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Improvement of Product Development Studies in Serbia and Bosnia and Herzegovina

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WP 1.1

Required competences and learning outcomes of curriculums in field of Management of Product Development, Innovations management, Eco-product Development, and Industrial Product Development

REPORT

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1. CHANGES AND CHALLENGES THAT ARE SHAPING FUTURE SOCIETY

Our civilization owes its present appearance to advances in technology and engineering capabilities to allow the application of technical achievements in different spheres of social life. Relying on scientific knowledge and recognizing the needs of society, Engineers have shaped the world we live in and enable the continued progress of science and society, relying on scientific knowledge and recognizing the needs of society.

Growth of human population and fast connections between people, cause the world to become more and more global village. In such society knowledge is the most important resource, because processes in human interaction rely on upon the information and abilities dependent upon learning. This kind of society can be identified as “knowledge society” in which the most important tasks are: problem identification, problem solving and exchange of ideas.

Having this in mind, one of the imperative task in future will be on first place for engineers, where they will help to the society by adjusting new developed technologies to the current needs. In addition, it is important to distinguish the patterns that overwhelmingly shape future social order, politic, nature's domain, engineering and business sector.

Basic changies and megatrends in future social order:

1. Globalization - the formation of a monetary, political and social space on the planet where individuals, plans, merchandise and capital are allowed to course. Globalization happens for a long time; however its full extension encountered the appearance of the Internet. The introduction of advanced data technologies in wide service have shortened span of the cycle in trade, banking and production.
2. Global human population growth is around 81 million annually, or 1.2% per year. Expectations are that growing will continue and reach 11 billion by the end of the century. This growth cause transition that is extremely troublesome to track in light of the fact that exceptionally fast changes occur.
3. Preservation of harmony between humans and the environment. Catastrophes in the recent 10 years (an Earth-wide temperature boost, environmental change, rapidly spreading conflagrations, and seismic tremors, quick annihilation of plant and creature species) caused that the predominant force that shape what's to come, become the need for sustainable development. A responsibility to resist the domination of nature must be established.

The influence of the aforementioned megatrends are reflected in:

- Dramatically expanded dependency of "all against all";
- Increasing mobility and migration of the population;
- Individualization of lifestyles;
- Easier access to knowledge;
- Reducing boundaries to get into new jobs;
- Increased rivalry;
- Search for talent everywhere.

Negative trends of development of society:

- Irrational utilization as model of lifestyle in "developed countries". It is likely that if all the individuals on the planet live on this model, the Earth should expand by 40-60 times.
- Waste and inability to recycling. The rate of items that cannot be recycled is increasing. Around the urban communities on the planet piles of waste are rising. Our civilization has become a "civilization of garbage".
- Unlimited right to compensation. The aggregate worth of all shares on the planet is limited. This causes the illusion of unlimited growth of money, regardless of the value on the planet. Result is the worldwide budgetary crisis.

It is expected that in the next 5-6 years, society will be overwhelmed by knowledge, exceptional mobility and competitiveness. Knowledge is the only resource that is expanding by its utilizing. Main problem which arises is how to save and secure knowledge because of its quickly losing value in the business sector. On the one hand knowledge is increasing very fast. On the other hand it gets out of date also very fast.

2. SITUATION IN SERBIA AND BOSNIA AND HERZEGOVINA

Since the business environment in Serbia and Bosnia and Herzegovina is currently very unfavorable (for Serbia: unemployment rate 24.1; GDP per capita $ 7,375, employed in industry only 27.2% of all, etc.), there is no institutional approach to the development of new products and innovation management in the companies.

After a significant decline of industrial production in Serbia and Bosnia and Herzegovina in the last decade of 20th century (war in the former Yugoslavia, economic sanctions, etc.), there was no recovery because it appeared that the privatization process has not been completed up to now and the largest number of domestic companies in the process of privatization was brought in the very bad condition, so that privatization is terminated. Such companies are currently in the restructuring process and they wait for the new privatization and mainly deal with current bussines and current existential problems. Faculties of Mechanical Engineering has a long-standing relationships with these companies, but this process which takes two decades has created a state of inertia towards product development activities, so that a questionaries in these companies get personal opinions of selected individuals.

