INTRODUCTION OF THE PROBLEM BASED LEARNING TO MECHANICAL ENGINEERING CURRICULA

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Abstract: Although the technical learning has a long and successful tradition in Brno, new trends must be accepted to cope with the needs of modern industrial demands. From the communication with our industrial partners and graduates we registered serious drawbacks of contemporary educational system leading to low competency of our students. To cope with this situation, an innovation of curricula in engineering areas of Applied computer science, Mechatronics, Engineering design, Robotics and Engineering mechanics and biomechanics is prepared. The key point of the innovation is the introduction of Problem Based Learning (PBL) into the above mentioned subjects. Main idea of PBL is shifting the educational process from the „learning by hearing“ to the „learning by doing“ mode. In the paper we describe our experience with PBL introduction as a part of a running project funded by the European Social Fund.

Keywords; engineering education, problem-based learning.

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1. INTRODUCTION

Faculty of Mechanical Engineering (FME) is the second largest one of the Brno University of Technology, having about 4400 students and 500 employees in 14 specialized institutes. It provides structured education (3 years Bachelor`s, 2 years follow-up Master`s and 4 years doctoral studies) in 50 study programs in both full-time and combined modes of study. All of the study programs are accredited in Czech and English, and there are joint and double degree programs in cooperation with other European universities. The university is a holder of European Credit Transfer System and Diploma Supplement Label.

FME provides university education in traditional mechanical engineering areas as well as in interdisciplinary branches, some of them in close cooperation with other BUT faculties and universities (Mechatronics, Mathematical Engineering, Physical Engineering and Nanotechnology, Precise Mechanics and Optics, etc.). Each year, about 750 students graduate from the faculty having good career prospects at both Czech and European labour markets. According to a survey that we realized at the faculty within our project, FME graduates are of those having no great problems to find a job (Fig.1). In spite of this successful performance, there are still serious drawbacks of contemporary teaching system, detected in discussions with our graduates and representatives of industrial companies. Criticism is aimed primary to lack of

social skills, ability of team work, soft skills and leadership. To improve educational procedures in this specific area, we prepare curricula innovations with main accent on team work in small groups, problem solution and mutual evaluation of presented solutions among concurrent groups. One example of successful application of this learning strategy is the project of walking robot design with typical distribution of responsibility of team members to different aspects of the problem: kinematics and dynamics of movement, design of mechanical parts, power supply, servo-drives, electronics and intelligent control. Area for this learning strategy is found partly by revision of classical courses, partly by introduction of new courses like Industrial Project or Diploma Seminar. Introduction of the new learning strategy and problems with its evaluation and impact is the subject of a new ESF project, described in the following text.

