INNOVATION OF TECHNICAL EDUCATION TO ENHANCE PRACTICAL KNOW-HOW

Tomas Keckstein, Jakub Jirasko, Martin Hynek, Petr Votapek

University of West Bohemia, Faculty of Mechanical Engineering (CZECH REPUBLIC)

Abstract

The lack of practical know-how and practically useful skills for graduates is a serious problem for a large number of technical universities around the world. This is why innovation in education is being implemented at the University of West Bohemia (UWB) at the Faculty of Mechanical Engineering (FME) in the Department of Machine Design (DMD) to reduce this problem among our graduates. The goal of this innovation is to broaden the practical knowledge of our students via practical projects that are focused on the types of real problems that graduates will have to deal with in their future careers. For this purpose several projects dealing with real machines, tools and equipment have been created. All of these projects are worked on by groups of students over one semester. These educational projects are described in this paper using the conversion of a small manual milling machine into a computer controlled milling machine as a sample project. All the steps of the project, from a 3-D CAD (computer aided design) model to the final converted machine are described. The main tool used for this type of education is called Project-Based Learning (PBL), which strengthens the learning of students and makes education more interesting. Students drive their own learning through inquiry, as well as work collaboratively to research and create projects that reflect their knowledge [1]. During the solution of these projects students gain practical skills that help them to solve problems that they may face in their future technical careers.

Keywords: Innovation, technical education, educational projects, project-based learning, practical know-how.

1 OVERVIEW

The challenge of every university is to lead and prepare students for their future careers and thereby provide industry with quality graduates. In technical education in particular, graduates need to have, apart from theoretical knowledge, practical skills. But today's situation in industry and on the labour market shows that this is not completely true. 'Today's engineering graduates need to have strong communication and teamwork skills, but they don't. They need to have a broader perspective of the issues that concern their profession such as social, environmental and economic issues, but they haven't. Finally, they are graduating with good knowledge of fundamental engineering science and computer literacy, but they don't know how to apply that in practice. [2] For graduates without practice it is very difficult to start in the field of construction. They must face the problem of working on an extensive project and collaborate with other people who are designing their own part of machine. [3] This problem is leading universities to make changes in their curricula and force them to adapt their teaching methods to accommodate modern trends. More than ever excellence in teaching remains fundamental but degree and other programmes of study need to have integrated within them a number of generic skills which enable prospective employees to develop advanced products and services and provide opportunities for lifelong learning and continuing professional development. [4] For this reason universities are implementing new methods of teaching to improve the quality of their graduates. The quality of future engineers depends very much on the quality of engineering education, which is itself dependent upon developments in engineering curricula. [5] The trend toward increasing the design component in engineering curricula is part of an effort to better prepare graduates for engineering practice. [6]

Lack of practical know-how and practical useful skills is one of the main insufficiencies that industrial experts are demanding to be improved. Engineering graduates now require a far broader range of skills and attributes than the technical capability that was formerly demanded. [5 Nguyen] The professional education of engineers demands the acquisition of a body of specialized knowledge, problem-solving skills, and good judgment for the service of society. [7] The difficulty of engineering studies means that it is not easy to gain practical skills when studying in a temporary job. This is why it is necessary to improve these skills in the educational process. The need to ensure that students gain practical experience of real industrial environments during their studies is therefore extremely

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important. [8] One of the proven tools for obtaining practical skills is Project-Based Learning (PBL), which helps to engage students more in a solved problem and force students to find more information about the studied area. The proposed project-based learning can motivate students to integrate and formulate the multi-disciplinary knowledge previous learned into a real-world embedded system project development. [9] Through extended investigation and experience with the studied problems, learners are required to identify knowledge needs, locate the resources to help them meet these needs, organize the relevant aspects, and integrate diverse information into coherent explanations or projects. [10] For these reasons the use of PBL is implemented widely in the mechanical engineering curricula at the Department of Machine Design of the Faculty of Mechanical Engineering (FST) at the University of West Bohemia (UWB) in Pilsen. This innovation of education brings more practical examples from real industry into the educational process. The main intention of this enhancement is to extend the real practical thinking and decision making of our students. The entire process of these practical subjects is explained in this paper using an example of the conversion of a small manual milling machine into a computer controlled milling machine.

2 DESCRIPTION OF INNOVATED EDUCATION

Innovation of the mechanical engineering curricula at our university is implemented with the intention of modernizing and enhancing the education process. Several subjects were selected for the implementation of education using this innovative process via one semester long projects. The power of this type of study is based on PBL. Project-based learning refers to the theory and practice of utilizing real-world work assignments on time-limited projects to achieve mandated performance objectives and to facilitate individual and collective learning. [11] The main purpose of these study projects is to bring education closer to industrial practice by using sample projects that deal with real products, tools, machines and other equipment that students can encounter in their future careers. All projects that students solve are based on a comprehensive problem that requires broad theoretical knowledge, thorough research and a creative approach. A sample project solution of one of these projects could be carried out according to the chart in Fig 1.