With regard to the relationship with our inquiries and very low current cooperation Faculties of Mechanical Engineering with them, eminent international companies have opened their factory in this region but they are not interested in new products developing in its factories in Serbia or Bosnia and Herzegovina.

We have recognized the optimistic and constructive opinions on the issues of product development and innovation management in small enterprises that are in close cooperation with the Faculties of Mechanical Engineering, but they also dont have systematic approuch in product development.

3. Description of general and subject-specific competencies of students

Students who complete graduate studies in field of Management of Product Development and Innovations management, Eco-product Development and Industrial Product Development become masters - experts who are trained to use modern scientific achievements in the field of product development and innovation management.

Graduate professionals of this study program can be employed in various industrial fields and in all areas where the skills of industrial product development and innovation management are needed. The graduates in this field can participate in the processes of product development such as: project planning, profile detection, idea detection, modeling of principle solution and embodiment, validation, production system engineering, production, market launch, analysis of utilization and analysis of decommission.

Modern trends and future technology make the product development process more complex. New approaches in the development of products outside the frame of traditional engineering disciplines and require an interdisciplinary approach to the development process. Interdisciplinary nature of the process of new product development requires a change in the system, methods, and educating of staff in the area of product development.

In addition to changes in the process of product development, the fact is that there is a large deficit in the general engineering education which has the effect that students after graduation can not be fitted in a real industrial process. The main reason for this not fitting is the inability of participants to transfer theoretical knowledge acquired during their studies into practice. Completed studies have shown that graduates have a very good professional and methodical competence, but their ability to elaborate, creative potential and social competence are unsatisfactory. Only 30% of engineers (Figure 2) are able to fully apply their knowledge in practice.

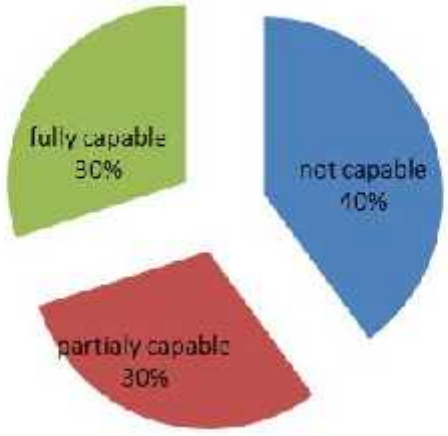

Figure 2: Ablity to applay knowledge of graduated

Over the last ten years, the world's leading universities have completely redefined the educational process in the above areas, in order to improve the above mentioned missing key competencies. In addition to changes in the curriculum, to enhance the interdisciplinary knowledge, has been changed the organization and methodology of the educational process. In addition to traditional lectures and exercises in which students gain knowledge of the process, the process of education introduced the team work on development projects, to expand the portfolio of available knowledge and competencies, and increased core competency of students in terms of social interaction and the

ability elaboration. This combination of experience gained while working on a development project in the area of education and scratched aims to encourage students to integrate their intuitive and analytical skills so as to enhance their creative potential.

In the future, the work of engineers will be multidisciplinary and interdisciplinary. It will include the complete product life cycle, from the product idea, through its concretization through development of specific innovative products, manufacturing, distribution, exploitation and finally recycling. The engineers must be able to create a new or improve existing products, through creativity, innovation and fascinating technologies and place it on the market. For the realization of these tasks engineers must have the knowledge of available technologies for successful creation and development of products, taking into account the available material and energy resources and environmental protection.

Because of this, engineers must expand their professional competence in the field of economy, work processes and quality assurance. In the frame of this interdisciplinary and partial work processes the additional qualifications in cooperative social behaviour with management and communication skills are required. This of course requires the development and implementation of relevant plans and programs in the field of education.

Engineers in the development must have the wide knowledge and be oriented towards the products and the processes.

Orientation to the products means comprehensive education of the engineers in the field of sciences and engineering to create new or further development of existing technical products. This primarily applies to activities related to defining the product profile, finding the physical effects for definition of the product concept, design, calculation, sizing, modelling and simulation of mechanical, pneumatic, hydraulic, regulation and control system components, as well as the development and testing of prototypes.

These include activities related to knowledge about other areas of the company, such as purchasing, sales, production, collaboration with customers and manufacturers.

