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**Improvement of Product Development Studies
in Serbia and Bosnia and Herzegovina**



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WP 1.2

**Education in the field of Industrial product development and
management of Product Development & Innovation
Management**

REPORT

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KARLSRUHE INSTITUTE OF TECHNOLOGY	3
HECTOR SCHOOL.....	3
UNIVERSITY OF SOFIA.....	4
SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA.....	5
UNIVERSITY OF NIS	5
BELGRADE UNIVERSITY	6
UNIVERSITY OF NOVI SAD.....	6
UNIVERSITY OF KRAGUJEVAC	6
UNIVERSITY OF MOSTAR.....	6
UNIVERSITY OF EAST SARAJEVO	7
CONCLUSION.....	8

[Appendix 1. Report of UNI](#)

[Appendix 2. Report of BU](#)

[Appendix 3. Report of UNS](#)

[Appendix 4. Report of UNIKG](#)

[Appendix 5. Report of SVEMO](#)

[Appendix 6. Report of UES](#)

Karlsruhe Institute of Technology

The Karlsruhe Education Model for Industrial Product Development – KaLeP (Karlsruher Lehrmodell für Produktentwicklung) – is a general education concept orientated at the real industrial development process and designed to promote competence in product development.

Since 1996 the Institute for Mechanical Design and Automotive Engineering – University of Karlsruhe (today Karlsruhe Institute of Technology) – was developed a new education concept, which was already being used during the training of design engineers in 1998. In particular, the changing working environment of industrial companies today is taken into consideration. The lecture ‘Mechanical Design’ is the basic component of the KaLeP-Model, which covers the constructive basics. The summer semester of 1999 marked the beginning of this new concept. Right from the start, the lecture was supported by an accompanying workshop, the goal of this workshop is to build up important skills, such as the capacity for teamwork, the ability to comprehend and to organise as well as to develop the student’s creativity, skills which are mostly neglected in today’s academic education. However, with two additional components – Basics in Product Development and Integrated Product Development – based on the lecture mentioned above, high-level training as a design engineer in product development can be achieved.

Karlsruhe Institute of Technology has different structure of studies with Bachelor of 3 and of Master 2 years, where much more subjects implemented concept of Industrial product development. Variety and number of elective subjects which is more than 800 at KIT cannot be followed by Universities in PC while their resources are limited. Just in area of Industrial product development there are around 50 elective subjects where students can more or less learn about product development. Also works shops and practical work is more used at KIT while they have long history of this kind of this work type and resources to carry out such work with students.

Structure of studies in Germany, where Faculty with 15 professors can have around 900 subjects is impossible for a University in PC where for example at University in Nis cca. 60 professors have around 300 subjects.

Structure of studies at KIT gives very good opportunities for teaching staff to organize work with students on a higher level and to focus knowledge transfer in some area. *Schwerpunkt* 1 and 2 are groups of elective courses in which student have to choose 4 courses that have similar topic. This all make organizing of workshops and practical work much easier.

Hector school

The Master Program “Management of Product Development“ is a mixture of applied scientific research and application-oriented development in the areas of methods and processes of Product Development and Systems and components of Drive train Engineering and Mechatronics. Objective is to find innovative solutions by the means of team-oriented work, based on performance and commitment of each member of the Board.

The primary goal is to enable young professionals to take a holistic approach when managing highly interdependent processes. Leadership for engineers in today's fast changing and complex environment does imply technological and organizational responsibilities as well as requires economical accountability and Human Resource Management know-how. Therefore all programs are based on 5 Management Modules where the participants are provided with general knowledge in Finance, Accounting, Marketing, Multiproject Management and International Law so they can consider commercial consequences of business decisions.

The engineering emphasis of each Master Program is laid on 5 additional Modules adapted to each specialization. The lectures in the Masters-specific field provide insight into the newest research topics. They convey current and state of the art methodology necessary to master the scope of innovative technologies.