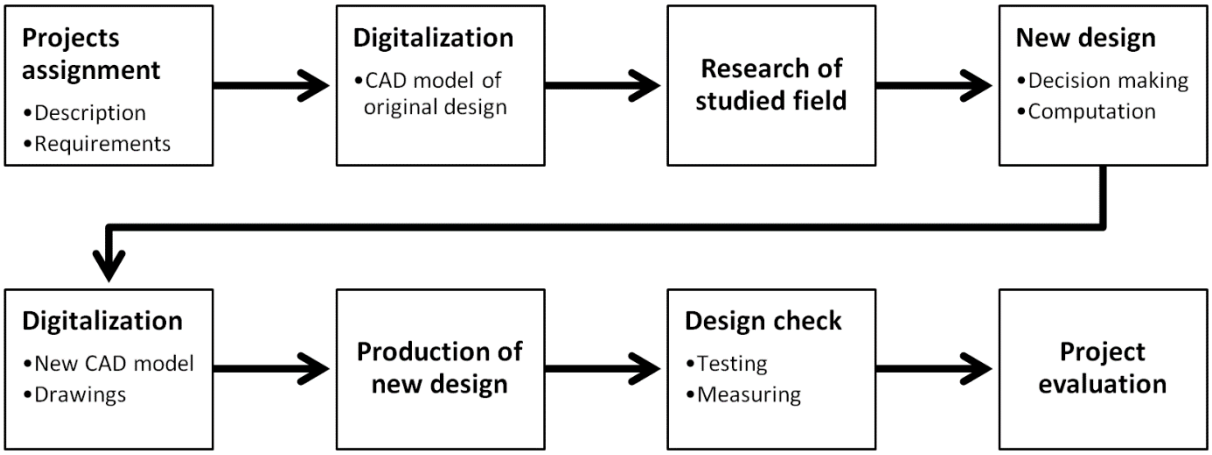

Figure 1. Project solving process

Every project has a specific process and every student chooses a specific approach. Therefore, all projects are different even if they have the same assignment. During the entire duration of the project students have the opportunity to discuss their solutions with the teacher that supervises their project. Facilitating project-based learning requires the kind of leadership skills that allow teachers to help a group of learners to move in the direction that they want to go, pointing out potential pitfalls or making suggestions without getting defensive when students decide they like their own ideas better. [12] All single steps of the process shown in Fig. 1 are described using the conversion of a small manual milling machine into a computer controlled milling machine as a sample project.

- Students receive a detailed assignment with a description of their task. The assignment always contains a description and specification of the device that they will be dealing with during their project and also requirements that need to be met for its successful conclusion.

- The first step is always the digitalization of the existing machine. Students have to create a 3D CAD (Computer Aided Design) model of the machine. This model will be used for checking the changes proposed by the students and also as a base for numerical computation.
- The most important part is research about the machine, its parameters and the technologies used. Students also have to study in more depth the field relating to their new design. For example, in the case of the milling machine conversion students had to study the options for the drives of machine tools, bearings of the drive mechanism and so on.
- After thorough research, students design the new machine. They have to decide which technologies fulfil their requirements best but they also have to design their improvements with regard to costs because they have to build the new machine. Another important part of designing the new machine are computations, because students have to check if their suggested improvements are correct and if they fulfil the required parameters. For the milling machine, students had to calculate the power of the drives so it exerts the required force, the required lifetime of the bearings and other necessary parameters.
- After deciding which parts and technologies will be used, the students create a new CAD model and technical drawings for production and assembly.
- For production of the new milling machine, students use machines that are available in our department. In Fig. 2a) you can see the original machine and Fig 2b) shows a converted milling machine that is controlled and programmed via computer or control panel and can work in automatic mode. By producing a real machine, students can test if the technological processes that they suggested were correct.
- When the production is complete, students carry out tests to see if the machine works correctly and they also have to measure and check if the required parameters of the machine are met by their improved design. With this, students learn about more practical procedures that they can use in their future careers.
- At the end, the entire project is evaluated by teachers from the field and also by experts from relevant industrial companies.

Figure 2. a) Original machine [13], b) Finished computer controlled milling machine on welded frame

During this process, students learn all the necessary information about milling machines and their features. In order to solve all the problems that appear in the project they have to get much more deeply involved in this field than through conventional learning in classrooms.

3 BENEFITS FOR STUDENTS

All the steps and tasks described in the previous chapter can be achieved using many different methods, technologies, and procedures. But students have to consider all the aspects in order to

achieve the desired results and the required parameters. This is only possible with detailed research and understanding of the studied field, and connection between all the steps in the production process from the assignment of the project to the final production and testing of the real machine. During these study projects students need to learn all about the structure of the machine, production technologies, creation of CAD and computational models, measurement, computer controlling, programming and many more practical and useful activities that they will certainly use in their future studies and after graduation in their careers. Also these practical skills give them an advantage on the labour market because a large proportion of applicants for any job are lacking any practical know-how. In fact, in a society where companies are looking for employees who have people skills, are able to work in teams, and have the competence to make decisions and solve problems as they arise, project-based learning can serve as a powerful tool to prepare students for the world of work. [12] A side effect of this innovation is that these subjects are more interesting than traditional learning in classes, and students are more attracted to learn in order to resolve the problems in their design projects.

4 CONCLUSION AND FUTURE WORK

This paper provides an introduction into the innovations that are being implemented in our department. The main aim of these innovations is to broaden the practical know-how of our graduates. This enhancement is achieved by implementation of Project-Based learning into several subjects. These subjects use the assignment of projects on the basis of machines, tools and equipment that are close to real industrial practice. The entire process of solving these educational projects by students in technical subjects is presented using a sample project of the conversion of a small manual milling machine into a computer controlled machine. All the steps of this project are described in detail and the advantages that students gain from using this educational process are also covered.

In the future we will conduct a survey among industrial employers from our region and we will try to find out if these innovations have influenced the quality of our graduates.

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