Orientation to the processes means education in the field of methods, systems and management. This is primarily related to the introduction, further development and learning of methods and systems for support of all the above activities, as well as planning and management of development projects, both as a collaborator on the project management and as a project manager.

Special attention in engineering education should be given to education and practical application in the field of modelling and simulation techniques, because of paradigm changes on which the product design process is based. The traditional design process implies that the designer defines the preconditions of loads and boundary conditions corresponding to real conditions of exploitation. Defining these assumptions is a very complicated task because the conditions of exploitation in many situations are stochastic. Definition of boundary conditions is also very complicated task because one product is used in a variety of conditions (geographical, meteorological, et al.). Based on these assumptions stress and strain calculations are done (analytical or numerical), the product design is checked and selection of material from which the product is made is performed. The success of the procedure depends largely on the accuracy of the assumptions and the proper definition of the boundary conditions, and also on the applied calculation methods, which are often

empirical.

High integration of multiphysical software tools for modelling and simulation of the behaviour of the product in exploitation, and a substantial increase in processing capabilities of modern computer systems, have enabled that the design process in the product development is based on the simulation of realistic loads and boundary conditions, that is the real physics of the product. Above approach significantly increases the quality and reliability of products.

Special attention in education should be paid to the innovation management and analysis upon which the conclusion about the economic justification of future development projects can be made. Future development projects largely determine which technology development is expected in the future. They will not only largely define the future development projects, but also determine the field of work and operation of the future engineers.

The competences of students cover three main areas: Management of Product Development and Innovations management, Eco-product Development, and Industrial Product Development. Management of Product Development and Innovation management is an integrated approach towards efficient product development uses virtual engineering processes in order to design highly utilized machine elements and systems. Eco-product Development is an approach to design of a product with special consideration for the environmental impacts of the product during its whole lifecycle. Industrial Product Development is the complete process of bringing a new product to market.

4. Description of learning outcomes

Training of students has to be not just in the area of "technical skills" but also in the area of "softer" skills such as social skills, creative potential, elaboration potential and methods skills. Majority of courses should be divided into three different components: Lectures, Workshops, and student project work. These components should cover different educational goals. The lecture should provide the theoretical fundamentals for both the other educational components. Purpose of other components is to enable students to implement in practice their knowledge.

4.1 Management of Product Development and Innovations management

After finishing graduate academic studies, a certificate which confirms completion of the acquisition of Master academic title in field of Management of Product Development and Innovations management.

Competencies that a graduate student gains are the adopting the methodology, quantitative and qualitative knowledge in field of Product Development (Integrated product development, Tools and technologies in product development, Success factors in product development, Basics of validation in product development); methodology and basic knowledge in economical and management disciplines (Project management, Innovation management, Marketing and branding, Engineering economy, Human Resource Management); specific law knowledge regarding protection of intellectual property (Protection of Intellectual Property).

4.2 Eco-product Development

After finishing graduate academic studies, a certificate which confirms completion of the acquisition of Master academic title in field of Eco-product Development.

Competencies that a graduate student gains are the adopting the methodology in field of Product Development (Integrated product development, Success factors in product development, Basics of validation in product development). The special focus is the combination of innovative ideas and reflections on environmentally compatible product design, Ecodesign. They should acquire the ability to effectively deal with software tools from the fields of ecodesign and product lifecycle management.

4.3 Industrial Product Development

After finishing graduate academic studies, a certificate which confirms completion of the acquisition of Master academic title in field of Industrial Product Development.

Competencies that a graduate student gains are the adopting the methodology, quantitative and qualitative knowledge in field of Product Development (Product Development Methods, Tools and Technologies in Product Development, Technological Design Considerations, Virtual Product Development, Model-Based Design and Multidomain Simulation, Industrial design); methodology and basic knowledge management disciplines (International project management); specific law knowledge regarding protection of intellectual property (Protection of Intellectual Property); specific „soft“ skills (Communication and Presentation Techniques).

5. Work competences

Relevant competences of product development engineers are professional competence, methodological competence and social competence.

The term professional competencies include practical knowledge and professional experience, as well as theoretical knowledge that an engineer in his work always has. Methodical competence includes methods and proper procedures used by experienced specialists in resolving known and partially unknown problems.

