use some general and recurring patterns of informational relationships which are available. These are the internal and external sources of information and the channels for connecting to these sources. Further, the information patterns that can be exploited trace the informational tasks the organization must execute in order to meet its

objective. These informational tasks relate to processing certain categories of information and to the refinement operations of that information. The informational tasks select the *cognitive programs* and operating mechanisms of the organization. The cognitive programs structure the processes of knowledge search, processing and utilization. In fact, they are some routines. The operating mechanisms run the cognitive programs, and consist of the interconnected flows of the other organizational resources (technology, stock, labour, money), which provide value to the customer. We can observe, therefore, the next logical stage: from the self preservation and development impulse to defined objectives, to specialized knowledge, to informational tasks, to cognitive programs, and finally, to the operating mechanism.

Connecting the internal communication system to the external connections and mechanisms is therefore a factor of great importance. According to this, the organization's borders problem seems to be a false problem. Of course, in terms of law and accounting, organizations are well defined entities, isolated from their environment. But the real economy of the organization ignores these barriers, however artificial. To function effectively, the organizations must engage in a lot of exchanges and relations with their environment. Formally, organization's boundaries are drawn by the balances of the accounts presented in the balance sheet and by the contracts showing its possession of goods, means, facilities or benefits etc. It is a relatively simplistic view: the organization is as small/large as it is its economic heritage. But how can we explain the existence of organizations with an impressive heritage, but facing serious operational difficulties, on the one hand, and the relatively small organizations in terms of heritage, but very dynamic and effective, on the other side? The explanation is as follows: the performance of the cognitive system based on an integrated organizational communication (connecting internal and external communications). The cognitive system is the factor that capitalizes and makes the organization's heritage operational. The organization is not just a portfolio of economic assets and liabilities. Viewing the organization as a portfolio of knowledge and connections and as an open network of communication flows is at least as important as its financial, accounting or legal representations. The organization's orientation towards objectives is made by structuring informational relationships with the environment (the resource provider). The fact that these informational relationships can be very different generates a multitude of different local opportunities for moving the organization's behaviour towards the objectives. Organization's life, and implicitly reaching organizational goals, takes place in a particular environment. The environment can be imagined as an open information space between the organization and its goals. Consequently, the organization is a communication system located in a communication space, a *filled* space. There are no standard procedures or rules for this filling, which explains the great variety of possible management solutions, because the management is the structure that ensures organization's orientation towards objectives, being responsible for the construction of this orientation.

There are two general factors that influence the management as a function of shaping the orientation towards objectives: 1) *The action of attracting the objective*. The organization's internal and external information space is set up in order to systematically push the organization towards its objectives. This means that any interaction or causal connection inside or outside the organization it is useful if it facilitates the accomplishment of the main management task - to direct the organization towards objectives. Linking the organization's cognitive programs with the variety of its behaviours is due to the pull action exerted by objectives. This action also determines the systematic configuration of the information transactions between the organization and environment. 2) *The action of pushing towards objectives* (impulse of the cause). It is exerted by the causal relations forming the basis for the organization's functioning. Causal and functional interactions, used by the management to guide the organization towards its objectives, determine it to develop specific information relationships with the environment. The redundancy of certain information relationships supports the organization to adapt to environmental conditions. If the objective's attraction shows what game is played and under what rules, the impulse of the cause shows how to play the game, how are complied the rules, with what means and how is rewarded the winner. It takes a complex network of

information relationships, from within and around the organization, to ensure its access to behavioural routines, necessary to fulfil the objectives.

Possessing knowledge is equivalent to possessing that information which consistently allows the behavioural routines to lead to the results presumed by the objectives. But knowledge does not automatically turn into the required behaviours. The relationship between knowledge and behaviours is mediated by cognitions, i.e. by the representations that organization members have about causalities - the connections between goals and means - that make the organization work. In all organizational cases, that knowledge should precede the action focused on specific objectives. Often, the action itself produces the cognitions and knowledge enrichment, or at least their change. From the cognitive point of view, the management's task objectives is to define the organizational objectives depending on the environment's features and to define the organization's cognitive system, as a benchmark for organizing the systematic network of information relationships involved in directing towards the agreed objectives. At this point must be drawn a distinction between reflecting information and functional information about the organization as an area of managerial intervention. The reflecting information describes the state of the organization or of the various organizational elements (e.g. stock levels, cost of capital, turnover, asset value, leverage, the average time for satisfying the orders etc.), showing what happens, but without explaining why. Causal information occurs by individualizing certain causal chains, expressing functions and interactions of the organizational elements. For example, labour productivity growth in an industrial enterprise can occur when increase the technical endowment level for the labour and the efficiency of the capital, and sales may increase when launching promotional offers etc. The problem of the management as a cognitive process (knowledge) is to convert reflecting information into functional information which is intended to guide the entire organizational system towards approved objectives. The conversion is possible if: are identified the specific effects chains of the interaction between different elements of the organization, interactions systematically correlated to the objectives; those chains of effects, based on systematic correlations, are used as "functional routes" to guide the organization towards objectives. Thus, the problem stated above can be solved by limiting to a number of subordinate information tasks that satisfy conditions (1) and (2) in various combinations. We can see that the cognitive problem of management becomes resolvable by understanding the information tasks to be performed by the organization, and thereby, the configurations of the information relationships that allow this. First, we mention the connection task: the organization must find and connect to those networks of information relationships that are able to provide the necessary knowledge. Secondly, it is the task of aligning, namely structuring and processing the collected information in forms that the organization could use to control its behaviours. The task of alignment is critical whereas through its realization the information inputs (reflecting information) is converted into cognitive effects and behaviours (functional information).

4. KNOWLEDGE DISTRIBUTION

The knowledge process underlies the organization process at all social levels, and any organization's interactions with its environment are primarily cognitive interactions, to acquire, process, and use the knowledge. To survive, it is necessary to know. The evolution of an organization throughout its life cycle, as well as the many micro-decisions and micro-actions that form its daily life, is based on a variety of cognitive acts. *Organizational learning and development* represent pair-dimensions of the reality of an organization. It is important to remember that all the elements of an organization are involved in the knowledge process, regardless of the hierarchical level on which it is located or the specialized function that is executed. It is proved that the network is the most common organization pattern in social systems, including the economic ones. At all organization levels - from the ordinary workers of a clothing mini-manufacture and to the vast regional economies, such as the European one - the elements and processes of the organizational systems are interconnected in a dense network type communicational structure. Networks are non-linear configurations for organizing and

their operation is based on various interconnected feedback circuits, negative and positive. Organizational networks are first of all communications networks, and, in this situation, cannot exist without a symbolic language, power relations, technical norm, value constraints etc. Organizations use communication to maintain themselves. In fact, organizations are made up of a multitude of communications, flowing through self-generating network structures. This means that each communication generates representations, meanings and interpretations that produce other communications, so that the entire network self-generates itself. We showed in chapter II that communication processes are basically reverse connections (feed-backs). Within the organization the multiple communication feed-backs intersect or overlap, creating a symbolic and normative framework consisting of philosophies, beliefs and values- a structured set of shared meanings, continually fed by new communications. This framework helps the organization's members to find their identity, and the organization itself - to realize its own borders. Of course, we mean no legal or economic borders, but the ones that shape the organization's moral-affective space, space composed of the expectations, loyalty, commitment and involvement of the members. Organizational Communication generates ideas, attitudes and contexts of meaning, on the one hand, and rules of behaviour, on the other side.

In organizations, communication not only acquires the knowledge, but also transforms it into behaviours. The organizations that are closer to the characteristics and behaviour of self-generating communication networks are more flexible, more dynamic. Of all the features of these communication networks, three are particularly important: (1) the existence of a strong sense of cohesion and adherence to a set of common values among its members, (2) openness to environment and tolerance for diversity and novelty, (3) increased learning capacity.

To bring the internal structure of the organization closer to the configuration of a self-generating communications network and to connect it to many other similar external networks is the key of competitive survival and adaptation of the organization. The features mentioned above develop when organizations develop like some communities of practice - common contexts of meaning [21]. A community of practice occurs within an organization if among its members there is a mutual commitment and solidarity based on which is further developed a shared repertoire of tacit rules, behavioural routines and knowledge. Communities of practice coagulate at the level of informal dynamics of the organization. They have an adaptive and complex nature, impregnating the formal structures. It takes place a formal hierarchical structure dilution by the appearance within it of informal concentrations structured in the network. Learning or the organization's capability to acquire knowledge and to transform it into goal-oriented behaviours depends on how are interacting the formal structures and the informal networks. An effective way to develop the organization learning ability is to encourage and strengthen communities of practice, for only in this way the process of creating and using knowledge has a natural character, and the knowledge dissemination is reflected not only in the operational performance, but also in a strong feeling of personal satisfaction for the organization's members. Knowledge creation and its counterpart - organizational communication - are not possible without spiritual, emotional and moral motivation. The flexibility implies the existence of an active communications network, organized as some multiple reverse connections that are interconnected. Setting up and fostering self-generating communication networks, as a support for learning and knowledge, means not only connecting the organization to its environment but, above all, connecting it, as much as it is possible, with itself. Ultimately, knowledge is created by the individuals who form the organization. The real capital of the organization is not knowledge, but these people. This finding leads to the conclusion that the essence of knowledge management is, in fact, the optimization of the human relations. Powerful and competitive organizations are knowledge-based organizations. The concept of *knowledge-based organization* is the label for four types of organizations: (1) organizations based on the knowledge incorporated in behavioural routines, with the support of advanced technologies and a consistent set of formal rules for their assistance, (2) organizations based on complex professional

expertise, (3) organizations based on symbolic analysis, (4) intensive communication organizations, that create knowledge.

The intellectual capital becomes the most important factor of competitiveness for these organizations. Their strength lies in knowledge, and the organizational behaviours of employees have considerable intellectual determinant. The intellectual capital results from the organization's cognitive resources, resources that can be located both at the intellectual and collective level. There are *three categories of cognitive resources* - accumulated (as an intellectual "stock"), the internal organizational processes and the organization's interactions with the environment. *Accumulated cognitive resources*, at the individual level, consist of the members' instrumental skills (scientific or professional languages, computing technology) and the general knowledge. At the collective level these resources comprise the organization's human capital (values, experience, skills) and the knowledge infrastructure (technical know-how, professionalism, entrepreneurial and industrial skills of the organization). *Internal organizational processes*, as cognitive resources, refer to the organization members' personal competencies (self-confidence, creativity, critical spirit, analytical skills, intelligence, psychological capital). At the collective level these resources are reflected in the innovation potential (concepts, patents), the process capital (organizational culture, internal communication networks, formal management systems, informal structures) and in the institutional capital (corporate governance, public relations, image, reputation, partnership networks). At the individual level, *the interactions* occur actively as cognitive resources, primarily through the formation of some social skills (teamwork, solidarity, expression). At the collective level these cognitive resources take the form of commercial capital (brands, brand capital, marketing skills), of the skills to work in a network, organizational openness towards the exterior etc. One of the core missions of the organizations, in general, and particularly of the knowledge-based organizations lies in capitalizing the intellectual capital, in order to achieve the highest possible efficiency of the activities. *Therefore, the management's obligation is to ensure the cognitive resources development and to manage the knowledge creation and distribution within the organization.* The intense-cognitive organization is the organization where intellectual capital becomes much more important than physical and financial capital.

In this context, it is necessary to highlight the elements that guide the organizations' reform towards the requirements of an efficient accumulation and exploit of intellectual capital: understanding that, by its very nature, the intellectual capital is symbolic, interpretive, accumulated and manifested primarily through individual behaviours of the organization's members. Hence this capital can be formed only under the conditions of flexible interpersonal relationships within the organization, which stimulates communication and knowledge sharing. This relational framework makes imperative the redefining of the power configurations within the organization. Intellectual capital determines the focus shifting from the organizational power based on status to the knowledge-based power. This power is negotiated depending on the type of knowledge needed by the organization, its importance for competitiveness, knowledge's capacity to become an "intangible good" of the organization and on the practical ways of capitalizing knowledge; understanding that, in the intense-cognitive organizations, the power is democratic, being widely spread among members of the organization, because, whatever its content is, tacit knowledge can be only partially converted into formalized, explicit knowledge; awareness of the risk of proliferating the organizational conflicts due to the subjectivity and relativity of the knowledge symbolic interpretations made by different members or groups of interests within an organization.

The accumulation of intellectual capital is fundamentally a learning process, referring actually to the formation of collective experience and knowledge based on organizational strategies and structures that stimulate the transformation of experience into behavioural references. Organizational learning takes place within specific relational and power networks, able to provide the reflexive feedbacks that ease the system's self-awareness - "learning to learn". Communicational openness is therefore a prerequisite for an effective organizational learning.

Learning is the indispensable premise of the organizational change. Explicitly, learning is even the organizational change process by transforming the personal and other organizations' experiences into rules, procedures and decision-making and action strategies. Although carried out by the members of the organization, the organizational learning is not limited to the amount of individual accumulations, involving the restructure of the behaviour, decision-making models, relational structures and collective action strategies, restructuring operated on the basis of what has been learned and, a very important thing, the systematic use of what the organization's members learned from the everyday work practices, through communication mechanisms that encourage learning and the practical application of the learned elements. Undoubtedly, the individual and collective learning processes are very closely related as they are often difficult to separate. Individual learning is highly experimental, being essentially a process of selection, accumulation and consolidation of certain experiences. Thus, the individual first observes and analyzes the organizational reality, then uses the results of these reflections for synthesizing abstract concepts and generalizations. In the next phase, the new concepts are tested in various practical situations, in order for those concepts that have proven their validity to start generating concrete experiences. Similarly, collective learning is a process of generating information by using the internal and external environment of the organization. This new information, derived from multiple internal and external sources, is permanently correlated and combined. The information is produced internally through the experiments, analysis of successes and errors and the use of data from the autocorrelation. New information is collectively integrated and interpreted in the organizational context. We can observe in the collective learning the manifestation of a *cyclic behaviour*: integration - interpretation - action - generation. Each phase of this cycle is characterized by a certain style of individual learning, having strengths and weaknesses. For example, the integration requires a reflexive style, which means that it succeeds only if the members are good listeners, tolerant, careful, with a balanced judgement and within the organization there are a variety of points of view. The weakness of this style refers mainly to the low personalization and to the distance. The interpretation is based on a theoretical style, which involves combining the observation with theory, rationalization and the logical analysis of information. The shortcomings of this style may be the extreme perfectionism, too much detaching, ignoring the intuitions. Action needs, however, a pragmatic style, which means that the members must behave as experimenters and innovators, to take the risks and be oriented towards action. The shortcomings of this style can result from neglect of the theory and dialogue. Finally, the generation takes place, in an optimal manner, based on the activist style, which calls for sociability, openness, communication skills, persuasion ability, accepting the competition. The weaknesses of this style can be getting stuck on details or speeches degenerating to populism. The organizational learning cycles are not linear processes: today we integrate new information and experiences and tomorrow we interpret them etc. The learning organization can be compared to a swarm or a forum: every day more individual and collective learning processes overlap, intertwine, converge, break, intensify, split etc. Organizational learning is like a continuous fuss. Every day, every moment, the learning organization needs all those styles and all their associated competencies to carry out the phases of as many learning cycles as it can. But very few people have multilateral capacities, able to show off a variety of skills needed for learning. This vast and complex organizational learning dynamic, apparently chaotic and without a purpose, arises from a combination of various communication processes within the organization and between the organization and its environment.

5. CONCLUSIONS

There are mixed representations of knowledge, symbolic and connectionist representations, each of them with its advantages and disadvantages. Different modes of knowledge representation are a fundamental element of any KBS. The multidisciplinary of Artificial Intelligence is found in the origins of these knowledge representation methods. Some reasoning mechanisms admit only one knowledge representation method (e.g. logical reasoning). Others, on the

contrary, are compatible with various types of representations. There is not an ideal representation. Choosing a method depends on the knowledge nature, the level of control to be exerted on reasoning and the type of the problem to be solved, as example diagnosis or planning.

While knowledge are created by people, organizations must motivate and support these creative processes, developing internal environments, specific to the organization, to support continuous innovation. In other words, organizations are required to mobilize the tacit knowledge created and accumulated at the individual level, based on the four sub-processes, to aggregate them in the form of knowledge goods available for the collective. When they exert this role, organizations must ensure five conditions for the spiral process of knowledge creation to be continuous, namely: (1) *intention* - is defined as an organization's aspiration to the own goals, and it is the base within the spiral. To create knowledge, an organization must support its employees by formulating this intention and proposing it to the employees. This is achieved by defining a mission or creating a strategy that can motivate employees to engage in knowledge conversion activities. (2) *autonomy* - everyone in the organization should be allowed to act according to their own motivation to access a range of new opportunities, to create and distribute knowledge. (3) *creative fluctuation and chaos* - fluctuation refers to the organization's ability to perceive and process differentially, in an adaptive way, a series of signals from the environment in order to increase their skills, knowledge and systems. The chaos is generated naturally from the outside, when the organization must cope with different real crisis, such as a decline in performance due to market changes or to a significant increase of the competitors' performance. But chaos can also be generated from the inside, subjectively by some leaders, by proposing unclear targets, imprecise, even inaccurate. (4) *redundancy* - refers to the overlapping of some information on different business processes, management responsibilities or throughout the organization. The distribution of such redundant information supports the tacit knowledge distribution process, whereas at the individual level can be obtained interpretations of certain trends, in relation to the interest of other organization's members. Redundancy is an organization's internal control over the direction towards which it moves. Basically it can be implemented by joint participation of several departments at the same task (is a fuzzy way to work together) or through a strategic personnel rotation. (5) *variety* - the organization's internal diversity must reflect, in an own form, the environment's complexity, in order to meet challenges from the environment. To achieve this condition, any member of the organization should have quick access to a range of needed information, going through, as much as possible, a small number of stages. For a company to develop knowledge in the form of competitive advantage, it must have a clear understanding of the knowledge within it, the forms in which they exist and the nature of the processes involving knowledge. Knowledge within the organization can be individual or collective, tacit or explicit, heuristic, procedural, declarative, technical, in the form of mental models. A key factor in creating any kind of knowledge listed above is the technology. The use of technology solutions for certain items, belonging to the knowledge creation, is not a recent phenomenon. The different knowledge conversion sub-processes, all equally important, require common technological support. The implementation of such solutions would be useful for: (1) socialisation- e-meetings, chats or synchronous collaboration, groupware that allows knowledge transformation, (2) externalisation (which involves creating mental models)- dialogue, collaborative systems and conference technologies, (3) internalisation- audio presentations, views, (4) combination- classification, searching within documents, data mining, knowledge maps, ontologies. Technical advances in the processing and storage capacity of computers, together with the linkage of these computers into networks of distributed nodes, have greatly increased the capability of organizations to deliver goods and services. With these increased capabilities have come heightened expectations for quality, accuracy, responsiveness, and capacity. Particular topics of interest on KMSs include, but are not limited to: Organizational Knowledge Management approaches, Information management challenges, Service Oriented Architecture (SOA), software environments, Semantic web services environments, Information modeling and the

representation of semantics, Intelligent software tools and services, Information management systems in practice.

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REFERENCES

- [1]. **S. Borghini**: Organizational creativity: Breaking equilibrium and order to innovate. *Journal of Knowledge Management*, 9(4), 2005.
- [2]. **B. Choi & H. Lee**: Knowledge management strategy and its link to knowledge creation process. *Expert Systems with Applications*, 23(3), 2002.
- [3]. **J. Clarke & P. Turner**: Global competition and the Australian biotechnology industry: Developing a model of SMEs knowledge management strategies. *Knowledge and Process Management*, 11(1), 2004.
- [4]. **J. Darroch**: Knowledge management, innovation and firm performance. *Journal of Knowledge Management*, 9(3), 2005.
- [5]. **K.B. DeTienne & L.A. Jackson**: Knowledge management; understanding theory and developing strategy. *Competitiveness Review*, 11(1), 2001.
- [6]. **A. Flanagan**: The elusive benefits of the technology support of knowledge management. *Management Communication Quarterly*, 16(2), 2002.
- [7]. **C. Garavelli, M. Gorgoglione & B. Scozzi**: Knowledge management strategy and organization: A perspective of analysis. *Knowledge and Process Management*, 11(4), 2004.
- [8]. **M. Gloet & M. Terziovski**: Exploring the relationship between knowledge management practices and innovation performance. *Journal of Manufacturing Technology Management*, 15(5), 2004.
- [9]. **R.M. Grant**: Towards a knowledge-based theory of the firm. *Strategic Management Journal*, 17(10), 1996.
- [10]. **M. Haas & M. Hansen**: Different knowledge, different benefits: Toward a productivity perspective on knowledge sharing in organizations. *Strategic Management Journal*, 28(11), 2007.
- [11]. **G. Kebede**: Knowledge management: An information science perspective. *International Journal of Information Management*, 30(5), 2010.
- [12]. **C.J. Kruger & R. Johnson**: Information management as an enabler of knowledge management maturity: A South African perspective. *International Journal of Information Management*, 30(1), 2010.
- [13]. **T. Lin & C. Huang**: Understanding knowledge management system usage antecedents: an integration of social cognitive theory and task technology fit, *Information & Management* 45, 2008.
- [14]. **I. Nonaka**: A dynamic theory of organizational knowledge creation. *Organization Science*, 5(1), 1994.
- [15]. **J. Parsons & C. Saunders**: Cognitive heuristics in software engineering: applying and extending anchoring and adjustment to artifact reuse, *IEEE Transactions on Software Engineering* 30 (12) Sher, P., & Lee, V. (2004). Information technology as a facilitator for enhancing dynamic capabilities through knowledge management. *Information & Management*, 41(8), 2004.
- [16]. **L.G. Pee & A. Kankanhalli**: A model of organisational knowledge management maturity based on people, process, and technology, *Journal of Information & Knowledge Management* 8 (2), 2009.
- [17]. **E. Rubin & Y. Wand**: A framework supporting the utilization of domain knowledge embedded in software, *Twenty-Sixth International Conference on Conceptual Modeling*, vol. 83, Auckland, NZ, 2007.
- [18]. **D.G. Schwarts**: *Encyclopedia of Knowledge Management*, Idea Group, ISBN 1-59140-573-4 (hc), ISBN 1-59140-574-2 (ebook), 2006.
- [19]. **S.M. Tseng**: Knowledge management system performance measure index. *Expert Systems with Applications*, 34(1), 2008.
- [20]. **A. Vaccaro, R. Parente & F.M. Veloso**: Knowledge management tools, interorganizational relationships, innovation and firm performance. *Technological Forecasting & Social Change*, 77(7), 2010.
- [21]. **E. Wenger**: *Communities of Practice*, Cambridge University Press, 1998.

