COMETa 2018
4th INTERNATIONAL SCIENTIFIC CONFERENCE
27th - 30th November 2018
Jahorina, Republic of Srpska, B&H
University of East Sarajevo
Faculty of Mechanical Engineering
Conference on Mechanical Engineering Technologies and Applications

LIFTING TABLE DESIGN IN A LEARNING FACTORY AT UNIVERSITY OF MOSTAR

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Abstract: Today industry faces challenges such as shorter time-to-market, high number of product variants and limited resources. Learning factories as close-to-industry environments for education have proven to be an effective concept addressing these challenges. The analysis of mechanical engineering curriculums at Faculty of Mechanical Engineering, Computing and Electrical Engineering has showed that product design and development has no proper practical learning. This paper presents new education approach in product design and development and a case study of lifting table development through the concept of Learning Factory at the University of Mostar.

Key words: learning factory, lifting table, product design

1. INTRODUCTION

The term “Learning Factory“ was first coined in 1994. in USA when the National Science Foundation (NSF) awarded a consortium led by Penn State University a grant to develop a learning factory. Thanks to that grant a college-wide infrastructure and a 2000 square meters facility equipped with machines, materials and tools was established and utilized to support hundreds of industry-sponsored design projects since 1995. [1]. This early model of learning factories emphasizes strong link between design projects gained through engineering education at faculty and real industry in order to make a close approach for students to real problems in industry [2–4]. Regarding Europe the Institute of Production Management, Technology and Machine Tools (TU Darmstadt) had one of the early learning factory implementations in 2007. Recently the use of learning factories has increased in Europe. The term “Learning Factory“ literally assumes system concept which includes elements of learning or teaching as well as a production environment [5]. These two words “learning“ and “factory“combination emphasizes the importance of experiential learning in high education and research institutions. Learning factories provide a real production environment where processes and technologies are based on real industrial sites. Learning factory concept offers a good environment for education and also resourses for technological and organizational innovation if it is used for research [6, 7]. In recent years, learning factories have been

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established in manufacturing education and research as promising learning and innovation platforms [8].This concept can be implemented in a lot of different ways. This paper presents new education approach in product design and development (PDD) through the concept of learning factory. Lifting table is designed in order to complement the learning factory configuration at Faculty of Mechanical Engineering, Computing and Electrical Engineering (FSRE), University of Mostar.

2. LEARNING FACTORY CONCEPT AT UNIVERSITY OF MOSTAR

The initiative of introducing of learning factory at FSRE, University of Mostar, has started in January, 2018. Faculty applied the project co-financed by European Union and implemented by Deutche Gesellschaft fur Internationale Zusammenarbeit (GIZ) and received a certain amount of funds for project Increasing Competitiveness of Small and Medium Enterprises (SMEs) through Creating Business Associations and Establishing a Learning Factory, within the EU ProLocal programme.

Faculty is leader and nine local metal and plastic industries are partners in this project. The main goal of the project is the development and realization of the learning factory concept in collaboration with enterprises, development of curricula and support to enterprises in the field of education and research. The role of enterprise in the project is a contribution to the development of lifelong learning curricula and the transfer of knowledge in the field of practical training in the learning factory. Local community plays important role in project supporting the building of infrastructure, fostering better cooperation between the academic community and SMEs, as well as raising awareness of innovation among citizens through activities and workshops on the project.

2.1 New education approach in product design and development

Learning factories have been widely spread in Europe, and have created many concepts and forms of facilities varying in size, function, and equipment sophistication in order to improve the learning outcomes of students in one or more areas of engineering knowledge. Competency development is generally seen as a learning factory key objective. Aiming to enhance learning experiance of students on PDD, FSRE has taken a new model of education approach. A new model of education approach in PDD is presented by algorithm on Figure1. In the learning factory, product development process begins with the generation of ideas that can be driven by market conditions and the needs of a local environment, coming from educational needs or as a result of academic research. Students go through four characteristic phases of the product development process from the idea to final product. The process is systematic and at the same time flexible to the type of product being developed. With this approach, students are provided advanced training of integrated product development in real industrial environment where they recognize the need and opportunities for industry to address and overcome problems using academic and scientific approach. This workflow model enables students a systematic approach to the integrated products design and their related processes including manufacturing and support, which is emhhasized by the pillars of the algorithm. Namely, during the design process, they will take into account the process of production, testing, and packaging. At the same time, they will gain experience in organizing the integrated product development process and working in interdisciplinary parallel teams. The goal is that each phase in development process is strengthened by pillars in each individual step, depending on the needs and requirements. This model enables the strengthening and enhancement of the students in the synergy of academic and industrial environments. Benefits resulting from this learning approach in PDD through the learning factory concept are reflected in the following:

- Education in Realistic Industrial Environment,
- Learning Process Modernization,
- Adoption of New Technology,
- Improving Innovation Capabilities.