University of Sofia

University of Sofia has three courses in field of Industrial product development and management of Product Development & Innovation Management:

The purpose of course “**Innovation Management**“ is to provide students with basic knowledge of the essence, objectives, functions and tasks of Innovation Management. At the beginning the course discusses the basic principles and builds conceptual apparatus. In its main part the course presents in depth some important topics such as innovative techniques, environmental effects on innovations, innovative strategies and innovative management tools to enhance innovation potential, organization innovation, marketing innovation. During the course the opportunities for small and medium-sized enterprises to engage in innovation are covered. At the end of the course the experience of Germany in the field of technology and innovation policy and the development of innovation centres is presented on the base of seminars and parallels with the practices in Bulgaria are made. Practical examples of innovation in the leading German companies are given.

Course “**Methods for product development**” is a compulsory, fundamental course within the undergraduate program for the specialty "General Mechanical Engineering". The knowledge and skills gained within the class create prerequisites for the effective professional realization of students in the traditional area of employment of the mechanical engineers - the development of new products.

The aim of the course is to provide students with knowledge in the general design methodology and with skills for searching new variant solutions. Using practical tasks that students work out within the course one aims at better understanding of the studying material and developing of skills to apply the taught content.

At the end of the course the students:

- know the main stages of the product life cycle and their impact on the process of creation of new products;
- know and apply the basic methods applicable to systematic design of products;
- be able to evaluate the quality of the design solutions;

- know the methods for organizing and managing engineering activities.

The main objective of the course in "**Design of innovative engineering products**" is to prepare engineers who will have design knowledge in order to use the innovative potential of the design. The main focus here is to observe the engineering design as a complex process of development of the proposed new product from the concept to the introduction, production and marketing.

The implementation of a proposal for a new product integrates a wide range of activities: research, strategy, experience, system for creative approaches. All these require from the experts for innovative design a complex of various professional competences as follows:

- Organizing the individual engineering design activity and developing innovative ideas;
- Managing the product life cycles;
- Ergonomic design of consumer-oriented products considering the impact of innovative solutions on the sustainability of the product (environment friendliness, social and environmental responsibility);
- Documentation and presentation of their work using different visual, audio, and text media.

Slovak University of Technology in Bratislava

Slovak University of Technology in Bratislava has implemented subjects in field of Industrial product development:

- Computer Aided Design
- Design in Transport Technology
- Optimization of Working Machines Structures
- Computer Design
- CAx Systems
- Theory and Methodology of Design of Machine Parts and Mechanisms
- Machine Parts - Selected Chapters

University of Nis

University of Nis established the new educational model in field of Industrial Product Development since 2005. The new education model is based on KaLeP (The Karlsruhe education model for industrial product development) developed at Institute for Product Development of Karlsruhe Institute of Technology and it already exist in the curriculum of Mechanical Engineering Faculty, University of Nis since year 2005.

Currently, University of Niš does not offer the curriculum in field of Management of Product Development & Innovation management.

Since 2012, Faculty of Mechanical Engineering provides education in Engineering Management at Bachelor and Master level. Again, the of Management of Product Development & Innovation

management are not in focus of engineering education. There are some subjects in curriculums essential to education in field of Management of Product Development & Innovation management but the key subjects/topics are missing. Another problem is that the subjects are distributed over several modules so the students can not pursue education in above mentioned field.

Belgrade University

University of Belgrade express that in their curriculums have enough opportunities to learn fundamentals of product development and innovation management at Master and Bachelor level and in Doctoral studies there is no obligatory course in Product Development and Innovation management.

Some of courses could be additionally improved (especially those held by staff members of relevant General Machine Design Department), by implementing new teaching methodologies, new teaching materials (handbooks, power-point presentations etc.), new workshops, new lectures (with latest trends in relevant scientific areas discussed) etc.

University of Novi Sad

Currently, University of Novi Sad, Faculty of Technical Sciences, Department for Mechanization and Design Engineering does not offer the curriculum in field of Management of Product Development & Innovation management. It offers only one subject Machine elements in this field. Since there is no clearly defined entity (module or study program) which is exclusively dedicated to product development, there is a need for improvement of the current state in this field.