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THE ECOLONOMIC BEHAVIOUR – THE BASE OF HEALTHY PROFIT. HOW THE METALLIC MATERIALS INDUSTRY CONTRIBUTES

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Key words: ecolonomic behaviour, the trezviu, "win-win" principle, the healthy profit, metallic materials.

Abstract: *The ecolonomic way of thinking and life is also determined organically by the man culture, by that spiritual traditional depth that helps him get close to the sense and significance of the goods it consumes, the choices that it makes, the surrenders that it is able to, in order to be who he is etc. Therefore, our view is that a human behaviour is only perceived as durability when the human being integrated it in cultural and moral terms, when this has become some kind of "to be", of the diversity of the world that it lives in, as uniqueness and individuality. Nothing that's not culturally and traditionally perceived by the human being, could not become the source of a sustainable healthy behaviour! The international known experience proves that any way of life that was commanded from outside, by force, didn't resisted, because it wasn't perceived in cultural, moral and traditional terms by the human communities that "were wanted for transformation"!*

1. ECONOMIC LIFE AS EXISTENCE IN RELATIONSHIP

An ecolonomic behaviour must also be settled on a certain **human spirituality**, that must permanently be supplied at the sense values¹, to be able to harmonize "to have" with "to be", without endangering our own survival nor our fulfilment as social human beings. **To have in decency and to be inside sense fulfilment, this is the true harmony between nature and the society inside the man**²!

The ecolonomic behaviour based on the culture of "to be" is the only one able to accept the **"trezviu"**³ of the **cultural life diversity** in harmony with the individuality and uniqueness of the human creation. We are not aware if the human being, through its ecolonomic behaviour, succeeds to create or if he is the one that discovers and imitates, with "its borrowed mind", "systemic wisdom", that harmony of life as interrelations and interactions between the "integrated integers"!

Based on such interpretations we could get closer to the cultural wisdom of the ecolonomic way of thinking and living, meaning that a certain way of feeding us is actually, a "culture of feeding us", that a way to perceive the family life, is actually "a culture of the life in love", that a way to produce, for example, in agriculture, various goods, is a "culture of corn, wheat", etc.

This is why we believe **that only what can be perceived as a culture of living, working and loving, may truly become sustainable. And if such way is directly compatible to the health of the human being and family, to the health of the communities and institutions, with the health of the natural or created environment, then and only then, we can call ecolonomic this way of thinking and living!** This means that any attempt, many times in the name of democracy, to change even through war a certain form of government, cannot be successful, if not assimilated in spiritual, cultural and religious terms. Actually, if such a change does not emerge from inside the human being and human culture, from the culture and faith of its community, but from outside it, it doesn't stand any chance to become sustainable, of sense!

The culture of "to have" in greed, like the culture of "to be" in terms of the will of power or domination is different than the culture of "to be" as fulfilment in harmony, human solidarity and social communion. **Actually, the values of the winner culture are distinct from those of the loser, of the rich one than the poor one etc.!**

So long as the **life is game of living**, that must be played, as Mother Teresa also states, it seems that the life is the one that lives us and asks us if we are ready to marry, to become unemployed, to get ill, to lose someone dear or to die etc. And it's not us who asks the life!!! We're always questioned by the life! Therefore, we must be

educated in the spirit of love to be able to always have an answer-skill to the questions of the life that lives us!

As a result, the ecolonomic behaviour also arises from the wisdom that "life is a game" that must be played, but not anyhow, but by the "music of systemic wisdom", characterized by harmony and supplied through the spirit of the rule "earning-earning" for all life actors, people and stars, animals and plants, air and water etc. All these are dancing by the same song, yet unknown, states Einstein. Or, the way that things are today at planet scale, after so many years of evolution, what do we find? That, actually, we play this game of life, but without harmonizing to who we are, with each other, or to the demands that the "health of the living integer" assumes. Outside harmony, as "integrated living integers", we represent but broken parts of an integer, that hampers our sense fulfilment⁴!

This means that it is unnatural to have rules of thinking and living in the family, different than those in the community, business organization, society. **The same rules must allow for intelligent human self-government of the individual both in family and community, in the organization that it works for as in the society that it lives in, in the environment that it survives in.** Obviously, we have in view the morality of the behaviour rules, governed by what Confucius says: "don't do to another what you don't wish to be done to you".

In reality, what happens to the man's behaviour? It is very different, in family, than the one in the business organization, in statements, in the relation with the natural environment etc. For example, we love our family and we don't wish to harm it, but we pollute the air and the water etc., which means that we don't cherish them and, hence, we harm them, treating them like a "business in liquidation"! In fact, we don't understand that as long as we are integrated-integers, if we contaminate the environment or obtain an unhealthy profit etc., we actually harm ourselves and the families that we're part of – as families of love, work, faith s.o. !

2. DETERMINANTS OF THE ECOLONOMIC BEHAVIOUR

"The game of life" or "life like a game in a relationship" must be one and the same thing. If we accept and understand that life at the scale of planet Earth is a "conscious living integer", it means that no matter who we are as living: plant, animal, human being, undertaking, community etc., we cannot "fulfil" of sense, we cannot make apples, we cannot produce milk, we cannot obtain healthy profit etc. but by thinking and striving as organic part of the "integer". Each of these integers, although they have their own "cosmeostasis", their operation is in interaction with the elements of the "living integer" that they are an organic part of (see also fig. 1)

A healthy profit for a company cannot be obtained but based on a healthy relationship with the employees, with the natural environment, with the community that the business is located in, with

¹ Capra F., *Momentul adevărului*, Tehnică Publishing House, Bucharest, 2004, pp. 287-328.

² See Papa Ioan Paul al II-lea, *Enciclice*, ARCB Publishing House, Bucharest, 2008.

³ The "trezviu" is the principle of giving life to life, even in the most difficult unavoidable circumstances.

⁴ Adler A., *Sensul vieții*, Univers Enciclopedic Publishing House, Bucharest, 2010, p.196.

the state budget, with the other organizations of the business world etc.

Therefore, a healthy profit cannot be obtained but from healthy businesses, in harmony with the employees that produce the goods, with the environment that offers the conditions supplying the sources, with the bodies that guarantee the rules of the game type

"earning-earning" for all the actors of the business world: people and families, communities and states, natural environment and man-created environment; with the other organizations manufacturing goods and services for people, seeking to gain a proportional part of the econonomic value that is acknowledged.

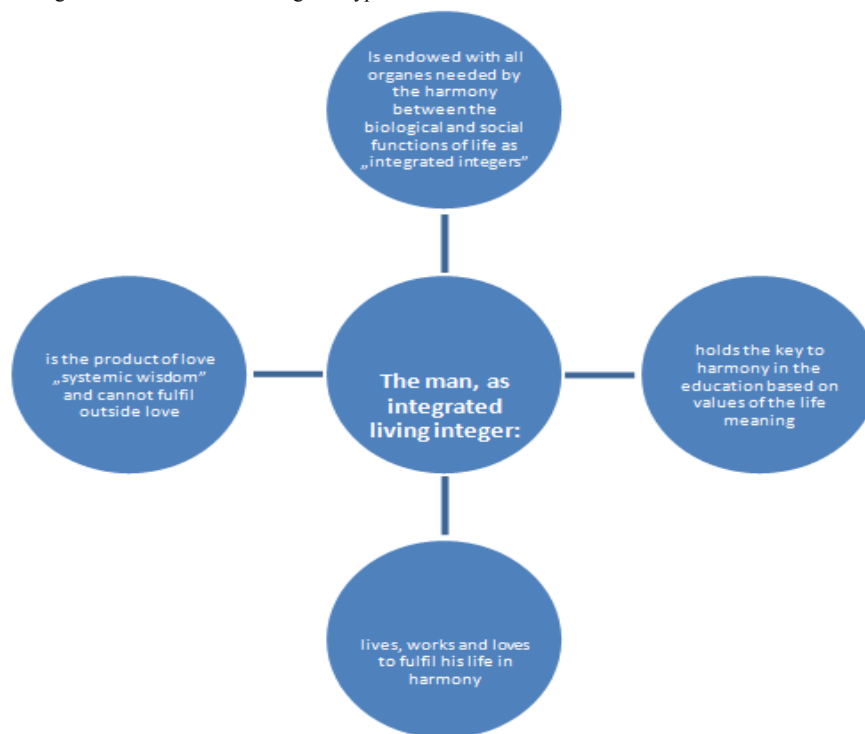


Fig. 1 Determinants of the behaviour in the econonomic society

Therefore, the economic life is an organic part of the social life and, together, of the ecology of living world, and, hence, it is equally important as the other forms of living, natural or human-created. Thus, the econonomic value is the only chance to achieve all the incomes of the carriers of production factors that attended its obtainment; employees, entrepreneurs, state etc.

This means that it is not normal, it is not natural, it is not healthy and it is not legal to increase the gross domestic product, as an expression of the economic growth, by destroying the life of environment or families, the life of people or human communities, etc. The economic life can and must produce GDP, but this should be a **human aggregate**, obtained by the rule "win-win" for all the actors of the business world and not by the rule "earning-loss", as it happens in present { See Popescu C., *Creșterea care sărăcește*, Editura Tribuna Economică, București, 2003.}! The transfer to **valuation of the health of the economic growth with the help of the human GDP**, that guarantees the people happiness, we believe it represents a **process that is more than revolutionary in the business**

management from econonomic perspective { Capra F., *op.cit.*, p.501}. In fact, it is a rebellion!

When, in the business world we seek to maximize, with any price, the financial gain of profit type, it means that this may increase at the expense of environment pollution, destruction of families and human communities, by making tax evasion and corruption, endangering the health of the national budgets and social life, in its entirety, etc. This is exactly what currently happens at the scale of the global economy. **We produce and contaminate, we sell and make tax evasion, we promote the behaviour consume, consume, throw, we obtain financial profits from the sale of goods that endanger the life of children and adults, we lead private and public businesses by using corruption as a mean to meet our egocentric purposes, at all costs etc.** Such economy not only that it is not for people, but it also harms the people, the families that the people are part of, the health of the local and central budgets, the balances of the ecological world that ensures our survival! These are the wrong ways of the non-proportional evolution that we are part of and that we have contributed to (see also fig. no. 2).

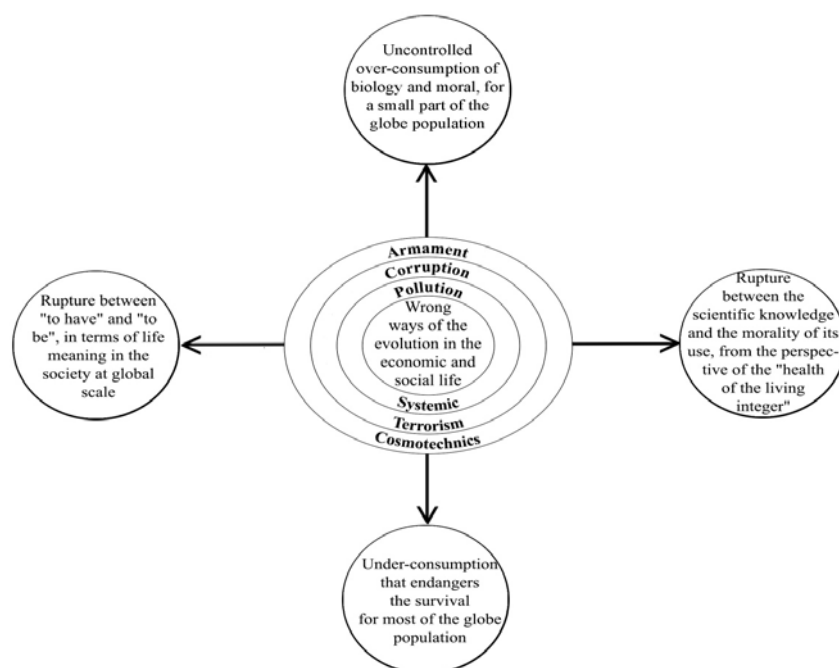


Fig.2 Wrong ways of the evolution in the environment created by the human

The **ecolonomic perspective that we submit to the attention of the economic scientific knowledge, and not only, does not contradict the organic need that the private businesses generate money profit.** This would be even impossible if we think that a business company is a living entity created by the human being, that cannot self-organize and self-reproduce, but from its own ecolonomic value. Beyond what it spends as financial effort, the net ecolonomic value generates financial profit as well as other incomes for the actors of the business world. What we stand for is that this financial profit should be healthy, meaning to be obtained from an existence in harmony type relationship with all the actors of the business world: owners and employees, families and human

communities, state and natural environment. Each of these actors, based on the contribution brought to the business world, obtain from the net ecolonomic value, based on the principle earning-earning and it doesn't happen like in the present time, where only few win and the rest lose, usually the majority! As a result, the science about the health of the economic life arises the issue of rethinking the economic concepts and theories, locating also at their foundation the ethical values that we've discussed about. In such concepts we could include: deserved salary, the healthy profit, the tax of the common sense, the due royalty, etc. A healthy profit for the entrepreneurs represents that ecolonomic net advantage, obtained without endangering the health of the common living integer (see fig. 3).

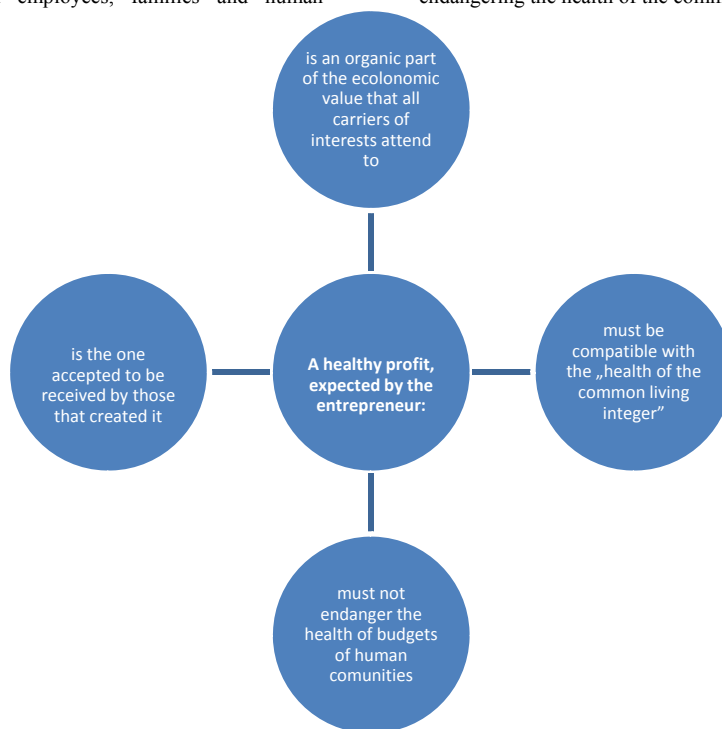


Fig. 3 Interactions of the healthy profit

3. FREEDOM OF RESPONSIBILITY, AS DEMAND OF THE UNIVERSAL HARMONY

The vision that we suggest on the world of human business arises from the interpretation of economy as a living entity of interrelations and interactions, the principle earning-earning representing the essence of the homeostasis of such entity, its invisible hand. Due to the economy as living entity is created by human beings, as answer-skill to the nature shabbiness, our view is that between their aims and the means of their achievement there must be the needed harmony.

The aims cannot be separated from the meaning of human life, construed by Viktor Frankl⁵ under the form of freedom to live in responsibility the proper life, even in the most miserable situations, known as the „tragic triad” defined by: **sufferance, guilt and death**. As long as man's life is considered an existence in a relation of the „integrated integers” type, it is natural to consider the world of human businesses as a mechanism to put in practice the accomplishment of everyone's freedom in organic interdependence with everyone's responsibility. The ecologic perspective that we propose, expressed as the value of freedom in responsibility suggests the idea of **earning-earning** for all actors of the business world, which does good to the businesses seen as entirety, as well as to the actors as interest carriers. Therefore, a freedom in the business world, missing the responsibility of its assumption means anarchy, leading to the rupture of the aims from the means of their achievement and, in the end, to the disharmony of the integrated integers created by the human being. In the name of harmony that characterizes the value of integrated-integers, the freedom of human behaviours may continuously develop up to the level of the responsibility of assumption of the consequences on the health of the living integer. We may say that the responsibility appears like a moral value that validates the freedom expansion, and that the freedom appears like the power that unchains the potential of creation, imagination and transformation that exists in every human being.

Hence, **the freedom of responsibility** is the value institution that sets at the basis of healthy growth, the energy existing in every actor of the business world. Without the freedom of participation, such energy remains locked-up inside, as without the responsibility of assumption of freedom, the energy may also turn into misfortunes!

The conscience of such ecologic behaviour in the business world comes from something simple: all those who manage and activate in the business world "are also citizens" and, thus, it is normal, natural and fair "to care about" what happens to the fellow humans, to the environment that they coexist and that you inherit. As business man, entrepreneur, employee, as families that everyone is part of, as democratic system of rules coordination for the entire private and public business world, **the behaviour of care results both from the wisdom of the proper freedom and from the ability to assume the understood responsibility**. As free as you are as entrepreneur, employee, political man, etc. as much as responsible you must be for the consequences of your actions on life as integrated integers, on the health of the living integer.

Such ecologic behaviour, as we call it, must manifest in the business world, and not only, under the form of the **care for people** who work in various companies and public organizations, for those usual men, that should feel treated as human being and not as numbers, as respected and valued for what they do. The care for such usual people is an ecologic behaviour to share the responsibilities among the actors of the business world, in such manner that, everyone and all together puts its own freedom to create under the dome of responsibility assumption for the consequences of the actions taken.

In order to understand, even closer to the truth, the need to respiritualize the human business in terms of care for the people, we may show the vision that Mother Teresa was practicing in her field of freedom in responsibility, by helping the poor ones. By referring to the participants to such action, Mother Teresa admonished the missionaries that: „None of us come here to be a number. We don't need numbers. We have a lot to work, but the numbers are of no use to me” { Zambonini F., *Teresa de Calcutta. Creionul lui Dumnezeu*, Pauline Publishing House, Bucharest, 2003, p. 130.}. Such motivation for the work dedicated to help poor people has as spiritual support the thesis that we know what we've been created for, and thus, to such great goal we must subordinate our entire behaviour, independently of the position that we occupy in the society. „Each one, states Mother Teresa, was created to be a saint. We've been created for the same purpose. To love and to be loved” { *Ibid.*, p. 175.}, hence, the ecologic behaviour that we've proposed is a behaviour of „living saint” and not of „living pork”. While the ecologic behaviour of „living saint” is attached to the **normal man** that understands to accomplish his own life in harmony with the other forms of life, the behaviour of „living pork” represents an **abnormal** behaviour due to, propelled by greed, will of power and domination etc. endangers by its choices the health of the other people, of the families and human communities, of the natural environment.

Specific contribution of metallic materials has to be analysed in the process of transition to ecologic society. The ecologic behaviour of these materials is very important for creation of the new society.

REFERENCES

- [1] Adler A., *Sensul vieții*, Univers Enciclopedic Publishing House, Bucharest, 2010.
- [2] Capra F., *Momentul adevărului*, Tehnică Publishing House, Bucharest, 2004.
- [3] Frankl V. E., *Omul în căutarea sensului vieții*, Meteor-Press Publishing House, Bucharest, 2009.
- [4] Papa Ioan Paul al II-lea, *Enciclice*, ARCB Publishing House, Bucharest, 2008.
- [5] Popescu C., *Creșterea care sărăcește*, Editura Tribuna Economică, București, 2003.
- [6] Zambonini F., *Teresa de Calcutta. Creionul lui Dumnezeu*, Pauline Publishing House, Bucharest, 2003.

⁵ See Frankl A. V. E., *Omul în căutarea sensului vieții*, Meteor-Press Publishing House, Bucharest, 2009.