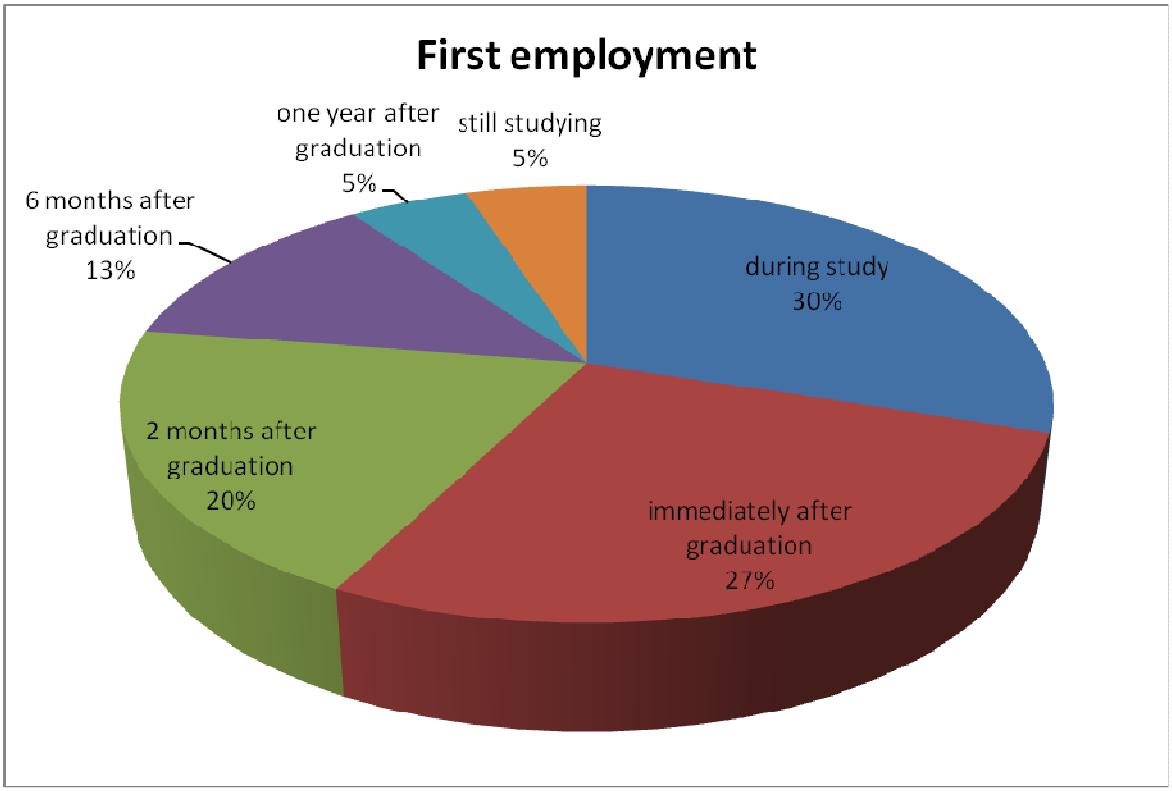

Figure 1 First employment of FME students

2. PROJECT DESCRIPTION

2.1 Drawbacks of the existing system

The system of technical education at the FME has been reflecting many changes, some of them come from the discussion with companies and the others as the feedback from the graduates. In general, graduates are well prepared in technical and theoretical areas, but the practical experience, social and language skills are of a great lack. Especially, the existing educational system leads to low competency of our graduates and students in areas like

- management ability

- adaptability and creativity
- communication, self-presentation, teamwork
- social, economical and juridical context of engineering activities.

Results of our survey in Fig.2 show what our graduates miss most when starting their professional careers.

