New concept in e-learning materials based on practical projects

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Abstract

The paper focuses on the application of new e-learning materials at the University of West Bohemia in Pilsen at the Faculty of Mechanical Engineering in the Department of Machine Design. These study materials are based on projects which were previously applied in practice and thus help students to master and become familiar with engineering issues from a practical viewpoint. E-learning materials are written in a structured and unified form in this sequence: introduction, active two-colour 3D models coloured according to function and machining technology, and overall drawing documentation.

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1. Introduction

The number of students graduating in engineering field has been declining in the Czech Republic for the last two decades. It has resulted in the insufficient number of engineering graduates in the labour market of the industrial branch in the Czech Republic.

Although industry is generally satisfied with the current quality of graduate engineers it regards the ability to apply theoretical knowledge to real industrial problems as the single most desirable attribute in new recruits (The Royal Academy of Engineering, 2007). Nowadays the employer has high demand of fresh graduates. He requires language knowledge, technical expertise and basic knowledge of CAD programs. Most of students deal only with the theory at school and they are not able to use their knowledge in practise at their first job so the employer has to

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spend considerable financial and time resources on the training of the new staff. This situation can cause financial problems to small and medium-sized companies and influence their competitiveness, too. Many authors have discussed how changes in the professional context of engineering have influenced demands of engineers and engineering education (Male, 2010). This problem is also described in the article (Vavrečková, 2009), which deals with the problem of educated specialists and their economic impact on the development of the state and describes the transition of developed countries into "The economy of knowledge type." (Vavrečková, 2009).

For the future it is necessary to keep and deepen relationship between universities and industrial companies. This cooperation cannot be ignored, even if this activity is time-consuming and financially demanding in the short perspective of time and do not show benefits to both parties immediately. Managers see the greatest benefit of cooperation with universities as contact with potential employees (Bodmer, C., Leu, A., Mira, L. and Rütter, H., 2002). In the case of inactivity of mutual cooperation, the number of students involved in the practical projects could be reduced and students would not be able to gain valuable experience for their future practice. This issue is highlighted by the authors of the article „A makeover for engineering education“(Wulf, Fisher, 2002).

Working on real projects allows students to explore issues arising from practice. This increases the quality of graduates and their employability. The literature (Gibarti, 2006) talks about „Investice do lidského kapitalu jsou investice do vědy a vzdělání“.

Over the last ten years the automotive industry has been on the increase in the Czech Republic. It caused the higher demand of the people with the machinery education especially those focused on the transportation technology. Many subcontractors, who produce a wide range of components for cars are dependent on the automotive industry. One of these branches is the manufacture and design of plastic injection moulds. Injection moulds produce decor, carrier, insulation and trim parts. It is a very extensive and sophisticated range of design and graduates have lack of experience in the issue. Based on the demand of graduates with broader experience which is still increasing at our Department of Machine design we decided to create a database of complex projects from the practice dealing with the design of injection moulds. It will help to improve the quality of teaching, which would systematically increase the level of practical knowledge of graduates at University of West Bohemia in Pilsen at Faculty of Mechanical Engineering, the Department of Machine design. The projects from the database will serve for studying and solving similar projects within Semester, Bachelor or Master Theses. This paper presents the new e-learning materials dealing with the design of injection moulds.

2. Description of the structure the study materials

For the new study materials the tool which is used for the production of the lid of the bin has been chosen as the example. This sample includes the description of the injection mould and its function. Next it describes the General Safety Rules with service, draft direction, 3D models in PDF format, drawings and datasheets of the produced components.

2.1 Information of mould and general safety rules with service

There has been a great emphasis on the logical order of the individual chapters. The first chapter begins with the basic description of the mould. The next chapters describe in details main components of assembly and subassembly. The upper part of Figure 1 (a) shows the main guide of the mould including the guide pillars, guide bushes and its function. This part is for better illustration provided with the picture where the guide pillars are marked with the red arrow. For better understanding one part of the machine has been shown in the working position where there is possible to see the whole guiding set. At the bottom part the leading of the guiding ejection system is described. The structure of the description is similar.