THE ECOLONOMY OF HUMAN BUSINESSES, A NEW PARADIGM, THE CONTRIBUTION OF METALLIC MATERIALS INDUSTRY

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Key words: integrated living integer, living integer health, ecolonomy, healthy profit, education re-disembodiment, metallic materials.

Abstract: The researches of the fields of quantum physics, holistic medicine, trans-personal psychology, systemic biology, anthropology etc. highlight the need to rethink the concept about life from the perspective of interpretation of the Planet Earth, as „a living and conscious entity”. The supreme value of life as „integrated-integers” is conceived by the new vision under the name of harmony, defined by the attributes: adjustment, coherence and resonance. No matter if we refer to the natural environment or to the environment created by the human being, the life in harmony appears under the form of the „existence in relationship” of the integrated integers. For this purpose, the human's life is „an integrated living integer” that is connected to himself, to the divinity – on the life vertical, as well as to the fellow humans, to the living integer – on the life horizontal. In this context, we consider that the ecolonomy represents a new manner of interpreting the world of human businesses from the perspective of the paradigm that we have titled “the health of the common living integer”. The world of human businesses includes the life as the first business of the human being, as well as the other forms of life known as economic, social, cultural, religious, political life, etc. According to such vision, the economy is a living entity created by the human being, as a skill-answer to the nature's „graspingness”, in conditions of uncertainty, that the defining attributes may be, healthy or ill. The ecolonomy is conceived by us as the science about the health of the economic life, as an organic part of the social life and together, of the living world ecology. Contribution of metallic materials for creation of healthy environment.

1. THE ROOT OF THE PROBLEM

In the spirit of the window opened to the new way of thinking and living, that we have called ecolonomic, our aim is to reinterpret the human businesses, in general, and the economic ones, in particular, from the perspective of the paradigm of the „health of the common living integer”. Such approach results from the interaction that created between the consequences of the actual global systemic crisis, and the wisdoms of high spirituality science men, able to offer the basis of a new vision of the problems that we are encountering. Therefore, let's remind the wisdom emerged from the famous dictum of Einstein that „it's not worth living a life but at the service of others”¹, as well as the thesis risen from the real life of businesses emerged by Richard Branson, according to which „doing well is truly good for businesses”² and for this „we must look beyond businesses. We must seek to reinvent the way that we live in the world and to transform the compassion and empathy into something new, vibrating and sexy”³.

The actual global crisis, considered by authors like Fritjof Capra⁴ and Joseph Stiglitz⁵, as a crisis of the cultural, moral, spiritual, economic and social values, that seriously affects the living standard of the people, the quality of their life, „the health of the common living integer”, raises the issue of the causes that determined the slide of the economic and social life outside the human ambitions for better, the consideration of Earth as „a business in liquidation”, with consequences on its bankruptcy⁶. It seems that the answer to what's happening and why, could not be supplied by the actual economic science that is stagnant in the project of the „fragmentary approach”, and that tears the economic life from the social life, say nothing of the ecology of the living world⁷!

In a paper called **Life as tragic optimism. Ecolonomic perspective**⁸, we were highlighting that „the common living integer” consists of the pre-existing „natural living integer”, known as the planet Earth as „alive and conscious entity” and of the environment

created by the human being that includes families and human communities, business organizations, bodies, as ruled of the game in the society, states and international state organizations (European Union, Asean etc.), public universal organizations and other spiritual institutional constructions of the world of human businesses. These are seen from the perspective of the „systemic wisdom” as integrated living integers, based on the formula of Hwa Yen philosophy, expressed through the formula: „One in One”; One in Everything; Everything in One; Everything in All”⁹.

In the virtue of such interpretation, any disturbance of the balance of any component of the natural living or of the living created by the human being, extended beyond the coexisting cosmoestasis, will affect the others, causing negative reactions, that will influence the „health of the common living integer”.

2. NET ECONOMIC BENEFITS OF THE BUSINESSES AND THE NEED OF „ANOTHER MIND”

In terms of this vision, a health harmonious economic growth based on the principle of *earning – earning* for all the actors of the economic life, generates a health profit. This is how it is also named by Richard Branson¹⁰, one of the richest business men in the world, meaning a gain under the form of an ecolonomic income^{**} that the substance and extent reside in that the relevant business has done good to the people, who enjoy its fruitage, like the entrepreneurs and not merely. Actually, it is the same vision that we encounter a long time ago, with Pindar who said that a normal natural profit is: „a profit that the company obtains with the agreement of those that generated it”.

A profit generated by a business that dissatisfies people, through the stressing atmosphere that they work in, through the incomes obtained contemptuously to their work, say nothing about their ambitions, from which it result goods that endanger the life of those consuming them, or that are made by contaminating the air and the water, the soil and the woods, etc, is a **non-healthy carcinogen profit**¹¹! In contrast with this practice of the global business management, the new vision proves that it is possible to be successful in business, to make health business that generates healthy profit if we take care to be “ecolonomically” responsible, to respect and cherish the people that we work with, to help them help themselves, by developing their trust in their forces and creativity. If

¹ Einstein A., *Cuvinte memorabile*, collected and annotated by Alice Calaprice, Humanitas Publishing House, Bucharest 2008, p.158.

² Branson R., *Afacerile pentru oameni*, Publică Publishing House, Bucharest, 2012, p.13.

³ Idem, 301.

⁴ See Capra F., *Momentul adevărului*, Tehnică Publishing House, Bucharest, 2004, pp.5-6.

⁵ See Stiglitz J., *Prețul inegalității*, Publica Publishing House, Bucharest, 2013, p.20.

⁶ Randers J., *2052 - A Global Forecast for the next Forty Years*, Chelsea Green Publishing, Vermont, 2012.

⁷ Popescu C., Tașnadi A., *Respiritualizarea. Învăț să fii Om. Ei despre Noi*, enlarged and improved edition, ASE Publishing House, Bucharest, 2011.

⁸ See Popescu C., *Viața ca optimism tragic. Perspectivă Ecolonomică*, ASE Publishing House, Bucharest, 2011.

⁹ After Grof S., *Dincolo de rațiune*, Curtea Veche Publishing House, Bucharest, 2008, p.496.

¹⁰ Branson R., *op.cit.*, p. 37.

^{**} Through **income ecolonomic** we understand what remains as the new value created in the business organization, which is fed proportional to the effort, fair wages, rents due, decent interest, taxes earned healthy profits.

¹¹ See Capra F., *op.cit.*, p. 307.

we always bet, said Richard Branson on: „people making good things, because „doing good is also good for business” { Branson R., *ibid.*, p. 18. Through income ecologic we understand what remains as the new value created in the business organization, which is fed proportional to the effort, fair wages, rents due, decent interest, taxes earned healthy profits} we have the chance to put in practice the principle of earning-earning for all actors of the business world. To be ecologically responsible it means to take care that the actions of our choices do not generate negative consequences for our coexistence in harmony.

The ecconomy as science about the health of the economic life, as organic part of the social life and, together, of the ecology of living world, considers the world of private and public human businesses as "a living integer created by the human being" in

harmony with the natural environment and with the ambitions for better of any and all actors, as generations that coexist and inherit. Such vision rises the issue of replacement of the principle "earning-loss" by the principle "earning-earning", both for entrepreneurs and employees, and for families and human communities, for national states, for the natural environment that we survive in. In terms of Einstein's wisdom that „it's not worth to live a life but in the service of others", our view is also that getting profit in the world of private business is possible without contaminating the natural environment, without endangering the health of people and families, of human communities, the health of national and regional budgets, „the health of the common living integer", (see also figure 1).

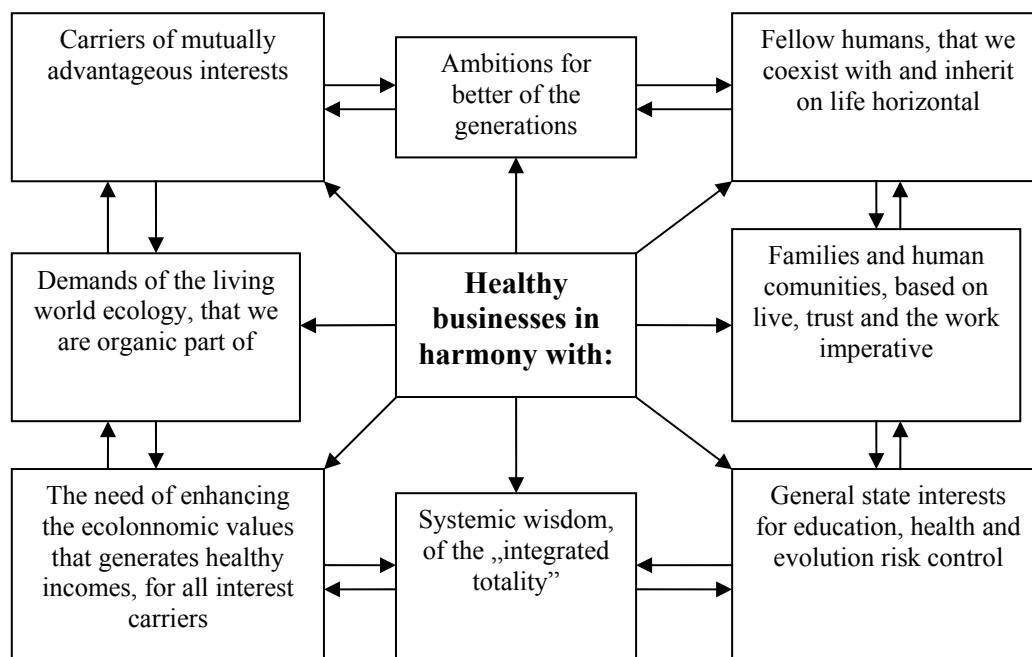


Fig.1. Health interactions of the business world

In this spirit, our view is that, like other researchers, science men and appreciated political men, it is required that we handle the „spiritual emergency” of the world that we live in: to put businesses from everywhere in the service of the „health of the common living integer”, consisting of people and their families, of the communities that they live in, of the states that they pride on and of the environment that they survive in! Such new radical way of regarding our world to transform it for corpus and sustained, we have called it the **ecologic way**¹². Such way of thinking and living does not mean a **reform** nor a **revolution**. These were until now, and the global result is defined by the words: **we are going the wrong way!** It is called **Rebellion**¹³, which means a transformation of the **inside world of the human being, of the conscience of the way of thinking and living the relation between „having” and „being” as „integrated living integers”**. And this because the true change **always** takes place from the inside to the outside of our world, where the paradigms by which we understand the world that we coexist in and that we report to¹⁴ nestle.

The **ecconomy** is viewed by us as representing the step to a new economic science for the business world, that conceives the health of the economic life and of the profits that it generates in terms of the „health of the common living integer” that the entire human society is an organic part of.

Taking into account what Einstein said that „the major problems that we face could not be solved but by remaining at the same level of thinking as when we have created them”¹⁵, the exit from the economic crisis” that we stand in and the record of our common evolution on the demands of the „health of the living integer” involve another way of thinking and living, that we've called the „ecologic” way, the way of the harmony with ourselves and with the Divinity, with the fellow humans, with the common living integer. It's actually the way of the life lived in love!

Fortunately, we also have available in the writings that reached us the ways by which we can form another mind, that understands what Fabio Barbosa, the president of the Board of Directors and the former executive president of Santander Brasil, said that „it becomes clearer and clearer that there is no incompatibility between doing business in an ethical and transparent way and obtaining good financial results”¹⁶.

The ecologic way of thinking and living means, in essence, **the love in action**. If **life is love**, as Mother Teresa¹⁷ used to say, if **life is a relationship in love**, as states Krishnamurti { See Krishnamurti J., *Despre educație. Artă învățării și valoarea vieții*, Herald

¹² See Popescu C., *Viața ca optimism tragic. Perspectivă ecologică*, ASE Publishing House, Bucharest, 2011, pp. 391-409.

¹³ Osho, *Cartea înțelegerii*, Mar Publishing House, Constanța, 2006, pp. 11-16.

¹⁴ Covey S.R., *Eficiența în șapte trepte. Un abecedar al înțelepciunii umane*, All Publishing House, Bucharest 1996, p. 27.

¹⁵ After Thorpe S., *Cum să gândești ca Einstein. Învățați regulile și descoperiți-vă genul ascuns*, Meteor-Press Publishing House, Bucharest, 2007, p. 31.

¹⁶ Through "the economic crisis" we understanding a global crisis, systemic, that affecting the values of sense, the principles of living in harmony, culture and traditions, education and health, the ecology of living and life as "integers integrated".

¹⁷ Quoted by Branson R., *op. cit.*, p. 14.

¹⁷ Zambonini F., *Tereza de Calcutta. Creionul lui Dumnezeu*, Pauline Publishing House, Bucharest, 2003.

Publishing House, Bucharest, 2012.}, the manner of ecologic behaviour based on love is the key to healing the today human being! Because, it's not the earth that's ill { See also Reeves H, Lenoir F., *Pământul e bolnav: ce șanse avem să supraviețuim*, Humanitas Publishing House, Bucharest, 2005. }, it's not the human society that's ill, but the human being, with its „borrowed mind” is ill, its behaviours are unhealthy, are governed by greed, by the will of power and domination! And, therefore, the consequences of such behaviours have disturbed the „coexisting cosmeostasis” { See Miller G. quoted by Marshal R. în *Adevărata educație pentru o viață împlinită*, Elena Francisc Publishing House, Bucharest, 2005. }.

For this we need **another education**, as we already said, **an education based on the sense values**, that Tolstoi also used to say about, „**to learn the children to live in love! The rest comes naturally**”! { See Tolstoi L., *Despre Dumnezeu și om. Din jurnalul ultimilor ani*, Humanitas Publishing House, Bucharest, 2005. } If we would love the earth, we wouldn't pollute it; if we would love ourselves as people, we would not kill each other in wars, we would not offer them products that endanger the health and even life! As said before, **the love deficit** is the main cause of the actual global crisis, that we've called the ecologic crisis, due to it negatively and seriously affects all the components of the „common living integer” { Popescu C., *op cit.*, pp. 495-533. }.

As a result, an ecologic way of human behaviour may be built in steps, by teaching the children to live in love and, not only the children, but also the adults! And this, because **the love is the conscience of true life**, on the transformation of which { Laszlo E,

Grof S., Russel P., *Revoluția conștiinței. Noua spiritualitate și transformarea planetară*, Elena Francisc Publishing House, Bucharest, 2009. } it depends the world that we live in and work in to guided by Truth, Kindness, Beauty and Faith { Laszlo E, Grof S., Russel P., *ibid.* }.

3. HUMAN VALUES OF THE ECOLOGIC SOCIETY

As long as the process of knowledge is specific to the human being, willing to understand what happens and why, both in the „outside” world and in our „inside” world, the ecologic way of life assumes to responsibly use the fruitage of knowledge for „the health of the common living integer”. The ecologic society that we think about, as future society for our common coexistence and sequence involves the respiritualize the thinking „knowledge means power” in order to learn to think and live in the spirit of another mind: „knowledge means wisdom”, doing good for people and their families, for communities and states, for the living world of the planet Earth that we are an organic part of! From living such thinking it should result that the **Ecologic Society** is based on the values of the freedom in responsibility, human solidarity and social communion, of the compassion and cooperation, organically expressed in the value of our common living integer, called, harmony. The harmony value actually integrates the other values that define the nature and the society inside the human being (see also fig. 2).

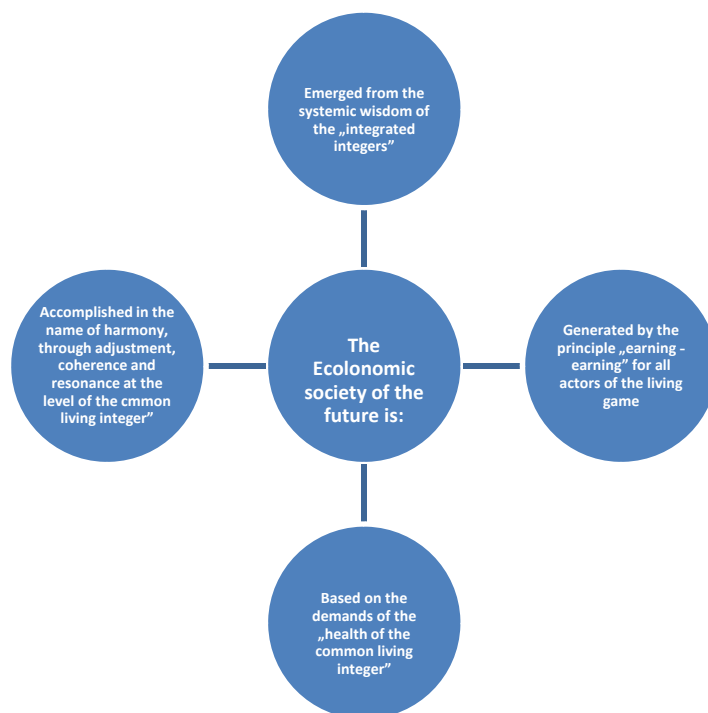


Fig. 2. Determiners of the Ecologic Society

In our view, **the ecologic behaviour is, first of all, an ecological behaviour** that the value assumes **to remove the excesses and the deficits that disturb the harmony of the living world**. Their consequences, beyond the system's capacity to self-adjust and self-govern through flexibilization, extended for a long time, over the „normal waiting time”, endanger the „health of the common living integer”.

Therefore, considering the ecological¹⁸ criteria with the human, communitarian, social, economic criteria, represents a crucial element that may turn the business world into a force that's beneficial for people and planet. This means to get to other ways „of living together, like in a true global village, where everyone may

prosper”¹⁹, said Richard Branson, where all the actors of the life of the „living integer” may win, by proportionally sharing the ecologic value that it is created.

Considering that planet Earth is „a living and conscious entity”, as characterized by the quantum physicians, the **ecologic behaviour must integrate with harmony**, with its defining attributes, **adjustment, coherence and resonance**, in order to be able to be in sense relationships not only to ourselves, but with the fellow humans, with the „living integer” that we are the organic part of²⁰.

¹⁸ See also Georgescu Roentgen N., *Legea entropiei și procesul economic*, Politică Publishing House, Bucharest, 1979.

¹⁹ Branson R., *op. cit.*, p. 29.

²⁰ Laszlo E., Currivan J., *CosMos*, Elena Francisc Publishing House, Bucharest, 2010, pp.19-20.

As said, there is the point of view, that is largely accepted by the science men of the new thinking that the value of freedom has exhausted, in historical terms, is potential for development. And this, because in the last period of time **the freedom slipped in the area of its negative side**, meaning that we are able to do anything, we don't have to give account to anyone etc.²¹

Therefore, it is important to note the recommendation of doctor Viktor E. Frankl made to the Americans that the "*Statue of Liberty* from the East Coast should be added a *Statue of Responsibility* on the West Coast"²². And this, because, says the scientist, "the freedom is in danger of degenerating into a simple caprice if not lived in terms of responsibility"²³!

The changeover from the value of freedom to the value of harmony, that also includes the freedom in responsibility, but also other values, represents the essence of the sense transformations that must support the achievement of a new education at planet scale, a process that we've called **respiritualizing the education**²⁴.

A human life in harmony, in terms of the ecologic society that we thought about, would be characterized by the following demands:

- It is lived in plenitude and health, in truth, kindness and beauty;
- It is with yourself, with the fellow humans, with the living integer;
- It is lived in the moral courage, before it is "too late";
- It is the expression of the sense found for the proper freedom in responsibility;
- It is the maximum possible from life, even in crisis periods;
- It means the vocational-type occupation;
- It means to do to other what you wish to be done to yourself;
- It means being worthy of our sufferance;
- It means controlling the death fear;
- It means to love, by offering "*trezvie*".

Within the unavoidable circumstances that life manifests as a choice, including the economic life, **the limitation is the one that determines us to integrate with our ecologic behaviour the rule of rationality**. The issue that the rationality assumes in the business world is related to the fact that such principle must be subordinated to the human being, making a better life for the human being and not for the money profit! The maximization of the money profit outside the fulfilment of man and of the "health of the living integer" is the biggest misfortune! The actual global crisis proves it.

In close relationship with these **values-conditionalities**, the ecologic behaviour based on **hope** assumes that this principle is **constantly promoted in life, in the business world**. When we make education in love, we actually teach the children to live in the spirit of the values of the life sense, to use the hope that it will be better for them and for those dear to them only because they love what they do and they do what they love to do, being implicated in the process of improvement of their own lives. Outside the hope for better, the rationality becomes carcinogen! The hope, as ecologic behaviour, is learned from the very first years of life. Actually, our entire homeostasis includes in its determination the hope as a way of life, that dies the last²⁵. Even the **rational hope** represents the supreme value in the medical secrecy. The hope value is the one that gives sense to the endurance of rationality.

In the ecologic way of behaviour we have also included the **faith in the hope certainty**, from this resulting the energy that supplies the convictions that only if we make things go better, we will be in harmony with ourselves, with the fellow humans, with the living integer. **The deficit of faith** could drive a behaviour such as: this man has nothing holy in what he does; he cares about nothing, he almost lost his compass in everything he does! Einstein himself,

stated that "science without religion is limped, religion without science is blind"²⁶. If we think that the real progress is the moral one, then the harmony between the science and faith is the key to such healthy progress for any and all carriers of interests at the level of the "living integer", based on the principle earning-earning.