University of Kragujevac

Faculty of Engineering University of Kragujevac in its current plan has a large number of courses which are based on product development and similar fields. Much of the content of this subject matter is taught within other courses.

The field of product development is most represented on Mechanical Constructions and Mechanization module. There is no clear defined entity (module or study program) which is exclusively dedicated to product development. There is a need for improvement of current state in this field.

University of Mostar

Analysis of the current state of education in the field of Product Development and Management of Product Development & Innovation Management at the University of Mostar, Faculty of Mechanical Engineering and Computing shows the following:

For bachelor degree students, the product development is most involved in the module Construction Design, where they have enough opportunities to learn fundamentals of product design and development through the courses presented in the Table 1. Some of the these courses could be improved by implementing new teaching methodologies, introducing new teaching materials

(handbooks, power-point presentations etc.), new workshops, new lectures in relevant domains etc., and also by equipping laboratories with modern equipment in order to improve research in a field of new technologies.

There is still no clearly defined study program or even module which would be exclusively dedicated to Industrial Product Development and Management of Product Development & Innovation Management. There is a space for improvement of the current state in this field.

Beside the course Computer aided integrated product design; some master degree study modules include some courses in the field of Product design and Project Management. Some of the current courses could be additionally improved by implementing new teaching methodologies, introducing new teaching materials (handbooks, power-point presentations etc.), new workshops, new lectures in relevant domains etc.

There are no obligatory courses on Doctoral degree studies strictly defined and named as PDMPD&IM, but it is incorporated partially through courses mentioned above.

University of East Sarajevo

Bachelor degree students have more than enough opportunities to learn fundamentals of PDMPD&IM, during the highly specialized training in the field of Integrated Product Development, which is provided in the 8. Semester. This subject is based on KaLeP model of education.

Relevant Master degree study modules include some basic courses in the field of Management, but Mechanical Faculty in East Sarajevo will introduce new subject relevant to Industrial Product Development in next year of Master course. Some of the present courses could be additionally improved (especially those held by staff members of new relevant Engineering Product Design Department), by implementing new teaching methodologies, new teaching materials (handbooks, power-point presentations etc.), new workshops, new lectures (with latest trends in relevant scientific areas discussed) etc.

UES (Mechanical Faculty of East Sarajevo) in the school year 2013/2014 will introduce new module “Engineering Design of Products”, mainly based of needs for education in the field of PDMPD&IM.

There are no obligatory courses on Doctoral degree studies related to the PDMPD&IM, but in the future, during the period of preparation of PhD studies in UES, subjects of this field will be include in official curriculum.

Conclusion

Based on curriculum on KIT and Hector school and comparative analysis with curriculums at PC Universities following things are concluded:

- Courses held at the Universities in PC are harmonized with the principles of Bologna declaration
- All Universities in PC have Bachelor, Master and Doctoral studies where mostly Bachelor is 3 years and Master is 2 years long. University of Nis and Novi Sad switched from system 3+2 to 4+1.
- Comparing organization at German Faculties with Faculties in PC, it is clear that Faculties in PC have less space and it would be good for governments of PC to implement system in which would be possible for Professor to have more courses.
- Curriculums of Universities in PC have different level of penetration of Industrial product development studies and they should continue with their integration and implementation.
- Curriculums of Universities in PC have very poor integration of Management of Product development and Innovation Management.

Based on comparative analysis of curriculums of PC and EU Universities it is clear that the basis of education in the field of Industrial product development already exist but it is necessary to harmonize current education programs with the Curriculum in EU countries. This relates primarily to teaching methods and considering Industrial product development as multi-disciplinary studies (integration of economic and business disciplines).

PC Universities does not have properly structured curriculum and programs in field of Innovative management and Management of Product development. Therefore it is necessary to develop new curriculums where in this fields would be achieved basic goal of increase competitiveness of regional industry.

In order to achieve above mentioned goal in future period PC universities should integrate following topics into their curriculums:

- International Project management and Methods and Techniques of Project Management

Project management is the process and activity of planning, organizing, motivating, and controlling resources, procedures and protocols to achieve specific goals in scientific or daily problems. IPM should provide participants with an introduction to project management with the aim to help them understand the objectives of project management and scheduling, to learn how to analyze planned projects and to control project execution.