The picture (b) shows another part of the e-learning materials where General Safety Rules are listed. In case of the machine operation or shutdown the operator has to follow these rules. It contains the rules during the manipulation with lubricants or disassembly and transportation of the mould. This part also includes general maintenance of injection machine and its each component.
2.2 Draft direction

The next part of the study material deals with the draft direction and so called reference curve of the moulded part. It is the first step when the design of the injection mould is made. First students become familiar with the different movements of the components that occur during the production process. Using pictures and simple explanations students can view what direction the components will move. In Figure 3 picture (a) you can see the main draft mould and moving of slides which allow the production of any undercuts. The main part is so called reference curve, which divides moulded part into the stationary and movable mould. For better illustration each trajectory is marked by different colours and arrows. The picture (b) allows viewing of the draft direction at interactive 3D Pdf file (see next chapter) view where each component is possible to see and suppressed. Students can also analyse all the components at various perspectives and distances.
2.3 CAD models

CAD models, which are the basis of the whole project, are a great source of knowledge for students of machine design. CAD models are created in various CAD programs for example Catia, Pro-Engineer, Siemens NX etc. It is not possible for students to own these softwares which are very expensive. For this reason all data from various CAD programs have been converted into 3D Pdf file. The biggest advantage is the ability to view the learning materials in PCs, laptops, tablets, etc. The only condition is to have software which is able to read Pdf files. It allows the program called Adobe reader, which is available with a freeware license.

In this file, students can interactively browse the selected parts based on the tools. CAD models are possible to turn around, zoom in, zoom out, create Sections and the parts can be suppressed or activated. Viewing the interactive CAD models at Pdf file is better than using the drawings because it is more effective and faster for the orientation. Especially beginner students who have little experience can get better overview of the study tools compared to problems they could have with the orientation of drawings.
2.4 Colours of CAD models

CAD models are divided by colours into two groups. The first group is coloured according to the methods of the function parts and the second one according to the technology of manufacturing. The benefit is the simplified and faster detection of the function of each part. The first defined range of colours indicates the parts with the same function for example transporting, stopping or measuring elements. The second range of colours identifies the manufacturing technology. Each face is assigned by the colour that corresponds to the manufacturing technology for example drilling, milling, or cutting the parts etc.

Figure 4 shows the colours of the parts according to the machining technology. On the left side the technological operations on each part are described. In the right part of the figure the table with the labelled legends is illustrated. The table is divided into four columns. The first column displays the list of colours used in the work. The middle column defines colours according to the RGB colour model. The third column describes the function of the given colours. Thus students are able to recognize the manufacturing technology of the face or produced parts quickly and easy.
3. Contribution to students and academics

The main benefit of these new e-learning materials is the teaching innovation at FME at UWB. The e-learning materials provide the know-how of injection machine design and help to improve the quality of teaching. The main part of the study material is CAD models which help students to understand the problems of the study field faster and easier. Students can explore each CAD model in terms of relationships, its parts and technological operations. Thus students can use the e-learning materials for Semester, Bachelor and Diploma Theses.

Technical specifications of each design project can be easily modified. Students can explore the original design of a project and make modifications according to the new instructions. Then they create their own projects and gain new experience in the field. Their designs approximate to real engineering projects in the practice.

The new e-learning materials will serve as a database of real design projects that will be available to all students and academics at FME at UWB. These design projects can be used in the framework of the teaching subjects. The teaching subjects will be enriched by the valuable know-how and academics will be able to explain the theoretical foundations on the projects in practice. Therefore they will be able to provide students with the importance and sense of the stated information.

4. Conclusion

This article is focused on the new concept of e-learning materials that deal with the design of plastic injection moulds. These e-learning materials have been designed to help students to become familiar with common design issues. Students will gain valuable design experience during their studies, because the materials are based on real projects solved in practice. Especially they are drawings and designs of injection moulds. This way Faculty of Mechanical Engineering at UWB upgrades and expands the database of the study materials. These new e-learning materials are gradually introduced into individual subjects. The main goal of this article is to present this new concept. The study materials are made in the form of structured Pdf that contains basic information about injection moulds with CAD models, General Safety Rules, service and complete drawings. CAD models based on the specific formats of CAD software had to be converted into 3D Pdf file. This format allows students to browse the data without the installed CAD software where the mould was created. The file Pdf is readable with Adobe reader which is freeware for most PCs, tablets, smartphones etc.

These study materials will be included into the system of the quality teaching at the UWB. We are convinced that these study materials will be helpful for students and bring up more competent and capable engineers, who have their first contact with the practice during the period of their studies, and not until after the access to employment.
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