The faith that, in a business it is very important to permanently pay a lot of attention to people, makes that their happiness reflect in the sense performance, in the company's state of mind, supplied by the authentic energy triggered by the man's competition to himself. The ecologic vision that we suggest shows that the energy triggered by the man's competition to himself is superior and non-destructive than the energy triggered by the competition between people!

The faith that if you do good in everything that you undertake you will also obtain the rewards you want, becomes one of the most powerful components of the ecologic behaviour, due to it integrates the harmony between the nature and the society inside the man, in the man's interior world being created that change that the man also wishes to see in the exterior world!

In the institutional – national and international behaviour, we've lived many years with the faith that, if we handle the serious problems that the human kind faces, the emergencies, by offering help and money, we can solve the cases that we encounter. However, today, what do we find? The serious problems that most of our world encounters, such as under-development and poverty, unemployment and social exclusion, lack of education and serious illnesses, drugs, terrorism, uncontrolled over-consumption of biology and moral etc., not only that we haven't solved, but these continued and worsened, becoming the most serious issue of our non-proportional evolution, like Papa Ioan Paul al II-lea²⁷ used to name it. Such evolution is the result of two diametrically opposite trends: **knowledge and the technology of knowledge implementation, upwards**, and the **morality of their consequences, downwards!** Actually, this non-proportional evolution is the expression of "human being fall" that endangers the "health of the living integer" that the human being is also part of!

What does this mean? That we haven't worked on the causes, we haven't tried to reinvent, to spiritualize the way that such people live. Of course, the financial helps are needed for emergencies. The issue that we also raise refers to building us "another mind", in order to start another way of thinking and living that emerges from the faith that **prosperity and poverty are in Us as human beings, in Us as families, in Us as business organizations, in Us as nation, people and not outside us**²⁸. In systemic terms, the life as "existence in relationship" proves that you cannot be wealthy or poor all by yourself! As you cannot love all by yourself!

In such context, the new faith that the ecologic behaviour assumes is based on what Gandhi said: "let's become the change that we want to see in the world". Or, as Covey said, "the real change always takes place from inside us towards outside us". The change in better starts with you. This is the faith of the ecologic behaviour that we also promote, in the new ecologic society, that we hope to represent the real freedom of responsibility for the human being as "integrated living integer"!

Contribution of metallic materials has to be deeply studied, in order to establish a new ecologic society.

REFERENCES

- [1] Adler A., *Sensul vieții*, Univers Enciclopedic Publishing House, Bucharest, 2010.
- [2] Branson R., *Afacerea pentru oameni*, Publica Publishing House, Bucharest, 2012.
- [3] Capra F., *Momentul adevărului*, Tehnică Publishing House, Bucharest, 2004.
- [4] Costea C., Popescu C., Tașnadi A. (coord.), *Criza e în noi*, ASE Publishing House, Bucharest, 2011.

²¹ See Semashko L., *Harmonious Civilization Universal Declaration*, 2009, published online on http://www.peacefromharmony.org/?cat=en_c&key=375.

²² Frankl V.F., *Omul în căutarea sensului vieții*, Editura Meteor-Press, București, 2009, p. 145.

²³ *Idem*.

²⁴ See Popescu C., Tașnadi A., *op.cit.*

²⁵ See also Popescu C., *Raționalitate și speranță. Paradigma întregului viu*, Renaissance Publishing House, Bucharest, 2006.

²⁶ Einstein, *op. cit.*, p. 211.

²⁷ Papa Ioan Paul al II-lea, *Enciclice*, ARCB Publishing House, Bucharest, 2008, p. 32.

²⁸ See Popescu C., *Criza e în Noi*, în volumul *Criza e în noi*, coord. Costea C., Popescu C., Tașnadi A., ASE Publishing House, Bucharest, 2011.

- [5] Covey S.R., *Eficiența în șapte trepte. Un abecedar al înțelepciunii umane*, All Publishing House, Bucharest, 1996.
- [6] Einstein A., *Cuvinte memorabile*, culese și adnotate de Alice Calaprice, Humanitas Publishing House, Bucharest, 2008.
- [7] Frankl V. E., *Omul în căutarea sensului vieții*, Meteor-Press Publishing House, Bucharest, 2009.
- [8] Georgescu Roentgen N., *Legea entropiei și procesul economic*, Politică Publishing House, Bucharest, 1979.
- [9] Grof S., *Dincolo de rațiune*, Curtea Veche Publishing House, Bucharest, 2008.
- [10] Krishnamurti J., *Despre educație. Artă învățării și valoarea vieții*, Herald Publishing House, Bucharest, 2012.
- [11] Laszlo E., Grof S., Russel P., *Revoluția conștiinței. Noua spiritualitate și transformarea planetară*, Elena Francisc Publishing House, Bucharest, 2009.
- [12] Laszlo E., Currivan J., *CosMos*, Elena Francisc Publishing House, Bucharest, 2010.
- [13] Marshal R., *Adevărata educație pentru o viață împlinită*, Elena Francisc Publishing House, Bucharest, 2005.
- Osho, *Cartea înțelegerii*, Mar Publishing House, Constanta, 2006.
- [14] Papa Ioan Paul al II-lea, *Enciclice*, ARCB Publishing House, Bucharest, 2008.
- [15] Popescu C., *Raționalitate și speranță. Paradigma întregului viu*, Renaissance Publishing House, Bucharest, 2006.
- [16] Popescu C., Tașnadi A., *Respiritualizarea. Învăță să fii Om. Ei despre Noi*, ediția adăugită și îmbunătățită, ASE Publishing House, Bucharest, 2011.
- [17] Popescu C., *Viața ca optimism tragic. Perspectivă Ecologică*, ASE Publishing House, Bucharest, 2011.
- [18] Randers J., *2052 - A Global Forecast for the next Forty Years*, Chelsea Green Publishing, Vermont, 2012.
- [19] Reeves H., Lenoir F., *Pământul e bolnav: ce șanse avem să supraviețuim*, Humanitas Publishing House, Bucharest, 2005.
- Semashko L., *Harmonious Civilization Universal Declaration*, 2009, published online on http://www.peacefromharmony.org/?cat=en_c&key=375.
- [20] Stiglitz J., *Prețul inegalității*, Publica Publishing House, Bucharest, 2013.
- [21] Thorpe S., *Cum să gândești ca Einstein. Învățați regulile și descoperiți-vă genul ascuns*, Meteor-Press Publishing House, Bucharest, 2007.
- [22] Tolstoi L., *Despre Dumnezeu și om. Din jurnalul ultimilor ani*, Humanitas Publishing House, Bucharest, 2005.
- [23] Zambonini F., *Teresa de Calcutta. Creionul lui Dumnezeu*, Pauline Publishing House, Bucharest, 2003.

TRANSITION TO THE ECOLONOMIC SOCIETY, THE EVOLUTION OF METALLIC MATERIALS INDUSTRY

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Key words: ecolonomic responsibility, ecolonomic behaviour, systemic wisdom, ecolonomic society, metallic materials.

Abstract: The transition to the wisdom era, as base of ecolonomic society is a complex process which begins with the human and institutional behavior respiration. The substance of this process has its source in rethinking education, from the perspective of transition to education in love and fully understanding of life. The contribution of metallic materials is important in this respect.

1. HUMAN BEHAVIOURS - AS BASE OF THE HEALTH OF WHOLE LIVING

The essence of the way to put human behaviours in the service of the „health of the common living integer”, natural and man-created, consists in the **men capacity to discover their own power of change, without fear or prejudices**. This means that at the level of every business organization, and not only, the centre of taking the decisions of change in better, not only for **me** but also for **you** should be located as **close as possible to usual individuals**, or even at their level, where it appears, in real terms, the power of intelligent self-government. As long as our fair perception reaches as close as possible to the depth of the wisdom that we are „integrated living integers”, the **ecolonomic responsibility** of each one of us lies not only towards himself but towards the others (see also fig. 1).



Fig. 1. Demands of the ecolonomic responsibility

Therefore, no matter if you're a man that promotes in real terms private or public businesses, the essence of ecolonomic responsibility, as an integrated living integer has as criteria of „ecolonomic optimum” „the care for people and for the planet that forms our global village”. So long as we understand such „global spiritual emergency”, it means that we act as part of the „systemic wisdom”: „we are all part of the problem: we waste, we spend and, to call things by their name, we destroy”¹.

To such „global spiritual emergency”, that Grof, Russell and Laszlo² call it „the conscience revolution”, we reach by striving to lay the foundation of a new educational model, based on the education in love and on the integral life understanding. Only an education in love, based on the assimilation of the meaning values, known as the freedom in responsibility, human solidarity, social communion and compassion, may lay the basis of new ecolonomic behaviours of type earning-earning for all the actors of the economic and social life. Understanding that the man's future is in the love family, and that the world's future is in the behaviours of the young generation, the new educational system assumes to teach the man to live his life in harmony, as Tolstoi says³, without promoting egocentric behaviours, propelled by greed, hate, will of domination etc. Such an educational model can help us **reinvent the way we produce and consume goods**, by relying on the lessons detached from the relationship with the natural environment. When a business organization obtains a healthy profit from businesses that do good to people and to environment, it is vital that such ecolonomic net advantages” are used to generate „positive changes”, in terms of the health of the common living integer. It's true that until now, a part of these „ecolonomic net advantages”, called healthy profits, and not only, were also used to manifest the institutional behaviour, called „corporation charity”. Such institutional organizational behaviour is not harmful but, on the contrary, it helps on something. The problem that arises is that, in cases of „human emergencies”, all the means of the human behaviours that may help sufferance, may unleash the man from such misfortunes, etc. should be used. Such way of human institutional behaviour was, it is and will be, as old as humanity, beneficial for the cases of "human emergencies" and not only.

2. LET'S LEARN THE PEOPLE TO HELP THEMSELVES

However, now, in terms of respiration of education and of human institutional behaviours, the ground issue is to implicate people „in the process of improvement of their own lives”⁴, in such manner as to learn that catching fish is more important than to offer it a fish from time to time, to save him from poverty! **On short term, the charity may be a spiritual emergency. On long term, it is vital to teach people to help themselves, by also creating a political, institutional and spiritual environment, that is favourable to such process of ageing in freedom and responsibility.** In a business world, where the profit cannot be removed because it endangers its continuity, Ray Anderson appreciates that, today „the businesses ... must exist for a much noble, much higher purpose”⁵. Such noble, much higher purpose is actually the expression of transformation from inside of the selfishness into altruism, of the freedom into responsibility, into human solidarity and compassion, without endangering life, its values as integrated living integer. Such way of thinking means to not consider the financial profit above the health of the common living integer, above the good of the human being and of the community that he lives in. Without minimizing the

¹ Branson R., *Afacerile pentru oameni*, Publica Publishing House, Bucharest, 2012, p. 29.

² See Laszlo E, Grof S., Russel P., *Revoluția conștiinței. Noua spiritualitate și transformarea planetei*, Elena Francisc Publishing House, Bucharest, 2009.

³ See Tolstoi L., *Despre Dumnezeu și om*. Din *jurnalul ultimilor ani*, Humanitas Publishing House, Bucharest, 2005.

⁴ Branson R., *ibidem*, p. 41.

⁵ After Branson R., *op. cit.*, p. 97.

significance of the financial profit for business existence and prosperity, Antoine Riboud, the founder of the company Danone said that „the sustainable economic value cannot be created if, at the same time, a human value is not created”{ *Ibidem*, p. 101.}. The healthy financial profit, as a condition of the business existence and development, represents a net ecologic value that is compatible with the other values of the human society that define „the life as existence in a relationship”.

In fact, the ecologic spirit in the formation of the business behaviour, promotes the **ecologic value** for the company as a

source of wages and healthy profits, for the incomes of the budgets of the human communities etc. Such ecologic value that may supply all the actors of the economic life, may see a healthy growth if it benefits from a favourable institutional environment, where the harmony between the participants and the responsibility for the consequences of the choices are consciously together and evolve, also in compatibility with the time and space of our coexistence and sequence (fig. 2).

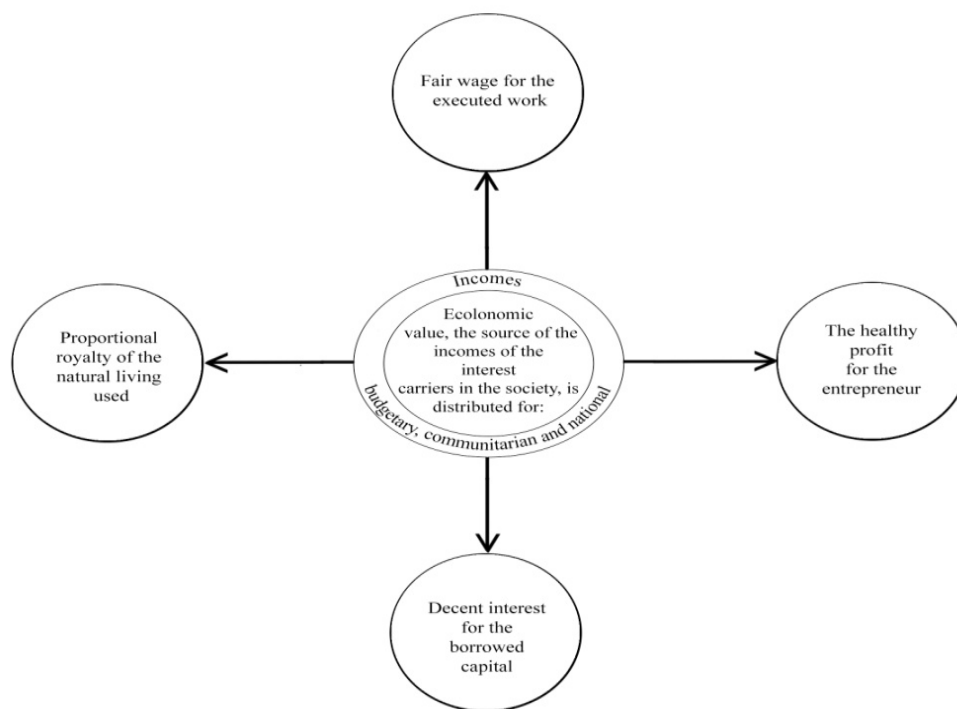


Fig. 2. Distribution of the ecologic value

The ecology as science about the health of the economic life, an organic part of the social life and, together, of the living world ecology, raises the issue of rethinking the way of living, producing and consuming, in such manner, that the life operation in the created environment deploys according to the same rules that exist in the Mother Nature. Such new vision, concerning the economic life, has in the wisdom of the natural environment, the universal laws governed by harmony, that, once also implemented in this environment created by the human being, accomplishes our existence as integrated living integers. The human being, being at the same time, nature and society, it is vital that the elements integrated in terms of education, faith, traditions etc. put forward its atavic potential and shape it in the direction of development as freedom in responsibility, as it results from the systemic wisdom of the microcosmos that we are in.

3. LET'S LEARN THE RESPONSIBILITY OF BEING MEN

While the freedom of being who we are is inherent to life as existence in relationship, the responsibility for its assumption is a complex process that forms step-by-step through the education in love, starting with the education from the family. Through education we learn to make the most of the potential that we have available and, at the same time, to wake up in order to get close to the wisdom that we cannot accomplish life but if we think and live as part of the living integer: family, community, society.

The way of waking up is the first step needed to put our businesses in the service of the people's life, by helping them not only to survive, but also to live with dignity, decency and harmony, changing inside. As long as we are aware that **life means existence in relationship**, that, in fact, we are in interrelations and interactions,

we all must commit to ecologic behaviour like „earning- earning” for all the actors of the economic and social life, and not just for some (see also fig. 3)⁶!

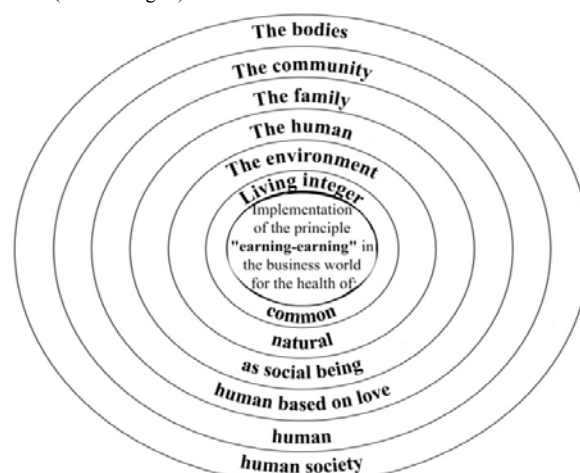


Fig. 3. Propagated impact of the principle „earning- earning”

The answer-skill to the issues that the business world encounters these days, to the ecologic crisis that we face, must be one of "integrated integers"-type, that results from a coherent and

⁶ Costea C., Popescu C., Taşnadi A. (coord.), *Criza e în noi*, ASE Publishing House, Bucharest, 2011.

simultaneous participation of trans-disciplinary character, transposed into a new thinking, as well as into a new way of life.

This is why we also think that the age that the human being and the human kind must enter is the one of **responsibility of using the knowledge, the life experience and faith** in terms of „health of the living integer”, of making the world **a better place for the generations that coexist and sequence unavoidably**.

Where from may such transformation come from, that raises the awareness on the need to be responsible as „integrated integers”? Our view is also that the source that may generate such meaning transformation lies in „reinventing the educational system”, in „faith respiritualization”, in order to develop another mind, radically distinct from the mind that lead us into crisis. Such a global transformation process must be the result of the same faith: **we all have the same religion, to believe that we can live in harmony with ourselves, with the fellow humans, with the „common living integer”**. Such faith, that the human and institutional behaviour relies on, emerges from the way that we interpret „the systemic wisdom” and that we integrate through our actions and facts, both as survival and as meaning accomplishment in uncertainty conditions.

The substance of such faith derives from the wisdom that **we must be the soul and the brain of Earth, as living and conscious entity and not as its illness!** Now, when the actual ecolonomic crisis highlights the wrong ways of our evolution, we believe that it is not too late to become conscious and courageous to understand that it is not good to only think about the needs and rights of the people. Without neglecting, we must have in view that equally important are also the needs and rights of the air and water, of the woods and fields, of the plants and animals, etc, that, together with those of people, form an integrated living integer, where One is in Everything and Everything is in One. The basic thesis of the ecolonomic concept that we wish to promote refers to the organic need to understand that we cannot accomplish our needs and we cannot defend our rights but if we understand that these are the organic parts of a living and conscious entity that sits on planet Earth. Unfortunately, these days, when usual people that are dominated by the concern of primary needs, live thinking about the needs of food and shelter, striving to keep their workplaces, etc, „don't have the time or energy, required to think more about the climate changes and disappearance of biodiversity, tigers, whales or lemurs”⁷. It seems probable that such way of ecolonomic behaviour is natural. As long as the needs for survival are endangered, the behaviour of fight and/or adjustment is lead by the selfish conscience of our homeostasis. At the same time, even such behaviour, if we don't think it and live it from the perspective that the fate of everyone and all seems to be common, the risks become more redoubtable. Hence, the survival appears as being kept under the control of everybody, only if we see our fate as one of the type of „integrated integers”, as being common to those that we coexist and sequence with in this space. Failing to understand the thesis that our survival is in the hands of systemic wisdom of integrated integers type, there is the danger to „rest on our laurels” that „we are not all in the same situation”. Or, today, following the revolution of knowledge and understanding that life is existence in relationship, here it is there and there it is here and, therefore, we can all have the same fate.

It is true that the integrality of life on planet Earth does not exclude the diversity of its living in social cultural environments that are distinct by origin. This means that at the level of this living integer we have both life in poverty and life in richness, we have both satisfied needs at the level of a under-consumption that endangers survival and needs that are satisfied through an over-consumption that has no connection to biology or moral of the human life⁸. Each of such liven life dualities becomes dangerous because the poverty breaches the rule of survival and the excess of richness separates “to have” from “to be”, inadmissibly wasting the limited resources that the others would greatly require. For example, to represent 6% of the planet population and to use 40% of its primary resources, it means a serious error of the institutional behaviour! As long as the resources are limited, at the scale of planet Earth, when someone consumes almost 7 times more than it would

deserve, it means that somebody else, consumes 7 times less than it needs!

If we consider that no one can progress all by itself, cannot be poor or rich all by itself, then it seems obvious and conclusive that only a proportional evolution in the utilization of limited resources, in the consumption of goods and services, is the one that may guarantee the life accomplishment in terms of harmony of the “integrated integers”, of the generations that coexist and unavoidably sequence.

When we find that the fight against the global poverty, the fight against pollution or terrorism, etc, has the result an increase of the intensity and extent of such phenomena created by the human being, it means that something must be changed in their control! This something, that must be changed, it includes in its determination the understanding of the fact that **for nothing we fight the impact of the human and institutional behaviours if we don't fight at the same time their causes**. Hence, an integrative vision is required, that simultaneously includes, **the fight to causes, manifestation forms, consequences as well as the respiritualization of our way of thinking and acting, of producing and consuming, of assuming the freedom in responsibility as parts of a „common living integer”**. Such integrative vision is learned through the respiritualization of education, meaning to pass to universal scale, to the education in love, based on integral understanding of life as existence in relationship (see also fig. 4).