This process in learning factory is realized within an open two-way information circuit between the academy and industry. This allows permanent teaching process improvement and keeping up the academic community with a modern industrial sector.

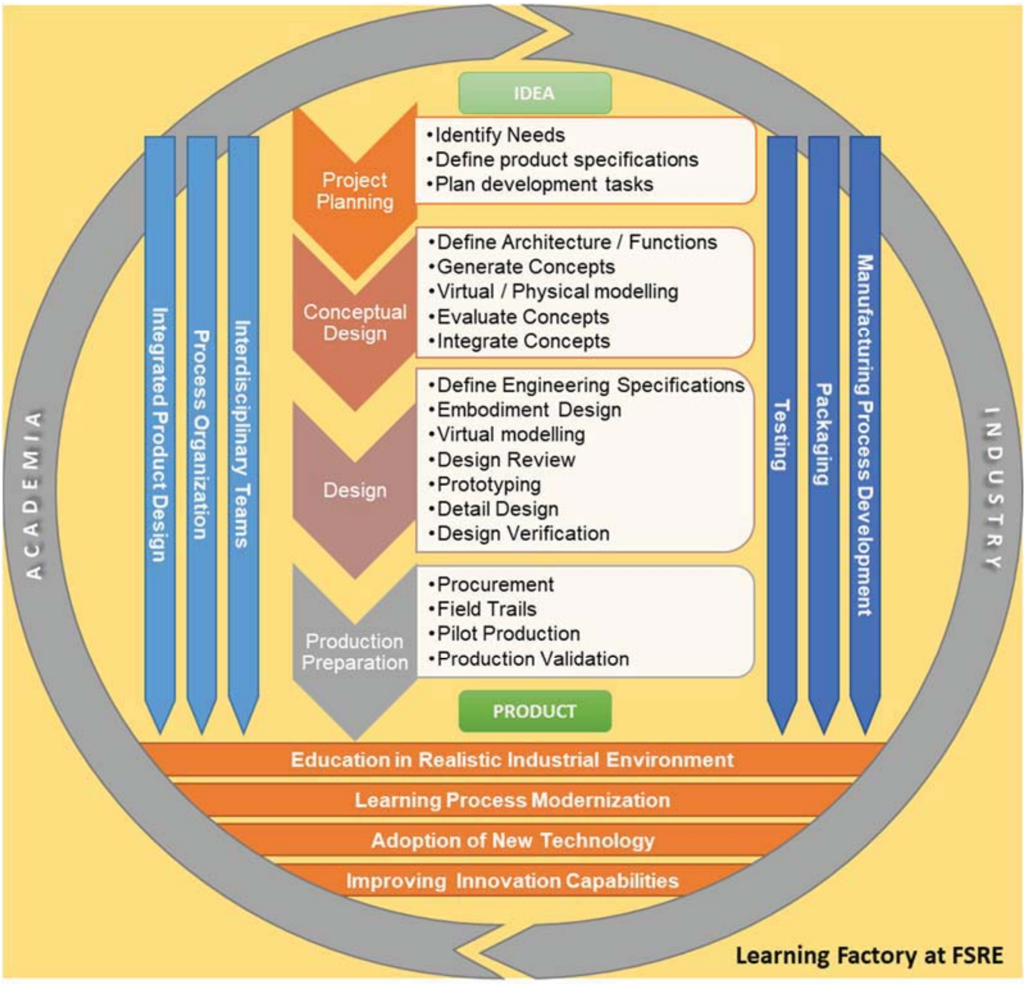

Figure 1. *The new education approach in product design and development through Learning Factory concept*

Working in learning factory environment students are able to focus on industry requirements and possibillities. Students are referred to the technology to be applied in specific processes and platforms that allow learning under market conditions of production. This is very important since it is known that the industry permanently monitors the latest technology and the latest information based on "know-how" philosophy. Students through education and practical work in learning factory are able to improve their professional, social, methodical and personal competences and also skills for cooperation and comunication in interdisciplinary groups such as:

- Problem solving abilities,
- Indepedency,
- Interdisciplinary expertize,
- Knowledge of production/testing/packiging proceses,
- Knowlge on crucial technologies,
- Project management,
- Communication skills.