The social competence includes all the parameters of social behavior and personal characteristics:

- Endurance
- Motivation
  - Iniciative
  - Working motivation
- Working approuch
  - Analitical approuch of thinking and working
  - Target orientation
- Working style
  - possibility of conducting
- Problem solving
  - Organisation ability
- Determination behavior
- creativity
- team behavior
  - cooperation

- coordination
- discussion willingness
- discussion competences

- behavior in social sitations

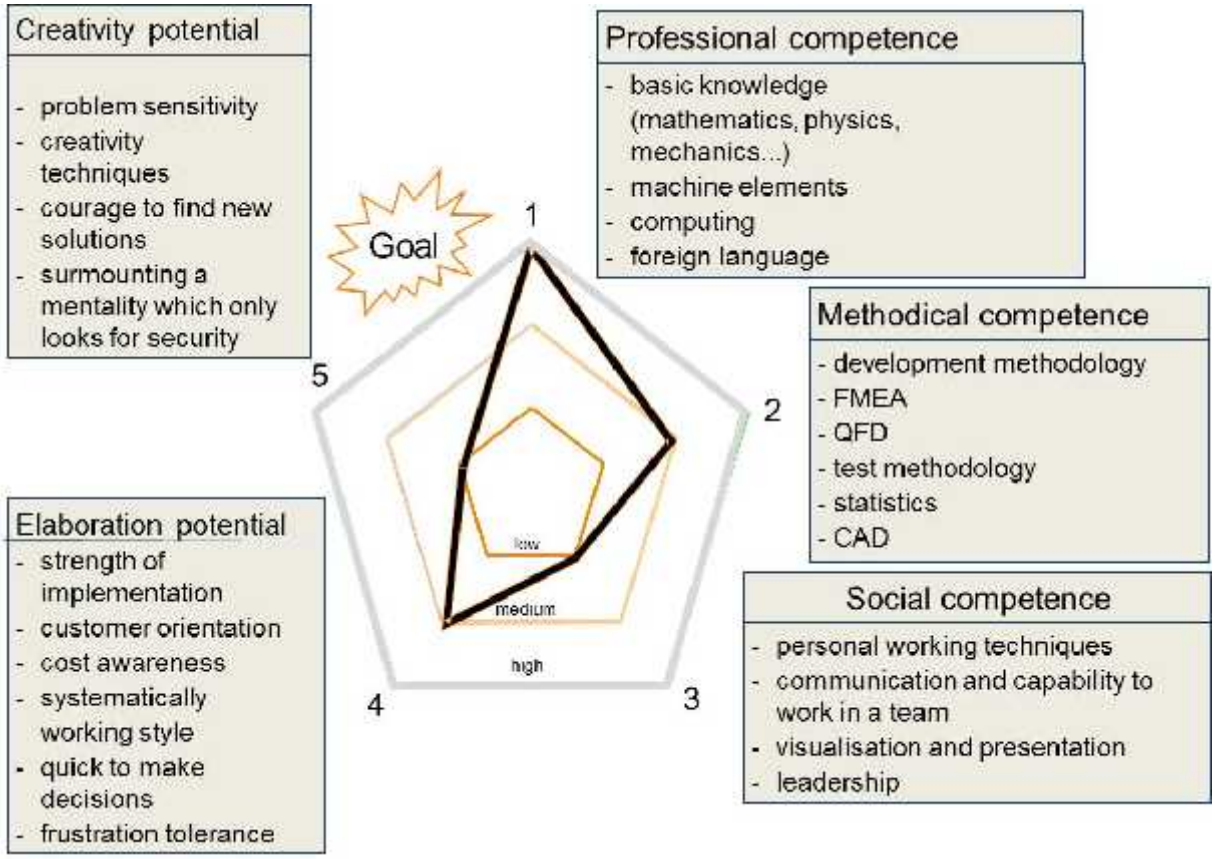

Figure 3: Importance of engeneers competences

The need of team work in the product development process strongly emphasizes that interpersonal - social competence. It is important to determine the personal competencies, which are very important for a successful work team. Important is also the actual competence, which team members have in relation to the upcoming task, only to be effectively resolved. Members of the team are different personality types according to their personal and social characteristics.

Figure 3. shows a possible score of engineers in different areas of their knowledge and competency profiles. In addition to notions of social competence encompasses the creative potential and elaboration.