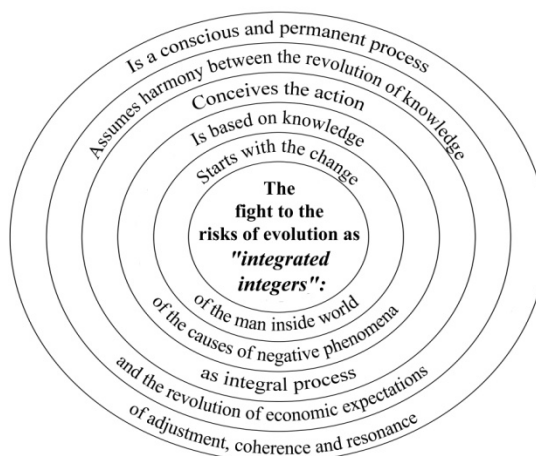


Fig. 4. The fight with the evolution risks

Such battle cannot be fight and, in particular, won from outside. Its dream is, goes and is won only from inside poverty, with those spirits awoken to understand that the true change only occurs from inside, from the need to change our “inside mind”, that mind that lead us into the poverty crisis, into the over-consumption crisis or into the pollution crisis, etc.

Only from this interior we can stop and look with more attention to the economic and social structures that crash or that are destroyed in the name of so called development. Such structures, that become inhuman not only through their sizes but also through the consequences of their existence, of multinational and excessive urbanization types, must be abolished as soon as possible because they endanger the harmony of life as integrated integers. The ecolonomic vision that we open from the perspective of interpreting economic life as an integrated living integer assumes to associate with our own conscience, with our fellow humans, with Mother Nature, on long term, in such way as to learn that we cannot accomplish life but in harmony as integrated integers. This is obviously about an **ecolonomic need** in harmony with who we are, with the natural interactions that we coexist and sequence in. The greed, the over-consumption, the will to dominate and exploit, are not part of the ecolonomic needs of our common living integer. And when this occurs, they disturb the „cosmeostasis” of our common living integer, generating behaviours on the wrong ways (see also fig. 5).

⁷ Branson R., *op.cit.*, p.199.

⁸ Papa Ioan Paul al II-lea, *Enciclice*, ARCB Publishing House, Bucharest, 2008.

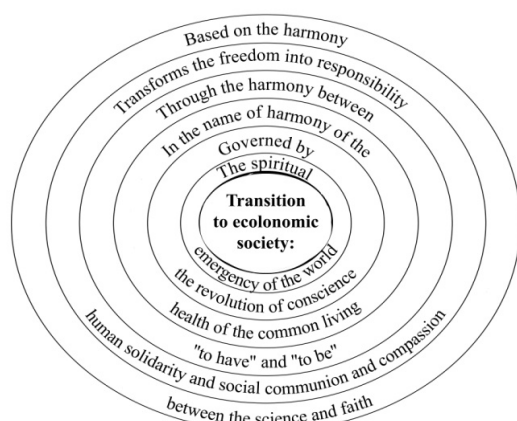


Fig. 5. The transition to the ecolonomic society

The transition to an **ecolonomic society**, originates from the spirit of the impulse of Gandhi regarding the change, from the opening of Einstein regarding the life that is worthy of living⁹, from the wisdom of Krishnamurti that life is existence in relationship¹⁰, from interpretation of quantum physics of „systemic wisdom”¹¹ that governs life at the level of our celestial body!

Such transformation process is the expression of understanding that „to have” in greed is not the meaning of life accomplishment in harmony, but of always being responsible for yourself, for the fellow humans, for the entire common living integer, from which you always learn that you cannot meaningfully accomplished but only if you think, aim, choose and live in love, solidarity, social communion and compassion. You do everything aware of the fact that you are an organic part of the „living integer”.

An economy outside the love of people and environment is a business on the wrong way, that endangers not only the human life, but also life in its living integer. While an economy for people, is, actually, a business system where the rule „earning-earning” is vital for all actors of the business world.

Therefore, an economist prepared in the spirit of businesses for people is the most healthy dream of an economic academic organization, at list, from now on.

In this respect the contribution of metallic materials has to be considered.

REFERENCES

- [1] **Branson R.**, *Afacerile pentru oameni*, Publica Publishing House, Bucharest, 2012.
- [2] **Capra F.**, *Momentul adevărului*, Tehnică Publishing House, Bucharest, 2004.
- [3] **Costea C., Popescu C., Taşnadi A.** (coord.), *Criza e în noi*, ASE Publishing House, Bucharest, 2011.
- [4] **Einstein A.**, *Cuvinte memorabile*, culese şi adnotate de Alice Calaprice, Humanitas Publishing House, Bucharest, 2008.
- [5] **Krishnamurti J.**, *Despre educaţie. Artă învăţării şi valoarea vieţii*, Herald Publishing House, Bucharest, 2012.
- [6] **Laszlo E., Grof S., Russel P.**, *Revoluţia conştiinţei. Noua spiritualitate şi transformarea planetară*, Elena Francisc Publishing House, Bucharest, 2009.
- [7] **Papa Ioan Paul al II-lea**, *Enciclice*, ARCB Publishing House, Bucharest, 2008.
- [8] **Tolstoi L.**, *Despre Dumnezeu şi om. Din jurnalul ultimilor ani*, Humanitas Publishing House, Bucharest, 2005.

⁹ See Einstein A., *Cuvinte memorabile*, culese şi adnotate de Alice Calaprice, Humanitas Publishing House, Bucharest, 2008.

¹⁰ See Krishnamurti J., *Despre educaţie. Artă învăţării şi valoarea vieţii*, Herald Publishing House, Bucharest, 2012.

¹¹ See Capra F., *Momentul adevărului*, Tehnică Publishing House, Bucharest, 2004.

OPERATIONAL MANAGEMENT TECHNIQUES TO PREVENT AND COMBAT THE UNDERGROUND ECONOMY IN ROMANIA, SPECIFIC SITUATION OF METALLIC MATERIALS INDUSTRY

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Key words: black labor market, underground economy, unemployment, metallic materials industry.

Abstract. *The underground economy in Romania is very high comparative with other EU countries. The economic crisis has brought a growing of shadow economy in a context where there were increases of taxes, in particular VAT and excise duties. A recent EUROSTAT report estimated the underground economy of tends to be 18% out of Romanian GDP. The present essay emphasizes the importance of political regulatory actions that must be put in practice in order to turn the grey economy into taxes paid to the budget. The author also explains the disadvantages of shadow economy in case of undeclared employment. The situation in the metallic materials industry is also studied.*

INTRODUCTION

The size of the underground economy in Romania, quantified in terms of data publicized in the media, generates different values and interpretations, the only common element being the existence of a broad phenomenon, hidden to the control of the appropriate forums or institutions.

In those circumstances, the national statistics that aggregates the macroeconomic results (most commonly GDP) established as purpose to measure also the size of the unobserved

economy. Although up to now it hasn't been reached a consensus among experts on the delimitation of the gray economy and illegal economy nor the measurement methods, there is a general consensus regarding the identification of the party unnoticed in statistical terms, referring to sharing economy two sectors: formal and informal (households) [1], each generating added value to commensurate official and underground. As a result, the structure of the hidden economy includes economic activities carried out of formal and informal sector (households) with the main feature being hidden common statistical observations.

The formal sector	The informal sector [2]
Includes productive units that operate as legal entities governed by the Law on the organization and functioning of companies, accounting law, government decisions (for public institutions) etc. Data on the activities of these companies are registered with the Ministry of Finance (Tax Register), the Chambers of Commerce and Industry (Trade Register) and the National Institute of Statistics (Statistical Register).	Includes family businesses and freelancers, who are required to submit annual income statements from the Ministry of Finance and are registered with the Tax Register and Statistical Register.

Table 1. Formal vs. informal economy[2]

The National Institute of Statistics (NIS) uses an analytical method for estimating the unobserved economy based on labor. In addition to estimating output, intermediate consumption and gross value added by those who work illegally, an evaluation is made to VAT fraud and the activities of unregistered units in the informal sector. Thus, according to NIS, within the hidden economy, the black labor market is the main component, followed by VAT fraud and the unregistered domestic activities.

According to the methodology adopted by the National Institute of Statistics, the unregistered units (in official records) may exist only in the informal sector, when taking into consideration in this category the private classes given by teachers, the labor provided by auto mechanics, the bricklayers and painters, tailors and shoemakers etc. On the other hand, both in the formal and the informal, there may function undervalued business registered establishments, in order to avoid tax obligations. This is part of the gray economy and its assessment is based on a specific methodology.

One problem with statistical evaluation of the gray economy is the non-response and lack of information from Statistical Register date, the only source for providing nomenclature units carrying out investigations, which often leads to underestimation of the actual size of the gray economy.

NIS considers that the following elements are part of the underground economy in Romania: labor underutilization, tax evasion within VAT evasion within income by declaring their informal sector activities, undeclared.

The size of the underground economy vary greatly, depending on the method of calculation adopted by each institution conducting such assessments. Therefore, various estimates of the share of GDP tax evasion must not be compared to estimates made by the NIS for the following reasons:

- the appearance of the differences that start right from the content of the economy (eg, estimates based on tax controls are a simple

extrapolation and inclusion in a fixed correlation to GDP, and the inclusion of these results should be analyzed in terms of content controls of the behavior verified units of direct influence on GDP);

- Controls are not made based on sampling methods with representativeness restrictions that would further allow extrapolation to the whole economy;
- Extending the behavior of fraud discovered for the entire community is irrelevant, leading to overestimation of the object specific indicators;
- Controls usually focus on taxes and fees which do not fall, failure to pay directly in the calculation of GDP (transactions without a license, certain taxes on income, using fraudulent invoices etc.) But are relative to GDP, issues which are not equivalent
- Estimates based on the data provided by the Financial Guard also include illegal activities, so a comparison with the estimate made based on macroeconomic indicators drives you underestimating or overestimating the economy.

THE THREAT ASSESSMENT

The proliferation of the underground economy in Romania was supported by a number of factors that have enabled a rapid development. It is illogical for the tax laws to be elementary and incomplete and to live into the persistent legislative uncertainty. The economic restructuring depends on the economic interests of political clients and privatizations that generated compromised proliferation of free expression of the underground economy and of the illegal practices.

The division of the public power made after the 1989 revolution was accomplished by sharing responsibilities with immediate effect increasing corruption practiced today in all economic and social backgrounds.

The corruption and the underground economy are in a relationship of interdependence because corruption is the entity

which engages in the underground economy, resulting in reduction of taxes collected directly from the state budget or increase further fiscal obligations. Therefore, the correct meaning, but also the main cause of the activities undertaken in the informal economy is all taxation. Tax burden at a superior level drives to the amplification of the phenomenon and generates reducing of the economic growth.

Public perception and attitude towards the state politicians and the rule of law is compromised as a result of the existence of the underground economy. It degrades both the respect of statutory regulations, laws and rules, and to the concept of voluntary compliance in paying taxes, as provided in Article 53 of the Constitution.

Moreover, income differences between individuals working in the informal economy and the formal economy grow substantially and damage occurs while living standards, sufficient prerequisite for individuals to perform work in the underground economy or to accept irregular work law.

The low level of economic development of our country, taxation and tax regulations rigid perfect legislation, corruption, and fiscal indiscipline and lack of civic morality make Romania a very attractive area for free expression activities in the sphere of economy.

Typically, active people with entrepreneurial spirit, with initiative and high sense of risk are more likely to be engaged in activities in the underground economy, as employment in this sector represents a viable alternative to the formal economy, as it offers many acceptable alternatives.

People are strongly motivated by material ambitions and aspirations and they are willing to provide a variety of activities to achieve revenue necessary to achieve the primary objective, while people who have moderate expectations about living standards in this case will show a balanced performance.

Also, those engaged in construction, transportation, telecommunications facilities, etc. are more likely to engage in underground economy than those working in education, for example. Education and teaching, regardless of its priority areas of social life, are lacking informal alternative. Moreover, the specializations and studies of these people, their dignity and pride to be the bearer of high level knowledge, prevents them to be engaged in such activities that could be perceived as "humiliating". However, willingness to learn new skills can switch them towards the underground economy.

Labor mobility is another factor that can influence the black labor market. People with high seniority in certain areas are not usually willing to perform any gainful activity. Moreover, if they have a regular income and they certainly will not risk to compromise their position by engaging in other activities specific to the hidden economy.

Various analyses have shown that women have fewer opportunities to work in the informal economy than men. The reality behind this work lies in the fact that the informal economy is mainly applied for physical effort and is occasionally.

Therefore, we can say that the choice of undeclared work to the detriment of the official whole process is based on motivational aspects [3]

Motivational element	Features
Personal Reasons	Are related to human needs and expectations. Needs are gaps which a person feels at some point. Expectations are people's beliefs in the existence of opportunities that can be achieved under an informal commitment.
Individual behavior	It is influenced by a number of economic incentives, intrinsic motivational factors and relational. Economic incentives obligatorily take the form of value, cash. They consider income, size, and free time available to the individual. Intrinsic motivators are in the nature of work, or interest in it. With regard to these relational factors occur due to friendly relations based on which entry occurs in the informal sector, and the desire for affiliation and gaining access to the material on which it can provide a certain social status.
Goal individual goals	Considering the high expectations on living standards. It's really about how, meaning that interest is focused individual. The motivation provided by the desire to achieve a certain objective proposed basically financial origin / material plays an important role in choosing the informal sector to the detriment of the official one.
Feed-back	Considers the possibilities of economy compared to those offered by the formal economy. Failure to find a formal job will materialize through frustration and cause the individual to turn to an informal job. Also, a formal job poorly paid, will be offset by an informal job, but very rewarding.

Table 2. Motivational process that it involves economy

Source: Adapted from Sasu H. (2007), *Rewards for employees of the company*, Economic Tribune no. 45/7 November 2007 pp. 34-37.

Among the threats that generate exacerbate underground economy are the following:

- unsustainable economic and social policies;
- the unemployment;
- the level of the unemployment benefits and the low wages;
- the large number of self-employed and of those "unpaid" material;
- the large number of part-time vacancies compared to the full - time one;
- taxation and the lack of efficiency of financial control - tax etc.

The failure of government economic and social policy is one of the reasons that affect dynamic economy and also undeclared one [4], [5].

The direct effect caused by the high level of taxation, the squandering of public money without a rational and coherent reason, but also reduction of employment and working time is in this context of undeclared reasons. Allocation and reallocation of labor income in society have clear objectives that allow adjustments of these distributions in harmony with the proposed social policies.

Not infrequently state intervention in tax - Budget is seen as generating social inequality. It calls for viable policies, policies of social justice, the appropriate allocation etc. Based on these observations we can say that the dynamics of underground economy is influenced by the failure of the state to adapt, direct and correct interventions in conjunction with the wishes of the majority population. Since Romania's achievement of such social goals could

cause a significant decrease in revenues, we may say that current government policies often ignore the wishes and needs of citizens.

Unemployment is perhaps one of the most important causes of undeclared expansion. Almost explosive growth of unemployment in Romania last year and its permanent upward trend requires special attention to this problem, especially because, as the unemployment rate is higher, the temptation to engage individuals in the black labor economy is stronger.

Therefore, another element that emphasizes the issues of the economy is the *unemployment benefits and low wages*. After 1990, the system of unemployment benefits provided smaller payments, but over long periods of time. But their relative level was higher than the official minimum wage, so that people looking for a job were tempted to stay unemployed than to work legally and be paid poorly. We believe that the very failure of the employment policies of the time very slow to dynamically generate the formal labor market. Thus were created the conditions for the unemployed to engage in shadow economy activities, especially in trade and agriculture.

A similar behavior has been noticed in the case of workers made redundant as a result of privatization and / or restructuring of public enterprises / autonomous administrations, who received several payments. Received payments equivalent to the salaries for many months, generated in the first phase disinterest in looking for a new job. Subsequently, they chose moonlighting either because it ensures them higher incomes than a living wage in the formal economy, either because they have not found a viable alternative.

Despite the fact that income from the underground economy is superior to the income generated by the formal economy, in the case of retirement or reinstatement in the public unemployment income to the individual by the state will not be able to provide it than a minimum subsistence. This is exacerbated by periods of economic crisis, also the number of new jobs is insufficient and parallel access to the labor market is restricted by the ratio of net official salaries and cost of labor.

In the last decade, the number of employees in the formal economy has declined significantly, probably due to exacerbation phenomenon of international migration. A large number of Romanian citizens have chosen the EU and beyond, to perform various tasks/jobs in the formal economy or underground host countries.

The influx of labor more or less qualified to other states resulted in a reduction of the income tax base salary and imposed total cost increase due to labor taxation.

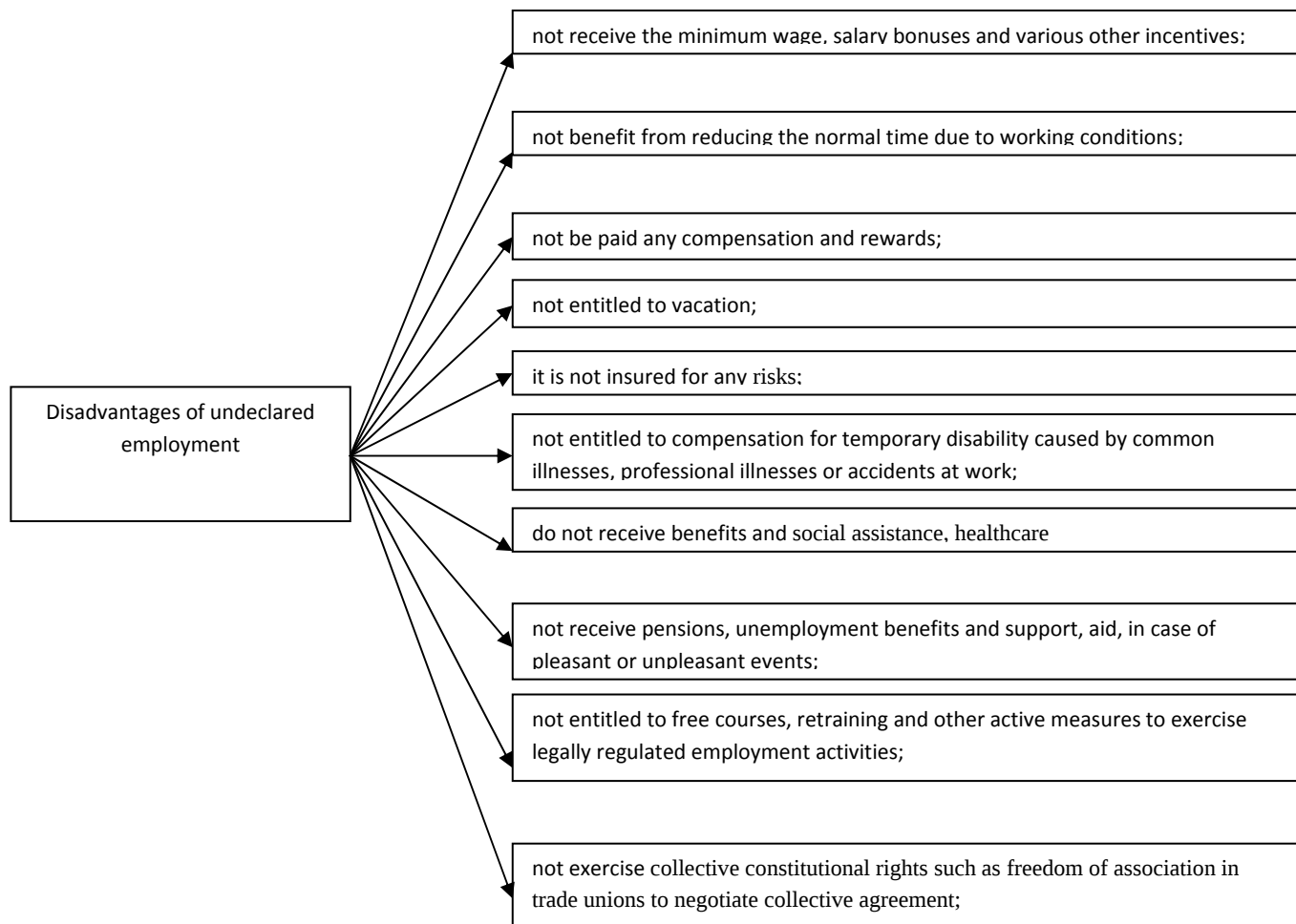


Figure 1 - Disadvantages of undeclared employment

Expansion economy amid level income tax reduces the income tax base, as more employees engage in activities untaxed. The immediate effect of this situation is an increase in the budget deficit, and the emergence of distortions in economic and social foundations that build collective arrangements.

The evolution of the economy was accompanied by permanent manifestations of a large underground economy. Official economic development comes amid increasing public spending, requiring additional public resources collected through taxes. As a result, revenues increase requires an increase in taxes and fees. Increasing tax rates also cause increased appetite for illegal employment.

CONCLUSIONS

The continuous growth and uncontrolled public spending favors formal economy collapse and anarchy. In such a negative context, covering the financing needs of the State requires analysis and reconsideration of various economic activities and implementing new rules and regulations to ensure substantial benefits for the resource. Only through such measures a considerable economy could

be transferred to the formal economy where property rights are approved by law.