From all of the above, it can be concluded that the proposed approach to academic learning in PDD ensures a correct understanding of engineering as much as computer technology at the same time. A modern engineer uses information and communication technology to better manage the design process and other processes including production and support processes.

2.2 Lifting table design

The idea for the lifting table design has come from the local industry needs for a lifting platform that should lift a man and/or load at a certain height. From the analysis, the requirements for design are defined:

- Table dimensions are 600x300mm,
- Maximum lifting height is 550mm,
- Minimum height is 200mm,
- Maximum lifting weight is 300kg,
- Total weight of the structure is up to 30kg,
- Easy to handle,
- Easy assembly of parts,
- Maximum Costs 300KM,
- Easy dismantling,
- Adopt to available manufacturing technology at the learning factory,
- Adaptable to different conditions of exploitation.

In the first design phase it is also very important for students to know the essential steps of the product planning process. This will help them to understand the origin of the requirements and if necessary to add to the list. Product planning and clarifying the task are consciously combined into one main phase. This is to emphasise the importance of integrating both activities.

After defining the product specifications, the conceptual design phase is methodically carried out. Different design concepts are developed, modeling is performed, the concepts are evaluated and the optimal design concept is selected for further development. Based on the requirements the manually driven lifting table is selected. In a design phase detailed embodiment design was done, focusing on the use of CAD tools (Figure 2). Detailed design and verification were carried out, followed by the purchase of required parts, production and assembly in order to make a prototype of the lifting table. Figure 3 presents parts and subassemblies of the lifting and final lifting table prototype is presented in Figure 4.

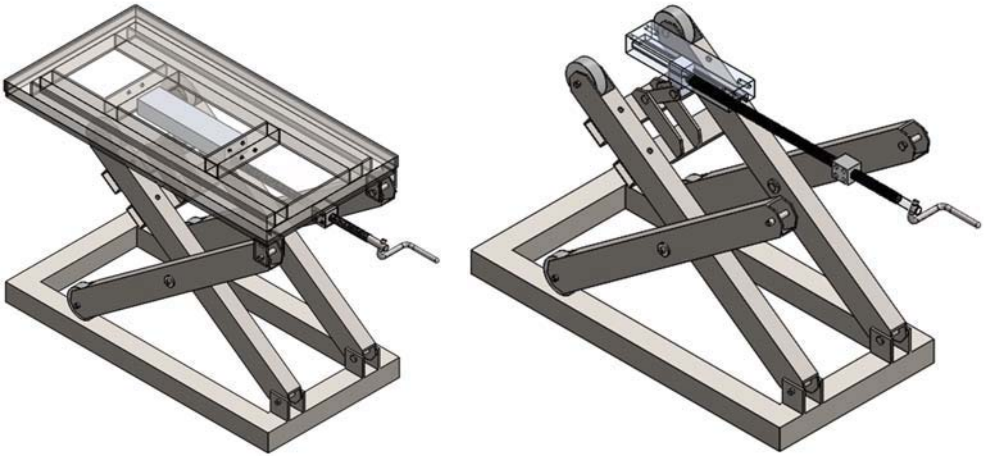

Figure 2. *Selected conceptual design*

Figure 3. *Parts and sub-assembiles of the lifting table*

Figure 4. *Lifting table prototype*

3. CONCLUSION

In this paper, an algorithm of transformation an idea to the final product design for manufacturing technology. It presents a systematic approach to learning and knowledge linking with the trends in various fields of engineering, from design to production and exploitation. The design of the lifting table through the concept of learning factory is intended to strengthen the competencies of students studying the product design and development. At the same time, in parallel with the design transformation, the algorithm model provides the development of student competencies in a real industrial environment. The advantage of introducing the learning factory algorithm is primarily due to the synergy of academic knowledge and the real industry sector. This model of student education can be used to strengthen competencies in other study programs at FSRE such as production engineering and mechatronics, as well as in electrical engineering and computing. In addition to the core engineering competencies, students will be able to strengthen their skills to work in interdisciplinary teams. In the coming years, the learning factory concept will be faced by significant challenges since manufacturing technology, industrial settings, engineering problems etc., are changing rapidly. The learning factory concept has to keep pace with these changes in order to be up to date or even proactively innovative in the years to come.

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