- Business economy

Students should learn how to allocate scarce resources over time under conditions of uncertainty. It encompasses the allocation of capital by households to firms (corporate financing) and the use of

capital by firms (corporate investments). Marketing should focus on creating optimal interaction between interest groups. Both customer behaviour and market dynamics determine marketing campaigns; therefore this course should place emphasis upon these points. Important aspects are market research and operations research, which are fundamental in implementation of marketing strategies.

- **Integrated Product Development**

Participants should explore the key elements of Integrated Product Development Processes and Industrial Design Engineering. Students will have in-depth introduction into product development. Course should teach how to build and manage cutting-edge product development teams. Design will demonstrate also how to translate customer needs into successful products with appropriate technical specifications. Participants will gain understanding of the Industrial Design Engineering significance. The effects and consequences of design modifications will be scrutinized as well as the influences of prototypes, models and simulation in achieving innovation.

- **Human Resource Management**

HRM should explore the key elements of innovation, creativity and leadership as well as the steps necessary to implement and manage it successfully and to increase the creativity factor of teams. HRM should outline an end to end roadmap for achieving breakthrough performance and demonstrate how to leverage technological innovation from multiple perspectives of the value chain. Innovation immerses the participants in the science and art of team-building, how to build teams, how to excel within them, and train them for maximum results. Leadership and conflict management will offer insight into the contribution of HR to organisational functioning. The Managing Training will consolidate the skills acquired through the previous courses.

- **CAPD (Computer Aided Product Design)**

Trough CAPD participants will explore the key elements of Simulation Methods. Participants will gain well-founded knowledge about potentials and limits of the simulation methods used, the necessary information integration and the IT-infrastructure and outline of the relevant software systems available on the market. Numerous methods of simulation will be presented to participants while gaining knowledge in Optimization and Interlinking of Methods, Information Integration and Visualization and Evaluation.

- **Factors of success in product development**

Participants should learn the systematic planning of processes with different tools and methods to support the finding of product profiles, product ideas and product concepts, such as: portfolio analysis, value analysis, analogy, design guidelines. For management of the product development process, the design structure matrix method should be presented. Different disciplines pertinent for the product development process should be discussed e.g. cost management of design processes as well as production cost associated with the new product.

- **Basic of Validation**

Should describe the significance of validation in the Product Development Process, the integration and management of validation processes, Planning of Experiments, basics of Modeling and Chain of Testing and Rapid Prototyping as well as Augmented Reality Systems. Participants should be

able to manage building of simulation models for technical systems, experimental validation methods and virtual validation methods.

- Innovation management

Innovation management is the discipline of managing processes in innovation. Innovation management includes a set of tools that allow managers and engineers to cooperate with a common understanding of goals and processes. The focus of innovation management is to allow the organization to respond to an external or internal opportunity, and use its creative efforts to introduce new ideas, processes or products.

- Intellectual property rights

Intellectual property rights are the legally recognized exclusive rights to creations of the mind. Under intellectual property law, owners are granted certain exclusive rights to a variety of intangible assets, such as musical, literary, and artistic works; discoveries and inventions; and words, phrases, symbols, and designs. Common types of intellectual property rights include copyright, trademarks, patents, industrial design rights, trade dress, and in some jurisdictions trade secrets. It is very important for managers and engineers to understand of intellectual property rights and use in process of product development and innovation management.

- Eco-design

Eco-design is an approach in product design with special consideration for the environmental impacts of the product during its whole lifecycle. In a life cycle assessment the life cycle of a product is usually divided into procurement, manufacture, use and disposal. Eco-design is a growing responsibility and understanding of our ecological footprint on the planet. Green awareness, over population, industrialization and an increased environmental population have led to the questioning of consumer values. It is imperative to search for new building solutions that are environmentally friendly and lead to a reduction in the consumption of materials and energy.

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. In that way theory of Constructivism should be implemented into teaching methodology.