Any rational person perceives as a coercive taxation, an obligation whose fulfillment negatively affects labor revenues, therefore the tendency is to minimize the amount of taxes paid.

The case of metallic materials industry presents specific situations.

REFERENCES

- [1] www.biblioteca-digitala.ase.ro/statistica_afacerilor
- [2] **Ivan Ungureanu C.** (2003), *National accounts. Concepts, methodologies and applications*, Irecson Publishing House, Bucharest
- [3] **Sasu H.** (2007), *Rewards for employees of the company*, Economic Tribune no. 45/7 November 2007 pp. 34-37.
- [4] <http://www.fatf-gafi.org/dataoecd/49/29/49684543.pdf>
- [5] http://ec.europa.eu/internal_market/company/docs/financial-crime/20110124_study_amld_en.pdf

PRIVACY-RELATED ASPECTS OF THE MARKETING COMMUNICATION WITH THE CONSUMERS: AN EXPLORATORY ASSESSMENT, SPECIFIC SITUATION OF METALLIC MATERIALS INDUSTRY

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Key words: privacy, marketing communication, Romanian consumers, metallic materials.



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Abstract: *The performances of the marketing communication with consumers depend on the appropriate selection of “traditional” (press, radio, television, outdoor) and/or direct media (mail, telephony, mobile telephony, and the internet), capable to draw the attention of the consumer, generate his/her interest, stimulate the desire for, and determine the buying of the promoted products, services, and brands. In the process of selecting these media, several privacy-related aspects should also be taken into consideration. The paper explores some of these aspects – preferences for searching or receiving information, preferences for receiving marketing messages in terms of the media employed as sources of information, attitudes towards disclosing, capturing, processing and employment of the personal data, assessment of the aggressiveness of the media employed in the direct communication, and the attitudes toward buying products and/or services after being directly approached – and presents the results obtained at the level of a sample including Romanian consumers. the importance of metallic materials industry has to be analyzed in this respect.*

1. INTRODUCTION

When companies are set up, it is compulsory for them to know exactly what type of needs their products / services cover, and moreover to know their target audience, consumers. Knowing exactly to whom their products, services or brands address to, companies should find out what characteristics do their customers have, which are their needs and wants, concerns and expectations, so that they know how to communicate with each segment. It is very important for companies to communicate efficiently with their target and persuade the potential and existing customers that buying their products, services or brands is in their best interest. The more organizations know about their target, the more effective their marketing efforts will be. Therefore, organizations should focus on finding not only *who* are the persons or organizations that *buy* their products, who are the *consumers* of the products, services or brands that they sell, *what* products/ services they want, the reasons *why* they buy and *how* they use these products, but also *which communication channels* they prefer, so that companies know what marketing instruments are accepted and appreciated by the clients. For organizations, communicating efficiently with the consumers leads to being well-known by them and selling them more products, services or brands; consequently, the importance of approaching the individuals or organizations only by using those marketing instruments that they have priorly agreed on being approached.

In order to develop marketing communication campaigns, companies use multiple communication instruments. The interactions between these instruments suggest that organizations should apply integrated marketing communications to benefit from the synergies [1][2]. Gurau [3] defines integrated marketing communication and presents the evolution of the concept, highlighting the trends of reducing the budgets allocated to mass advertising campaigns and concentrating on segmented or personalized communication with final consumers [4][5]. Van Raaij, Strazzeri and Woodside [6] consider that the social and technological developments interact and make the traditional mass marketing approaches obsolete due to the new options and possibilities that the consumers have. The internet and the mobile communication technologies have created the need for a new approach to marketing communication [3][7][8]. When deciding what communication means to use, companies should consider not only the audiences indicators, such as: market share,

rating, reach, cumulative ratings cume, gross rating points (GRP), cost per thousand (CPM) or cost per point (CPP), but also the impact that these communications have on the consumer's private space, because some of them are more aggressive and some are better accepted.

Companies should be very careful when selecting the direct communication means they will use in order to approach the consumer, pay attention to those aspects related to the consumer's private space and respect his privacy. The *consumer's private space* includes an amount of information referring to the demographic, psychographic and behavioral characteristics of the individuals (frequently described in the literature as personal data), and the rights the consumer should have, on a hand, to disclose or not this information and, on the other hand, to have this information protected through the appropriate laws and means [9][10]. Analyzing the evolution of the definitions given to the personal data between 1998 and 2008, Grant [11] has concluded that the content of the personal data, representing the central issue in the data protection, is still under debate. Still, there is a strong need for identification and definition of this data as consumers are more and more approached through direct marketing campaigns by the different organizations. Although most of the consumers have realized that participating in direct marketing is a necessary part of being in a consumer society, they are concerned about the unauthorized use or the misuse of their personal data and information, mainly in the forms of sale of their data without permission, unsolicited contact by businesses, the feeling that businesses know too much about their personal information, and the accuracy of data retained in databases [12].

The results of a research, conducted on the Romanian market [10], show that the definition of the consumer's private space may have at least three major implications: a better understanding, a more appropriate assessment and a more effective seizing of the value of personal information; a better legal environment regulating the capturing, processing, administration and employment of the personal data; and a more effective consumer's control over the personal information and, consequently, over his or her private space. Senicar, Jerman-Blazic and Klobucar [13] propose several privacy-enhancing technologies for the internet users providing certain privacy to them.

2. METHDOLOGICAL NOTES

Several privacy-related aspects of the marketing communication

with the consumers have been assessed through this exploratory research approach: (1) consumers' preferences for searching or receiving information about the different products, services, and brands, (2) consumers' preferences for receiving marketing messages in terms of the media employed as sources of information, (3) attitudes of the consumers towards disclosing, capturing, processing and employment of the personal data, (4) consumers' assessment of the aggressiveness of the media employed to communicate directly with them, and, (5) attitudes of the consumers toward buying products and/or services after being approached through the media employed to communicate directly with them.

Associated to these *objectives*, the research conducted has provided information based on which a set of *hypotheses* have been verified: H1. the majority of the consumers prefers both to search and receive information; H2. the internet is the most preferred medium employed by the consumers as source of information; H3.1. the majority of the consumers does not agree to disclose their personal data to companies or public entities; H3.2. the majority of the consumers would like to express their consent before disclosing their personal data to companies or public entities; H3.3. the majority of the consumers does not agree to have their personal data collected when buying products and/or services; H3.4. the majority of the respondents does not agree to have their personal data processed after buying products and/or services; H3.5. the majority of the consumers does not agree to have their personal data employed in the promotion of the companies' products and services; H4. the majority of the consumers consider the approach by mail, telephone, mobile telephone, and the internet as aggressive; and H5. the majority of the consumers would not buy products and/or services after being approached by mail, telephone, mobile telephone, and the internet.

The data have been gathered at the level of sample including 153 respondents from Bucharest (the Capital city), aged 23 to 34, with a higher education, and holding a professional status of full-time employees, freelancers, entrepreneurs, managers, and students. The data have been collected in January 2012.

3. MAIN FINDINGS

Obtaining information (commercial, financial, technical, etc.) about the products, services, and brands that are to be bought is essential in the making of the consumer's buying decision. There are three ways the consumers may consider in order to obtain this information, and, consequently, three major types of related behavior: (1) an active behavior, specific to the consumers preferring rather to search for, (2) a passive behavior, specific to the consumers preferring rather to receive, and (3) a mixed behavior, specific to the consumers both searching, and, also, willing to receive the information.

The results of the research do not confirm the related hypothesis (H1): the majority of the respondents (52.0 %) prefer rather to search for the information regarding the products, services, and brands they intend to buy. Yet, an almost similar part of the respondents (44.7 %) prefers both to search this information and to receive it, most probably through the marketing communication campaigns employing direct communication media. Somewhat surprisingly, the weight of the respondents preferring rather to receive this information is very low (3.3. %), a result that is very close to the average response rates generated by the direct marketing campaigns conducted by the organizations.

Preference for rather searching for information of interest regarding the different products, services, and brands describes the consumer's behavior as an active, and, in the same time, as a defensive one: on a hand, the consumers get and process this information, and make buying decisions with a solid information background; on the other hand, this active behavior prevents and limits the attempts of the organizations that approach directly the consumers, providing them with the necessary information in the decision-making process. Apparently, the consumers tend to prefer to search for information not necessarily to be better informed, but to defend their private space.

The success of the marketing communication with the consumers depends significantly on the appropriate selection of the media used as marketing channels: the "recipe" of an effective communication campaign includes an assortment of channels capable to draw the attention of the consumer, generate his/her interest, stimulate the

desire for, and determine the buying of the promoted products, services, and brands. In order to enhance the communication effects, an integrated approach, combining "traditional" (press, radio, television, outdoor) and direct communication (mail, telephony, mobile telephony, and the Internet) channels, is employed.

Table 1. How do consumers prefer to receive marketing messages

Information sources	Count	% of responses	% of cases
Daily press	15	4.2	9.8
Periodical press	10	2.8	6.5
Radio	14	4.0	9.2
Television	41	11.6	26.8
Outdoor	22	6.2	14.4
Mail	19	5.4	12.4
Telephone	6	1.7	3.9
Mobile phone	26	7.3	17.0
Email	87	24.6	56.9
Internet	114	32.2	74.5

The results of the research confirm the related hypothesis (H2): the internet is the medium most preferred by the respondents (74.5 %) as a source of information, and, thus, as a marketing communication channel, while the television remains, although at significantly lower levels by comparison to the previous years, the "traditional" marketing communication channel most employed by the respondents (26.8 %) to obtain information about the different products, services, and brands. Television holds a dominant position among the "traditional" media employed as marketing communication channels, followed, at a significant distance, by the outdoor. The daily and periodical press and the radio appear as rather peripheral media that can be employed to approach specific market segments or niche markets. Three out of four respondents seem to use the internet as a source of information, the preferences for other channels, such as mobile phone and the mail, being significantly lower, yet still higher than those for "traditional" channels other than television. The very low level of preferences for the telephony, seen in relationship with those for mobile telephony, suggest a higher openness of the respondents toward the mobile marketing instead to the classical telemarketing campaigns. Also, the high level of preferences for email, as an online marketing communication channel, provides promising perspectives for a potential rise of the weight of the consumers willing to receive information about products, services, and brands.

The rise of the internet in the recent years, that has determined both the consumers and organizations to migrate to the online environment – one supporting the searching for information, as well as its receiving, had apparently two important results: the decrease in the consumers' employment of the "traditional" media as sources of information, and the limitation, in terms of diversity, of the media considered by the consumers in their decision-making process – the respondents have indicated, as an average, two or three media, mainly by associating the internet and another "traditional" or direct communication medium.

Table 2. Attitudes of the respondents toward disclosing personal data to the companies and public entities (n=153; percentages)

Disclosing personal data to:	Agree	Rather agree	Rather not agree	Not agree	Don't know / Don't answer
Companies	15.7	23.5	33.3	24.8	2.6
Public entities	26.1	30.7	30.1	11.1	2.0

As the data in the Table 2 reveal, there is a significant difference in terms of the respondents' attitude toward disclosing their personal data to the companies, respectively the public institutions and/or authorities: the majority of the respondents (58.1 %) would rather not agree to make this data available to the companies, which confirms the related tested hypothesis, while the similar attitude in relationship with the public entities is quite opposite – the majority of the respondents (56.8 %) would rather agree to make their personal data available to them, which does not confirm the related hypothesis (H3.1). The consistency of these results is supported by the extremely low weight of the respondents unable to express their attitude (less than 3 % in the total of the sample). The reliability of the measurement is confirmed by the value of the Cronbach's Alpha (0.814).

This difference between the companies and public entities in

terms of the attitudes toward disclosing the personal data is related to the way consumers perceive the employment of this data: apparently, the consumers tend to believe that companies could employ their personal data in a more threatening manner for their private space and privacy, while their trust in the appropriate employment of this data by the public entities is significantly higher.

Table 3. Attitudes of the respondents toward expressing their consent before disclosing their personal data to the companies and public entities (n=153; percentages)

Consent given before disclosing personal data to:	Agree	Rather agree	Rather not agree	Not agree	Don't know / Don't answer
Companies	79.1	16.3	2.6	0.0	2.0
Public entities	72.5	18.3	5.9	2.0	1.3

As the data in the Table 3 reveal, the consent given by consumers before disclosing their personal data is highly important both in the case of the companies and public institutions and/or authorities: the majority of the respondents would rather prefer to have their agreement solicited before making this data available to the companies (95.4 %), respectively the public entities (90.8 %), which confirms the related hypothesis (H3.2). The consistency of these results is supported by the extremely low weight of the respondents unable to express their attitude (less than 2 % in the total of the sample). The reliability of the measurement is confirmed by the value of the Cronbach's Alpha (0.868).

The caution is the word describing the best the consumers' attitude in this respect: the companies and the public institutions/authorities should solicit the agreement of the consumer before collecting his or her personal data as a proof of the honest processing and employment of this data, without affecting the consumer's private space and privacy.

Table 4. Attitudes of the respondents towards capturing, processing, and employment of their personal data by the companies (n=153; percentages)

Companies should not ...	Agree	Rather agree	Rather not agree	Not agree	Don't know / Don't answer
...capture personal data	32.7	21.6	26.1	15.7	3.9
...process personal data	38.6	21.6	21.6	13.1	5.2
...employ personal data	54.9	16.3	13.1	11.1	4.6

As the data presented in the Table 4 reveal, the attitudes of the respondents toward the collection, processing, and employment of their personal data by the companies is a rather reserved one: thus, the majority of the respondents would rather not agree to have this data collected (54.3 %) and processed (60.2 %) after buying different products and/or services, respectively employed in marketing communication campaigns promoting products and services in the market (71.2 %), which confirm the related tested hypotheses (H3.3, H3.4, and H3.5). The consistency of these results is supported by the very low weight of the respondents unable to express their attitude (less than 5.2 % in the total of the sample). The reliability of the measurement is confirmed by the value of the Cronbach's Alpha (0.707).

The reserves of the consumers in terms of their personal data collection, processing, and later employment suggest that this data should be mainly employed in the database marketing activities, and less in direct marketing campaigns. The results also reveal the importance of educating consumers for a better understanding of the content of their personal data, the appropriate manner of collecting, processing and employment of this data, and the rights they are entitled as providers of personal data.

Table 5. Consumers' assessment of the aggressiveness of the different direct communication media employed by the companies to approach them (n=153; percentages)

Direct communication media	Aggressive	Rather aggressive	Rather not aggressive	Not aggressive	Don't know / Don't answer
Mail	5.2	13.7	31.4	45.8	3.9
Phone	51.0	35.3	5.9	4.6	3.3
Mobile	47.7	34.6	9.2	4.6	3.9

phone					
Internet	3.9	5.2	23.5	66.0	1.3

As the data presented in the Table 5 reveal, the majority of the respondents perceive the approach by telephone (86.3 %) and mobile phone (82.3 %) as being rather aggressive, which confirms the related tested hypotheses, while the internet and mail have been perceived as rather not aggressive, which has confirmed only partially the related hypothesis (H4). The consistency of these results is supported by the very low weight of the respondents unable to express their attitude (less than 4.0 % in the total of the sample). The reliability of the measurement is confirmed by the value of the Cronbach's Alpha (0.779).

A degree of aggressiveness for each of the considered marketing channels has been established through the transformation of the items of the measurement scale from a qualitative into a quantitative expression ("aggressive" – 4, "rather aggressive" – 3, "rather not aggressive" – 2, and "not aggressive" – 1), is 3.37 (fixed telephony). The average scores expressing the aggressiveness of the considered marketing channels are: 3.37 (telephony), 3.30 (mobile telephony), 1.77 (mail), and 1.46 (internet).

The consumers tend to perceive as more aggressive the approach conducted by marketing channels that involve a direct contact with them – both the telephony and mobile telephony allow the organizations willing to communicate to initiate and have a dialogue with consumers. The mail and the internet instead are perceived as less aggressive because they allow consumers to keep a distance that creates a certain level of comfort in their relationships with the organizations approaching them. The consumers receive the messages regarding the different products, services, and brands without having to participate in a dialogue with the senders; the communication loop closes when consumers demand additional information or make an order for the promoted products and/or services.

Table 6. Consumers' attitudes toward buying products/services after being directly approached by the companies through different direct communication media (in percentages; n=153)

Direct communication media	Yes	Rather yes	Rather no	No	Don't know / Don't answer
Mail	23.5	24.8	23.5	22.9	5.2
Phone	11.8	18.3	35.9	28.8	5.2
Mobile phone	11.8	21.6	32.7	27.5	6.5
Internet	34.0	32.7	19.6	9.8	3.9

As the data presented in the Table 6 reveal, the majority of the respondents have had a rather reserved attitude toward buying the products/services after being directly approached by telephone (64.7 %) and mobile phone (60.2 %), which confirms the related hypotheses, while the similar attitude in relationship with the other two marketing channels has appeared to be more friendly, the majority of respondents willing to buy after being directly approached through the internet (66.7 %) and mail (48.3 %). The consistency of these results is supported by the very low weight of the respondents unable to express their attitude (less than 6.5 % in the total of the sample). The reliability of the measurement is confirmed by the value of the Cronbach's Alpha (0.898).

A degree of willingness to buy has been established for each of the considered marketing channels through the transformation of the items of the measurement scale from a qualitative into a quantitative expression ("yes" – 4, "rather yes" – 3, "rather no" – 2, and "no" – 1). The average scores expressing the aggressiveness of the considered marketing channels are: 2.14 (telephony), 2.19 (mobile telephony), 2.52 (mail), and 2.95 (internet).

The consumers' willingness to buy products, services, and brands promoted through a direct approach employing mail, telephony, mobile telephony, and the internet as marketing channels tend to be higher when the approach is conducted in a less aggressive manner through the employment of communication channels with a lower degree of aggressiveness. From the perspectives of the consumers' private space and privacy, keeping a safe distance up to the organizations attempting to connect with them increases the possibility for the consumers to buy the different products, services, and brands.

The association between the degree of aggressiveness of the

marketing communication channels and the willingness to buy products and/or services promoted through these channels has been assessed using the Pearson correlation coefficient whose value (-0.9345) suggests a extremely strong and backward connection between these variables: higher is the perceived aggressiveness of a medium (or a marketing communication channel), lower is the willingness to buy anything promoted after being directly approached through that medium (or marketing communication channel).

4. CONCLUSIONS, LIMITS OF THE RESEARCH AND FURTHER RESEARCH DIRECTIONS

The research conducted has provided several conclusions regarding the impact of privacy-related aspects over the marketing communication with the consumers:

- the consumers' preferences for searching the information to be used in the decision-making process of buying different products, services, and brands describe the consumer's behavior as active and defensive: apparently, the consumers prefer to search not necessarily to be better informed, but to defend their private space by avoiding its direct approach by the organizations;
- the rise of the internet in the recent years has determined a decrease of employment of the "traditional" media (and marketing communication channels) as sources of information, and limited, the diversity of the media, respectively the marketing communication channels, considered by the consumers in their decision-making process, most frequently to the association between the internet and another "traditional" or direct medium;
- there is a significant difference in terms of the attitudes of the consumers toward disclosing their personal data to the companies, respectively the public entities, as the companies are believed to employ the personal data in a more threatening manner for their private space and privacy. Both the companies and the public institutions/authorities should solicit the consumer's agreement before collecting personal data as a proof of safeguarding his/her private space and privacy;
- the reserves of the consumers in terms of their personal data collection, processing, and later employment recommend the employment of this data mainly in the database marketing, and less in direct marketing campaigns. The education of the consumers for a better understanding of the content of their personal data, the appropriate manner of collecting, processing and employment of this data, and the rights they are entitled as providers of personal data is essential;
- the consumers tend to perceive more aggressive an approach conducted by media (marketing channels) that involve a direct contact (such as the telephone and the mobile telephone), and less aggressive the approach using media that allow them to keep a distance that creates a certain level of comfort in their relationships with the organizations (such as the mail and the internet);
- finally, the consumers' willingness to buy products, services, and brands promoted through mail, telephony, mobile telephony, and the internet tends to be higher when the approach is less aggressive i.e. employs less aggressive media. Higher the perceived aggressiveness of a medium is, lower is the willingness to buy anything promoted through that medium.
- The contribution of metallic materials in this respect has to be deeply studied.

As an *overall conclusion*, an active and defensive consumer should be approached by the organizations and/or public entities using a combination of communication media including the internet and other less aggressive media, only with the previous consent of this consumer, in a trusted context of collecting, processing, and employment of the personal data, aiming to generate a certain result such as buying of a certain product, service or brand.

The main *limits of the research* derive from its exploratory nature and regard the size and the structure of the investigated sample, respectively the formulation of the research objectives and the related hypotheses. The *further directions* of research should take into consideration at least: (1) the improvement of the sample by covering other segments of consumers in terms of age (35 and more years old), residence (other urban cities), and education (average educated consumers), and (2) increasing the depth of the research approach by

including, as research objectives, of the elements regarding the effects, on micro and macroeconomic levels, of the inappropriate employment of the consumers' personal data.

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5. REFERENCES

- [1] A. Prasad, S. P. Sethi: *Integrated marketing communications in markets with uncertainty and competition*, Automatica, Vol. 45, No. 3, pp. 601-610, 2009, ISSN 0005-1098.
- [2] D. E. Schultz: *Integrated marketing communications: Maybe definition is in the point of view*, Marketing News, Vol. 27, No. 2, 1993, p. 17.
- [3] C. Gurau: *Integrated online marketing communication: implementation and management*, Journal of Communication Management, Vol. 12, No.2, 2008, pp. 169-184, ISSN 1363-254X.
- [4] M. Durkin, M. A. Lawlor: *The implications of the internet on the advertising agency-client relationship*, The Services Industries Journal, Vol. 21, No. 2, 2001, pp. 175-190, ISSN 1743-9507.
- [5] L. Eagle, P. J. Kitchen: *IMC, brand communications, and corporate cultures*, European Journal of Marketing, Vol. 34, No. 5, 2000, pp. 667-686, ISSN 0309-0566.
- [6] W. F. Van Raaij, A. Strazzeri, A. Woodside: *New developments in marketing communications and consumer behavior*, Journal of Business Research, Vol. 53, No. 2, 2001, pp. 59-61, ISSN 0148-2963.
- [7] R. Winer: *New Communications Approaches in Marketing: Issues and Research Directions*, Journal of Interactive Marketing, Vol. 23, No. 2, May 2009, pp. 108-117, ISSN 1094-9968.
- [8] C. D. Bodkin, M. Perry: *Goods retailers and service providers: comparative analysis of web site marketing communications*, Journal of Retailing and Consumer Services, Vol. 11, No. 1, January 2004, pp. 19-29, ISSN 0969-6989.
- [9] C. Vegheş, C. Pantea, D. Bălan, M. Rădulescu: *Attitudes of the consumers regarding the processing and employment of their personal data*, Annals of the University of Oradea – Economic Studies, TOME XIX, No. 1, July 2010, pp. 797-802, ISSN 1582-5450.
- [10] C. Vegheş, C. Acatrinei, D. Dugulan, M. Palade: *A marketing view over the role of the public authorities in the protection of the consumers' private space*, Annals of the University of Oradea – Economic Studies, TOME XX, No. 2, December 2011, pp. 811-816, ISSN 1582-5450.
- [11] H. Grant: *Data Protection 1998-2008*, Computer Law & Security Review, Vol. 25, No. 1, January 2009, pp. 44-50, ISSN 0267-3649.
- [12] J. A. Pope, A. M. Lowen: *Marketing implications of privacy concerns in the US and Canada*, Direct Marketing: An International Journal, Vol. 3, No. 4, 2009, pp. 301-326, ISSN 1750-5933.
- [13] V. Senicar, B. Jerman-Blazic, T. Klobucar: *Privacy-Enhancing Technologies - approaches and development*, Computer Standards & Interfaces, Vol. 25, No. 2, 2003, pp. 147-158, ISSN 0920-5489.

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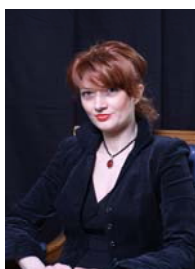
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MARKETING COMMUNICATIONS OF SMALL AND MEDIUM ENTERPRISES - A RESEARCH FROM THE CUSTOMERS PERSPECTIVE

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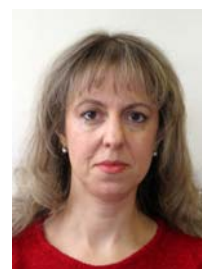
Key words: marketing communications, promotional tools, SMEs, Romania.



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Abstract: This paper aims to highlight some of the aspects regarding the marketing communications of SMEs in Romania, from the perspective of their clients. The research conducted on this purpose was intended to reflect the perceived utility of the communication techniques and tools for the companies that have relationships with SMEs on the Romanian market. The research results have revealed that the marketing communication tools used by SMEs are adapted to the characteristics of the client-companies (number of employees, annual turnover, type of capital, structure of marketing activity), but the most used tools are not always perceived as most useful from the customers point of view. The main conclusion of the research is that SMEs have to choose the most appropriate modalities of marketing communications, in order to be able to enhance their position on market, develop the relationships with their clients and gain a competitive advantage.

INTRODUCTION

EU official definition given to small and medium enterprises (SMEs) fall into this category all firms with fewer than 250 employees and operates independently of the major companies on the market, with a turnover of less than EUR 50 million or volume of the total assets of less than EUR 43 million [1].

The SME sector includes three types of enterprises [2]:

1. The category of micro, small and medium-sized enterprises (SMEs) is made up of enterprises which employs fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million.
2. Within the SME category, a small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million.
3. Within the SME category, a microenterprise is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million

A rapid assessment of the *scale of SMEs in the European Union* [3] shows that:

- in 2012 there were approximately 20 727 627 SMEs representing 99.8% of all businesses operating in the EU;
- SME sector has created 87 477 311 jobs and in some fields the specific weight of jobs created by SMEs exceeded 75%;
- average number of employees of an SME working in the non-financial business sector was 4.22. SMEs employed almost 90% of total employment in recycling sectors, motor vehicles and construction;
- SME sector generated EUR 3 587 540 million representing 58.1% of total value added in the EU and contributed over 80% of the value added economic sectors such as real estate transactions, recycling and construction while large enterprises have mattered over 90% in value added in post and telecommunications sectors, mining and production of tobacco products.

SME sector development in the European Union carries significant footprint of *rather reserved attitude of Europeans towards entrepreneurship*: given that for 58% of EU citizens idea of setting up a business was a rather unfamiliar, both present and prospects

associated SME sector is under a constraint which reduces or even eliminate constitute a challenge for the Union as a whole and for each State member. The fact that more than half of EU citizens prefer employee status of the entrepreneur, suggests the obvious limitations, given the attitudes of Europeans towards risk associated with setting up a small business, falling SME development [4].

The most important individual business constraint reported by European SMEs was the limited demand: 46% of the managers interviewed in the territory of the current European Union told that the limited purchasing power of their customers constituted a difficulty over the last two years. Beyond the constraint of a limited demand, two problem areas emerge as affecting most European businesses: the problems of stringent administrative regulations (over one third of SMEs claim to have faced difficulties in this area over the past two years, 36%) and the issues of the availability (35% report problems) and cost of appropriate human resources for the enterprise (33%). Other constraints and difficulties encountered in the last few years by the European SMEs refer to the: problems with infrastructure (e.g. roads, gas, electricity, communication, etc. – 23 %), limited access to finance (21 %), implementing new technology (17 %), implementing new forms of organization (16 %), and lack of quality management (11 %). [5]

The Europe 2020 Strategy set out the foundations for future growth and competitiveness of the SMEs sector considering a renewed vision and a number of actions to be taken at both EU and Member States' level to support entrepreneurship in Europe, based on three pillars: (1) developing entrepreneurial education and training to support growth and business creation (through increasing the prevalence and quality of entrepreneurial learning and higher education for entrepreneurship, (2) creating a right business environment through better access to finance, supporting new businesses in crucial phases of their lifecycle and help them grow, unleashing new business opportunities in the digital age, easier business transfers, turning failure into success: second chances for honest bankrupts, clarify and simplify the regulatory burden) and (3) role models and reaching out to specific groups (by seeing entrepreneurs as role models and reaching out to women, seniors, migrants, the unemployed, young people) [6].

RESEARCH METHODOLOGY

This research aimed to assess client (company) perceptions of marketing communication of small and medium enterprises collaborating with on Romanian market.

Research objectives

- Determining how is organized marketing activity in the client-company
- Identifying sources of information used by the client-company about collaborating SMEs
- Identifying techniques and tools used by SMEs, in communication with the client-company to promote products /services they offer
- Evaluation of these techniques and tools based on the perceived utility for the client-company
- Identification of interactive media used by SMEs in campaigns, to promote products / services
- Evaluation of these means of communication by the perceived utility for the client company.

The community studied is the client companies of SMEs in Romania. The observation unit is the company that works on the market in Romania and has buying-selling relationships with the Romanian small and medium enterprises. Information was collected through direct research type survey by interviewing that person in company who is management responsible for the relationship with business partners. Information gathering tool was a structured questionnaire containing five sections (corresponding to research objectives). The sample contains a total of 460 client-companies, structured according to the number of employees, annual turnover and type of capital. Thus, depending on the *number of employees*, the structure of the sample was: less than 9 employees : 44%, between 10 - 49 employees: 39% between 50-249 employees:: 13%, 250 and over: 4%. Sample structure according to *annual turnover* is: a turnover smaller than or equal with EUR 2 million: 83%, over EUR 2 million - EUR 10 million: 11%, over EUR 10 million - 50 million EUR: 3% and over EUR 50 million: 3%. Regarding the *type of capital*, the sample contains companies with Romanian capital, in proportion of 88%, 6% foreign owned and joint ventures 6%. Research was conducted in parallel with another study conducted among SMEs in Romania, within which was analyzed their marketing communication. Each SME included in this sample was asked to indicate five customers currently collaborating with these companies forming the present research sample.

ANALYSIS AND INTERPRETATION OF RESEARCH RESULTS

To more accurately describe the perception of client-companies on marketing communications of collaborators small and medium enterprises on Romanian market requires a more detailed knowledge of the respondents, not only in the classical features used in statistics (size of turnover, number of employees, ownership, type of capital, and so on) but also in terms of their **marketing activities**. So, asked if they have a specific structure of marketing, 72% of the participating companies said they do not have such a department. This variable affects the answers given in this research, as will be demonstrated during the analysis, basically there is a proper marketing department outlines some experience in the marketing of the company and the evaluation of such activities of the business partners.

A second objective of the research focused on the **sources of information** used by the client- company about collaborating SMEs, respondents were asked where they heard about them. As can be seen from Fig. 1, the main source of information is the offer of cooperation received from SMEs (53.9%), participation in special events (fairs, exhibitions, shows) having a relatively low percentage (14.5%). This result comes somewhat in contrast to marketing theory which recommends attending such events for companies targeting business to business market.

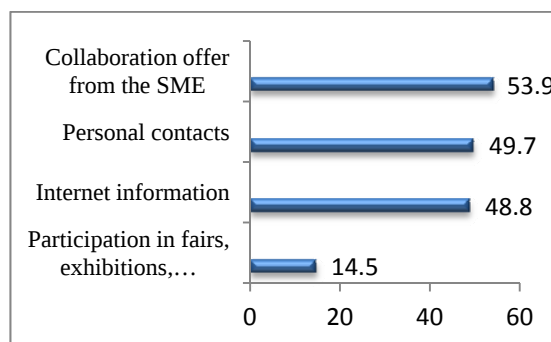


Fig.1. Sources of information used by the client-company regarding the SMEs collaborating with (%)

Modalities of contacting customers showed in the table above were analyzed in detail, in particular those relating to offers of cooperation and information from the Internet, in order to find the methods most commonly used by SMEs in their relationship with client-companies. The respondents said they had received offers of cooperation from SMEs through catalogs / presentation materials (61.8%) or through the Internet (52.7%).

In terms of information on the Internet, this is done most often by consulting websites (83%), followed by access databases (23.9%) and social networks (7.8%).

The next objective of the research was to identify the marketing techniques used by SMEs, in communication with the client company to promote products / services they offer. As can be seen from Fig. 2, although it is business to business market, all advertising is most commonly used, with a percentage of 87.2%, last hovering public relations, with only 33%.

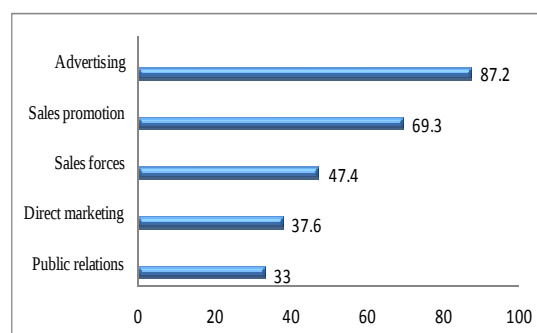


Fig.2. Communication techniques used by SMEs in relationships with their client-companies (%)

Each technique involves using a set of specific tools, so we wanted a breakdown in terms of the tools used for advertising, sales promotion and public relations.

Fig.3. shows the corresponding advertising tools, which are presented according to the frequency with which they were mentioned by respondents. It can be seen that the first are advertising catalogs, flyers and brochures, at a significant distance from the rest of the instruments.

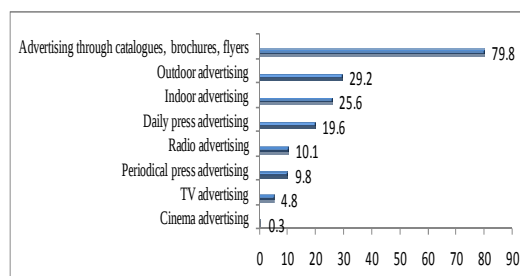


Fig.3. Advertising tools used by SMEs in relationships with client-companies (%)

Regarding specific sales promotion techniques, it can be observed that there is a tool significantly distanced from the others: discounts (see Table 1). The explanation for such a difference in the frequency of use of price reductions compared to other instruments refers to the elasticity of demand according to price, especially for this time of financial crisis.

Table 1. Sales promotion tools

Tools	%
Discounts	81.2
Promotional gifts	29.2
Point-of-sale advertising	27.3
Sampling, demonstration, free trials	21.6
Merchandising	4.4
Promotional contests or lotteries	2.2

As public relations technique, SMEs often use the participation in fairs, exhibitions or specialized salons instrument referred to by 75% of client companies participating in the research (see Table 2). The last places are media relations (the explanation being that such a tool is more effective, so it is often used in relation to SMEs media) and sponsorship (which is the ultimate target audience rather customers - individuals, not companies).

Table 2. Public relations tools

Tools	%
Participation in exhibitions, fairs and specialized salons	75.0
Special events	33.6
Relations with mass-media	27.3
Sponsorship and mecenate	21.6

Further, the research aimed to identify the utility perceived by client-companies related to communication techniques used by SMEs, so the research participants were asked to give a mark on a scale from 1-10, where 10 means maximum utility. As can be seen in Fig. 4 most appreciated technique in terms of utility is communicating through sales forces, the explanation being that the business to business market is huge emphasis on direct dialogue between the participants in the act of sale. The lowest mean score was obtained by advertisement (7.69), which is actually quite logical, considering the fact that marketing theory states that advertising is more suitable for business to consumer market, where that the utility business to business market is lower.

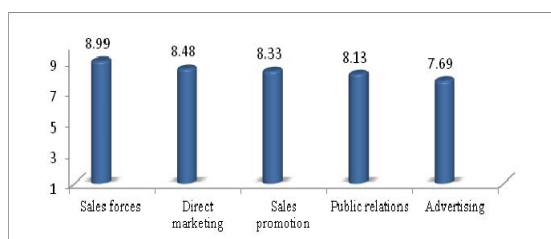


Fig.4. Utility of marketing communications techniques used by SMEs (measured on a 1-10 scale, 10 representing the maximum utility)

Within each technique was evaluated also the utility of communication tools so that will be presented further notes provided by the client - companies for specific advertising and sales promotion tools.

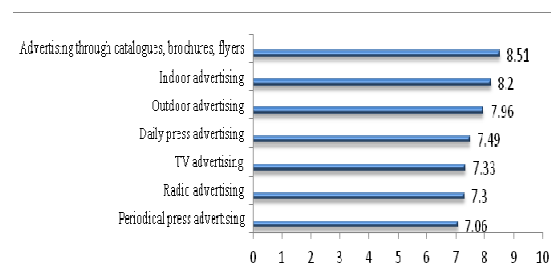


Fig.5. Utility of marketing communications tools specific to advertising (measured on a 1-10 scale, 10 being the maximum utility)

As marketing theory mentions the most useful form of advertising for business to business market is through catalogs, flyers and brochures through which is sent a direct message to the target audience, such means of communication allowing a detailed presentation of the company, and products / services. Coming in last fall TV advertising, radio and the press, they are rather mass media for business to consumer market when it wants to communicate with a large number of individual consumers

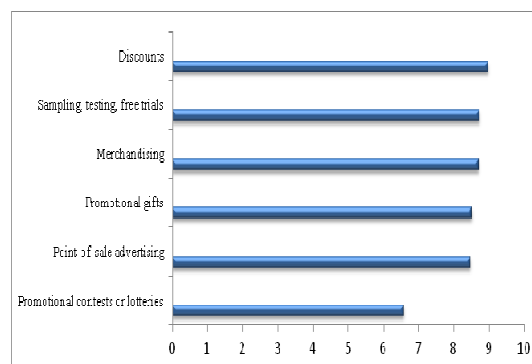


Fig.6. Utility of marketing communications tools specific to sales promotion (measured on a 1-10 scale, 10 being the maximum utility)

Given the elasticity of demand according to price and interest of the companies to reduce costs in times of crisis, it is normal discounts to be regarded as the most useful form of sales promotion. This is followed by distribution of samples, tastings, demonstrations and free trials - instruments through which SMEs out their products and services among the target audience. The least appreciated from the utility point of view is the promotional contest, which is more effective on business to consumer market.

Realizing an overview of the perception of the SMEs marketing communication from the perspective of client companies, it can be concluded that the most popular are forces sale, price reductions and distribution of free samples. At the opposite pole are advertising (TV, radio and print media), promotional contests and lotteries.

In order to complete the communication marketing strategy, in addition to the techniques and tools, it is necessary to establish appropriate communication means for both the sender of the message and its receptor. Thus another objective of the present research was to identify the interactive media used by SMEs in campaigns to promote products / services. For an analysis of the most relevant, research focused separately on types of communication campaigns - advertising, public relations and direct marketing.

Table 3. Interactive media used by SMEs in relation to client-companies (%)

Interactive media	Type of campaigns		
	Advertising	Public relations	Direct marketing
Video-conferences	-	2.4	0.8
Interactive TV	3.5	4.2	1.1
Mobile phone	34.0	59.5	55.7
Internet	83.2	64.9	83.7
Blogs	6.6	13.1	6.1
Social networks	9.4	18.5	8.7

From Table. 3 is observed that the Internet is the most widely used interactive media, the difference from other means being significant for advertising campaigns. However in public relations campaigns the mobile telephony was mentioned with a high enough frequency by respondents. With regard to communication via social networks, can be observed that these are best suited for public relations campaigns (18.5%), which applies also to blogs (13.1%).

Following correlations made with the main characteristics of the client companies were obtained the following information:

a) In advertising companies

The choice of media used by SMEs in their relationship with client companies is influenced by the size of the client, so that the mobile phone is used more for small businesses, while the share of Internet usage and blogs increases with company size-client (from 82.3% to 100% for small businesses to large companies, where the Internet and from 4.4% to 14.3% for blogs).

Also in advertising campaigns, social networks are used more in relation to client companies that have a specific structure of marketing (15.5%) compared to firms that do not have a marketing department (7.1%).

b) In public relations campaigns

Although the advertising campaigns, mobile telephony was mostly used in small-client relationship with the companies, the situation is opposite in public relations campaigns where with increasing size of the client company grow and share the use of this means of communication in marketing (from 55.4% to 80% for small businesses to large companies).

Internet and blogs retain the same increasing trend with increasing size of the client- company also in public relations campaigns.

c) In direct marketing campaigns

The mobile phone is used more in public relations with client companies, while the Internet is used more in relation to the private (75% versus 54.4% for mobile and 75% compared to 84.5% for the Internet, public company versus a private company).

Regarding the correlation with the size of the client company, retained the same relationships identified for public relations campaigns - with increasing size of the company increases the percentage of those who use the Internet and mobile phone.

A final objective of the research took into account an evaluation of client-companies regarding **utility of interactive media** used by SMEs in Romania. Thus respondents were asked to evaluate the utility on a scale from 1-10, where 10 means maximum utility in relation to SME. A relevant analysis of these media has to be made separately for each type of communication campaign, in order to identify appropriate means for each technique implemented.

Table 4. Evaluation of interactive media utility depending on communication campaign type (on a 1-10 scale, 10 representing maximum utility)

Interactive media	Type of campaigns		
	Advertising	Public relations	Direct marketing
Video-conferences	-	7.75	8.50
Interactive TV	8.88	9.00	8.00
Mobile phone	8.50	8.62	8.91
Internet	8.73	8.47	8.68
Blogs	8.24	8.33	8.75
Social networks	8.33	7.86	8.09

From Table 4, we observe that the most useful advertising campaigns means of interactive communication is interactive television (8.88), closely followed by Internet (8.73). All interactive television is first and for public relations campaigns (9.00), but the second we find mobile phone (8.62). Moreover, this mode of interactive communication is considered to be the most useful for direct marketing campaigns (8.91), followed by blogs (8.75).

CONCLUSIONS

Under conditions of limited resources requires management of production processes in a long-term perspective, to ensure

harmonization between the economic interests of organizations, interests of customers / consumers and the overall interests of society. Large companies may consider a higher extent these concerns, given their potential. For SMEs it is more difficult to implement traditional marketing and communication policies, the fact that some tools used for this purpose are not suitable to their resources and capabilities.

The research results reveal that there are some differences between communication techniques used by SMEs and utility perceived by client- companies. Thus, although advertising is used mostly as a way of communicating to SME client companies, these rank last the advertising in terms of utility, considering as the most efficient communication through sales forces. In terms of sales promotion, its usefulness is assessed differently, depending on the instruments used. While the discounts and samples are considered useful, promotional contest and lotteries are perceived as having a low utility. Also, analyzing interactive media used by SMEs in dealing with client companies reveals that the Internet is used predominantly, although in terms of client companies a high utility of interactive television is provided followed, depending on type of campaign communication, by Internet, mobile phone or blogs.

Therefore, the choice of marketing communication techniques and tools used by SMEs should take into account the specific of business-to-business market and should be based on the knowledge of the opinions and perceptions of client-companies regarding the utility of different communication ways.

Given that marketing communications is one of the keys to creating and developing relationships with client companies, SMEs need to consider integrating communication efforts in order to maintain themselves on a market driven by information and oriented to interactive customers.

REFERENCES

- [1].European Commission, *What is an SME?*, available at http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index_en.htm, downloaded June 28, 2013.
- [2].European Commission, *Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises*, Official Journal of European Union, L124/36, May 20, 2003, available at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:124:0036:041:EN:PDF>, downloaded June 28, 2013.
- [3].Ecorys, *EU SMEs in 2012: at the crossroads. Annual report on small and medium-sized enterprises in the EU 2011/12*, available at http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/files/supporting_documents/2012/annual-report_en.pdf, downloaded June 28, 2013.
- [4].European Commission (2012), *Entrepreneurship in EU and beyond. Report*, available at http://ec.europa.eu/public_opinion/flash/fl_354_en.pdf, downloaded June 28, 2013.
- [5].The Gallup Organization (2007), *Observatory of European SMEs Analytical report Flash EB No 196 – Observatory of European SMEs*, available at http://ec.europa.eu/enterprise/policies/sme/files/analysis/doc/2007/03_analytical_report_en.pdf, downloaded June 28, 2013.
- [6].European Commission (2013), *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Entrepreneurship 2020 Action Plan: Reigniting the entrepreneurial spirit in Europe*, available at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0795:FIN:EN:PDF>, downloaded June 28, 2013.

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RESEARCH ON EMPLOYERS' NEEDS REGARDING ECONOMIC GRADUATES' COMPETENCIES - PILOT STUDY FOR METHODOLOGY ADJUSTMENT

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Key words: educational marketing, graduates' competencies, employers needs

Abstract: *The higher education institutions, which are more and more characterized by a stronger competition, must learn to apply scientific management and marketing principles, in order to enhance their competitiveness. Students, on the one hand, and employers, on the other hand, have increasing expectations in terms of learning outcomes. This paper aims to present a pilot-study, conducted to assess the willingness of employers to engage in a long term relationship with the universities in order to express their views on the competencies provided to graduates by study programs in economics. In addition, this pilot-study seeks to adjust the methodology of a complex research that universities in the economic field must conduct to identify the employers' needs and expectations on the issues that define the learning outcomes.*



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INTRODUCTION

Educational and labour reform on the Romanian market, in line with the Lisbon Strategy and the Bologna Process, involves restructuring and improvement of the higher education system. This process is achieved through the development and implementation of a system that allows improvement of the academic management and of the quality of the academic educational offer of the Romanian economics education institutions in terms of adapting to the changing demands of the labour market.

Thus, there is mandatory a complex research that will produce that information on which we can analyze and redefine the academic curriculum in accordance with the requirements of the labour market in order to improve the quality of university programs and to harmonize the higher education qualifications with labour market requirements.

The universities in the economic field are important providers of workforce for many employers. Therefore, the point of view of the latter is important. Harmonization of the academic education offer in relation to labour market requirements is not possible without detailed knowledge of the employers' expectations.

As the qualifications are the official recognition (by a study document that gives legal right to practice a profession) of the individual learning outcomes value, we aim to find employers' views on the issues that define these results: knowledge, skills and attitudes of higher education graduates.

LITERATURE REVIEW

One of the most important goals of higher education and higher education institutions is to prepare graduates for employment after graduation. In order to achieve this goal, the higher education learning institutions have to provide them with the competencies that the organizations require. Some researchers are interested in determining the congruence among the competencies considered essentials for successful managers by business organizations and the competencies considered important by business schools for their graduates. These researchers [1] identify significant discrepancies between the competencies that business units value and those that business-schools curricula emphasize.

In the past (the two last decades of 20th century), some authors considered that business school graduates were not very well prepared for employment [2] and others expressed the opinion that there was little evidence on the relationship between courses taken in high school and labor market outcomes, even critics of the curriculum of American high schools often asserted that high school programs left students poorly prepared for the labor market [3]. In this context, it can be observed the interest in defining degree program curriculum in aligning with the knowledge and job skills by sharing information and a close collaboration with employers [4]. At

the same time, Chapman and Randall [5] analyse the theories related to the curriculum design process (Learning Theory & Mezirow's Transformative Model, Adaptive Leadership Theory) and propose a new curriculum design process, which assists in the transformation of faculty perspectives on how to create a business education, in order to develop flexible and creative professionals.

Daud, Abidin, Sapuan, and Rajadurai [6] investigate the potential gap between important dimensions of business graduates' attributes and the actual performance of these graduates in their post-graduate employment. The results of the study reveal that is impetuously necessary "to enhance the quality of the curriculum and to make it relevant to the needs of the market industry". Increasing HE's competitiveness by improving the quality of study programs is important both for higher education service providers and stakeholders. Stimac and Simic [7] discussed some definitions of education quality, such as "a continuous process of fulfillment of set education standards" (Ivosevic, et al., 2006), or "evaluation of the process of education shown through process of improving educational development of beneficiaries... in order to reach the set goals" (Barnett, 1992). In order to increase the quality of educational programs and to create a competitive market position for a higher education institution, the authors consider that it is necessary to adopt a marketing approach and create strategies and activities in terms of market performance.

Many researchers have tried to put into perspective the usual practices of managing higher education marketing, in order to move away from education as per supply to education as per demand. From the marketing approach, they have identified research-based planning and program development, relationship marketing and non-traditional methods for education delivery as key areas for future focus [8].

Romanian higher institutions must be market oriented, to a greater extent. In order to improve the quality of services, marketing becomes a necessity, and the existence of a marketing department in every school may be desirable for enhanced market-orientation of HE programs [9].

THE RESEARCH PROPOSAL

Thus, to identify the needs and expectations of employers in relation to skills, knowledge and attitudes of the Romanian higher education graduates will be considered within the following research.

The objectives for the further research are:

1. Identifying the preferences of employers for the type of studies required for employment in entry-level position and management position, which requires higher education in Economics: do the employers prefer to hire graduates of specialization required by the job, graduates of higher economics education, regardless the discipline or university graduated, or graduates of higher education regardless the field.

2. Identifying the employers' preferences on the experience required for employment in a job that requires higher education in Economics, an entry level position: do the employers prefer to hire graduates without experience, to be formed in the company, graduates with experience, but not necessarily in a similar position, or graduates with experience in a similar position.

3. Identifying the employers' preferences on the studies required for employment in a job that requires higher education in Economics, an entry level position: are preferred Bachelor graduates, Master graduates or Ph.D. in Economics.

4. Identifying the employers' preferences on the studies required for employment in a job that requires higher education in Economics, in a different position from than entry level: are preferred are preferred Bachelor graduates, Master graduates or Ph.D. in Economics.

5. Determining how important are considered the criteria which define attitude when is assessed a graduate degree in Economics, to be hired for a job that requires economic specialization on an execution position: self awareness of strengths and weaknesses; self awareness of emotions; the ability to cope effectively with stress and frustration; flexibility and willingness to adapt to change; capacity for self-assessment; self confidence; the need for personal development; active listening / intellectual curiosity; ability to handle extreme situations; team spirit; spirit of observation; sense of initiative; sociability; creativity; analytical thinking; ethical behaviour from professional point of view; responsible behaviour from professional point of view; willing to develop himself from professional point of view.

6. Identifying employers' opinions on the usefulness of knowledge and skills that should prove the graduates of higher education in Economics, as formulated in RNCIS:

- o Knowledge and understanding of the basic concepts and methods of the specialization field, appropriate usage in professional communication
- o Usage of the basic knowledge for explanation and interpretation of various types of concepts, situations, processes, projects, etc. associated to the that field
- o Application of basic principles and methods for problem solving / well defined situations typical for the domain in the context of expert assistance
- o Appropriate use of standard assessment criteria and methods to assess the quality, the merits and the limitations of processes, programs, projects, concepts, methods and theories
- o Elaborate professional projects using principles and methods established in the field

7. Identification of also other types of knowledge and skills that meet the expectations and needs of employers in relation to employees with higher education in Economics

8. Determine the employers' opinion on the existing differences between the real needs of the organization and training offered to students of universities / Economics faculties, in terms of skills and competencies required for a position:

8.1 identify the differences between the real needs of the organization and training offered to students of universities / Economics faculties, in terms of skills and abilities

8.2 Collecting the employers' opinion on the deficiencies arising from these differences

9. Determining how often are found in the organizational structure of the employers the jobs specific to areas of Economics graduated.

10. Identify occupations, which according to employers, should be reflected in the organizational structure of their organization, but there are not in COR

11. Determining whether employers take in account the professional competencies specific to Economics specialization, when evaluate a candidate for a job (for each economic area).

12. Identification of minimum performance standards used to assess skills that employers use in the employees' evaluation process (for each economic area).

Getting information necessary to achieve the objectives outlined above involves a complex process in which has to be engaged both, the academic environment and employers. In order to collect this information, it will be necessary to conduct a research using both qualitative and quantitative methods.

Thus, it is expected, in a first stage, a pilot study to check the functioning of the relationship between academic and business environment to learn the employers' opinions on the proposed project, to determine their willingness to be involved in a short, medium and long term relationship with the academic environment. However, based on the information obtained from the pilot study the methodology will be refined and the research and information gathering tools will be improved.

Pilot-study methodology

In order to achieve the proposed research's objectives, as defined in the previous step, a pilot study was conducted which focused on the following aspects:

- Evaluation of the functioning way of the relationship between academic and business environment
- Identify the employers' point of view, on the proposed project (survey to identify labour market's needs regarding the skills and qualifications of Economics higher education graduates)
- Establish the employers' availability to enter into a short, medium and long-term relationship with the academic environment
- Testing the methodology of gathering information and identifying issues to be improved

For this reason, the pilot study involved a qualitative research investigation, by making a total of 9 in-depth interviews with members of the management team of companies operating on the Romanian market, involved in the evaluation process of candidates for a job that requires Economics higher education.

In-depth interviews were semi-guided type, and the discussions were on the following topics:

- i. The relationship between the academic and business environment
- ii. The importance and usefulness of the research project from the employers' perspective
- iii. The ability to establish a short, medium and long term relationship between business and academic environment
- iv. Opinion on the proposed information collection methodology

Research results

The discussions results were the following:

I. The relationship between the academic and business environment

Interviewees were responsive to the request to be involved in research. Everyone we talked to believes it is necessary to strengthen the relationship between academic and business environment. The relationship between universities and employers may be a good starting point in this process, but it is necessary to formalize these through partnership agreements in order to ensure a coherent functioning of this relationship.

II. The importance and usefulness of the research project from the perspective of employers

Since the research project is important in the process to restructure and improve the Economics higher education, to improve the quality of Romanian Economics higher education institutions' offers order to adapt to market demands, respondents considered it very useful.

"I'm so glad you took this initiative and I consider it a good one, especially if it will follow some changes. I think it needs some fine tuning so that the things to get better, and better. I hope my feedback is constructive." (hospitality entrepreneur with experience in human resources, management, banking).

According to employers, students lack contact with reality, student practical work should be much better put together - for example, one respondent suggested placing freshman in practice from the first year of Master Study Programs (multinational human resources director) and the content of courses and exams requirements should consider more the aspects that have practical utility. Since the project aims to identify employers' view on the issues that define individual learning outcomes, namely knowledge and skills of graduates, in order to harmonize the educational offer in relation to labour market requirements, it is perceived as being extremely useful.

III. The ability to establish a relationship short, medium and long between business and academic environment

Everyone we talked to expressed their willingness to be involved in restructuring and improving process of the Economics higher education system, considering the need for greater harmonization between business and academic environment.

Those interviewed were all agreed that adapting educational offer to the labour market depends on the thoroughness and consistency with which employers are involved in this process, but also on the availability of academic environment, management structures and the teachers, to adapt to the labour market, and on the availability on the employers' proposals.

"...Should be better anchored in the reality of practice" (multinational human resources director)
There are also a number of barriers that affect this relationship: when and how the academic environment relates to academic business.

"... would have much to discuss, but I have great time limitations" (head of department, a multinational)
"... presentation is done with a heavy language and misfit to the everyday realities, to practice." (department manager, national company).

IV. Opinion on the proposed information collection methodology

Following discussions with respondents revealed the following aspects:

- o The time needed to fill a questionnaire is too long. Respondents consider that a period of no more than 20-30 minutes would be reasonable
"I think a request for time exceeding 20-30 minutes cannot be considered realistic for completing the questionnaire" (multinational human resources director)
"I believe the period is too long. Of all the questions, last question it took six minutes, following Business Administration section" (hospitality entrepreneur with experience in human resources, management, banking)
- o It is recommended to inform respondents about the time needed to fill in the questionnaire

It would be better to know from the beginning what amount of time you should allocate to fill in the questionnaire. "(Manager SME)

- o **The questionnaire is very long** and has many overlaps between fields. Respondents suggested restructuring its on fields - each field to match a specific questionnaire and to be filled in by those who lead the departments that employ graduates of those specific fields.

"Frankly speaking, I was quite scared by the questionnaire's dimension" (multinational human resources director)

"The questionnaire is very long (...). I suggest breaking it in sub-questionnaires specific to different types of departments and to be effectively targeted to those who run these departments." (Head of department, national company)

"I see overlaps between the fields presented and it is difficult to understand the logic" (head of department, a multinational)

"I think this questionnaire should be filled in from the very beginning on specializations. Once the questionnaire is addressed on specializations subsequent breakdown should be done on sub-specializations." (Hospitality entrepreneur with experience in human resources, management, banking)

- o **It is recommended, as much as possible, to be taken out the open questions** and to replace them with mixed questions to facilitate both the questionnaire's filling in and the information analysis
- o **The job title of COR does not meet often with the names used in practice** and it can be a problem for those who fill in the questionnaire if the person is not familiar with the terminology of the COR.

"I know it's the official nomenclature legal and mentioned in the labour books. This is not the one used in everyday life in the organization and although it would seem logical that the HR department to know this nomenclature is not the case (...). That is likely to scare the person who has to fill in the questionnaire" (multinational human resources director)

"Jobs names from various departments does not exist in the nomenclature" (department director, national company)

- o **Some standard are missing from COR**, which is why it is recommended this to be adjust

"Occupations from COR are not complete and does not meet the situation in practice" (manager SME)

"Standards jobs are missing from the list and these should be included in the COR" (head of department, a multinational)

- o **It is recommended to review the job's competencies**, as the current wording is clumsy, sometimes far from the terminology used in practice

"It is obvious that the wording is a pedagogical one and some wording does not reflect what is practically real" (department director, national company)

"It would be better to consider revising some wording in accordance with the terminology used in practice" (head of department, SME)

"The competencies are too theoretical; I think it should be slightly reformulated at each I sat thinking about what they really want to say" (hospitality entrepreneur with experience in human resources, management, banking)

- o **one the question** "When evaluating a graduate degree in Economics, to be hired on a job that requires Economics studies - an entry-level position, how much do you relate to the following criteria" should be eliminated certain skills that are not specific to an entry level job.

"Issues such as the ability to handle extreme situations, the ability to mitigate conflicts, organizational skills and strategic thinking are specific to management positions, and their presence is not justified in this context" (Manager, SME)

- o **one the question** "When evaluating a graduate degree in Economics, to be hired on a job that requires Economics studies - an entry-level position, how much do you relate to the following criteria", **the criterion "emotional intelligence" may not be well understood by all respondents**, which could lead to irrelevant results

CONCLUSIONS

Investigations made during the pilot study allowed essentially the following conclusions:

- Although there are, at this point, partnerships between universities and companies, these do not assure in a satisfactory proportion, the adaptation of the educational offer to labour market requirements;
- Employers are receptive on university's proposals regarding the restructuring and improvement of Romanian Economics higher education system, agreeing that it is important to be involved in this process. However, solutions must be found to mitigate the effects of the factors identified as brakes in developing long-term relationships between business and academic environment: on the one hand, the time - people who would be involved in this relationship having management positions in the companies in which they work, and thus having many responsibilities, on the other hand the ability and willingness of employers integration proposals.

- The research proposed to be done with the purpose to identify employers' needs and expectations related to knowledge, skills and attitudes of the Economics higher education graduates is viable and can generate interesting and useful results from the project's perspective. It is important, however, based on information obtained from qualitative research, to achieve some methodological adjustments.

Adjustment methodology for gathering information based on the results of the pilot study:

I. **Concerning the research objectives** will be addressed the following issues:

1. Since the purpose of the research is to identify employers' needs and expectations related to skills, knowledge, skills and attitudes of the Economics higher education graduates were worded again / removed the objectives related to a management position
2. Objective number 7 has been removed ("Identification of also other types of knowledge and skills that meet the expectations and needs of employers in relation to employees with higher education in Economics") since part of the answers to the question corresponding to this objective is not different from some of the criteria in question 5, and others are among the skills specific to each field.
3. It is necessary to redefine objective no. 10 ("Identify occupations, which according to employers, should be reflected in the organizational structure of their organization, but not in COR") taking in account that:

- the majority of respondents did not answer to the question relevant for this objective;
- the main problem for employers, from this point of view, is determined by the fact that, in the COR are mentioned occupations

and these names are used in practice, being necessary a harmonization between these two.

Therefore, the objective no. 10 will be to identify, where applicable, the names of occupations used in practice and their correspondence in the COR.

II. Since variable "Emotional Intelligence" may cause difficulties both in terms of understanding (being the rather unclear from the conceptual point of view, for some respondents), and in terms of a response indicating how much the respondents take in account the emotional intelligence as a criterion for assessing candidates on a post, it was decided to use the descriptors of the concept (its detailing was done according www.inteligenta-emotionala.ro): self awareness of strengths and weaknesses; self awareness of emotions; the ability to cope effectively with stress and frustration; flexibility and willingness to adapt to change; capacity for self-evaluation; self-confidence; personal development needs; active listening;

III. **Proposed changes in the research objectives will be reflected in the questions in the questionnaire**

IV. **Administration of the questionnaire will be made on domains and sub-domains** where is the case to facilitate its filling in and to reduce the time that the respondents should allocate to this activity.

V. **Respondents will be informed at the beginning, which is the duration of filling in the questionnaire**

REFERENCES

- [1]. S. E. Abraham, L. A. Karns, *Do Business Schools Value the Competencies That Businesses Value*, Journal of Education for Business, July/August 2009, pp. 350-356, ISSN 0883-2323
- [2]. L. W. Porter, L. E. McKibbin, *Management Education and Development: Drift or Thrust into the 21st Century*, McGraw-Hill, ISBN 0-07-050521-7, New York, 1988

[3] J. S. Altonji, *The Effects of High School Curriculum on Education and Labor Market Outcomes*, The Journal of Human Resources; summer 1995; 30, 3, pp. 409-438, ISSN 1548-8004

[4] D. Ang, T. Griffin, *Supply Chain Management for Higher Education*, The Business Review, Cambridge, Vol. 11, Num. 2, December, 2008, pp 28-33, ISSN 2167-0803

[5] S. A. Chapman, L. Randall, *A New Process Model for Curriculum Development in Business Education*, The Business Review, Cambridge, Vol. 20, Num. 1, Summer, 2012, pp. 9-16, ISSN 2167-0803

[6]. S. Daud, N. Abidin, N. M. Sapuan, J. Rajadurai, *Enhancing University Business Curriculum Using an Importance-Performance Approach.*, International Journal of Educational Management, Vol. 25 No. 6, 2011, pp. 545-569, ISSN 0951-354X

[7] H. Štimac, M. L. Šimić, *Competitiveness in Higher Education: a Need for Marketing Orientation and Service Quality*, Economics & Sociology, Vol. 5, No 2, 2012, pp.23-34, ISSN 2071-789X

[8] V. Umashankar, *The importance of managing points-of-marketing in marketing higher education programmes – some conclusions*, Journal of Services Research, Volume 1, Number 1, April-September, 2001, pp.125-140, ISSN 0972-4702

[9] I. Dumitru, *The Influence of Graduates Professional Experience over General Business Perception*, Metalurgia International, Vol. XVIII (2013), Special Issue no. 7, pp. 165- 167, ISSN 1582-2214

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Errata

In the Metalurgia International magazine no. 9-2013, page 256 in the article „THE ROLE OF PREVENTION AND PRECAUTIONARY PRINCIPLES IN REDUCING THE WASTE MANAGEMENT PROBLEMS LINKED TO HEAVY METALS: DIRECTIVE 2002/95/EC,, the corect order of the authors is: Ruxandra Malina PETRESCU-MAG^{1,2} and Ioan Valentin PETRESCU-MAG^{2,3}, instead of Ioan Valentin PETRESCU-MAG^{2,3}, and Ruxandra Malina PETRESCU-MAG^{1,2}.

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