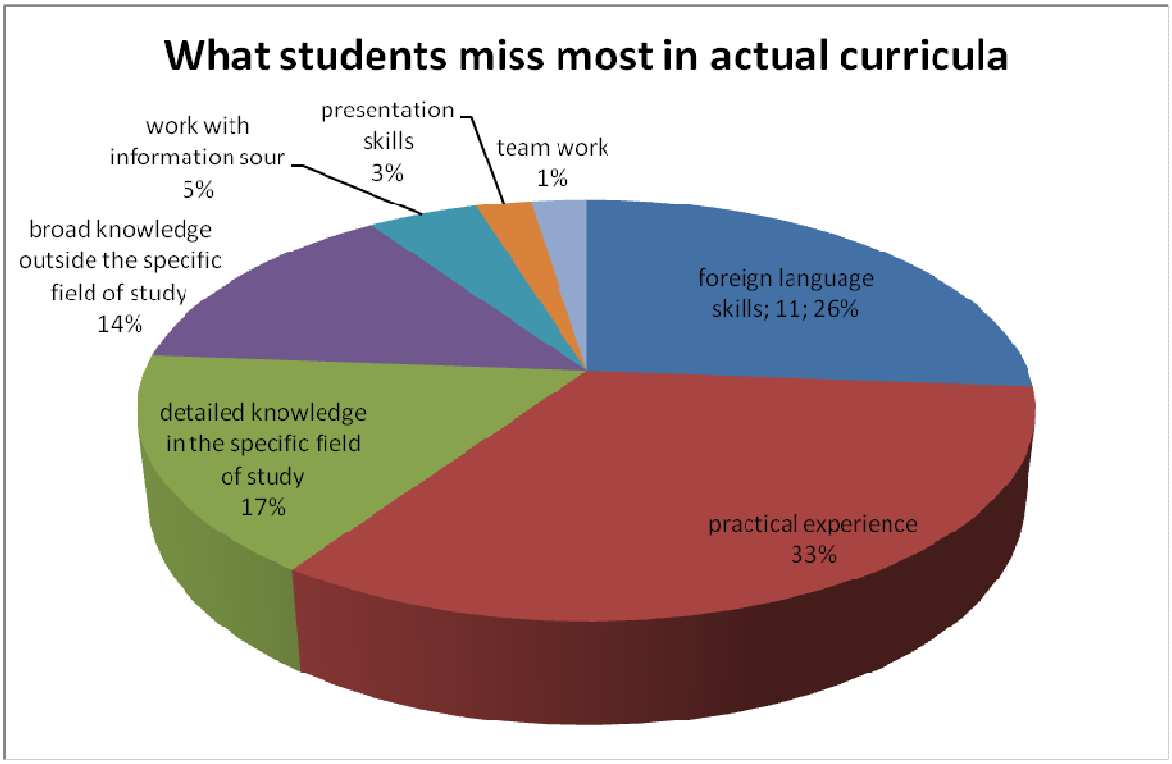

Figure 2 Results of survey among graduates

To cope with this situation, an innovation of curricula and educational methods in engineering areas of Applied computer science, Mechatronics, Engineering design, Robotics and Engineering mechanics and biomechanics is being prepared within the support of ESF project no. CZ.1.07/2.2.00/07.0406 "Introduction of the Problem Based Learning to Mechanical Engineering Curricula" (May 2009 – April 2012; http://opvk22.umt.fme.vutbr.cz/).

2.2 Project aims

The main idea of the project is shifting the educational process from the „learning by hearing" to the „learning by doing" mode, from isolation to openness, from separated to modules, from specific knowledge bulk to dealing with specific complex task (Brodeur et al.(2002), Lo (2007), Fink (2002), Hadim and Esche (2002)). The key point of the innovation is the introduction of Problem Based Learning (PBL) into as many subjects as possible, reasonable and effective in different ways for Bachelor`s and Master`s programs. Problem-Based Learning is a widespread teaching method in disciplines where students must learn to apply knowledge, not just acquire it.

The main goal of PBL is to provide students with opportunities to apply knowledge and is focuses on problem formulation as well on problem solving. The main features of the PBL are as follows:

- leaning is student centered (student makes a choice about how and what he wants to learn)
- learning occurs in small student groups and promotes collaborative learning
- teachers are guides or coaches
- a problem is a vehicle for the development of authentic problem-solving skills
- new information is acquired through self-directed learning.

To introduce the PBL into the educational process at the FME means that the learning process in engineering disciplines becomes more enjoyable and more efficient for students mainly through practical projects, provides team work and other soft skills experience and stimulates a student interest itself.

2.3 Project partners and key activities

There are several departments of two faculties being involved in the project – Institute of Solid Mechanics, Mechatronics and Biomechanics, Institute of Design, Institute of Computer Science, Institute of Production Machines, Systems and Robotics (all Faculty of Mechanical Engineering) and Institute of Power Electrical and Electronic Engineering (Faculty of Electrical Engineering and Communication).

The project consists of the following main parts – key activities:

1. analyses of the labor market (a survey among graduates and companies focused on skills missing) – the survey was realized among 132 graduates (2007-9) of study branches involved via emails
2. usage of external experience and comparison of similar study programs offering by partner universities – still ongoing process of monitoring of partnership faculties and their study programs offered (extension, content, courses, modules, learning methods and forms, possibilities of joint / double degree programs)
3. problem based module structure (a system of basic educational modules with defined processes, methods, structures and criteria and their use for other study branches)
4. formal and content changes of courses included (up to extension enabled by the accreditation of the Czech Ministry of Education) – new or innovated educational materials, different credit evaluation, implementation of the new trends and knowledge in research and technologies, instructive forms of education, team projects working out, opponency of the projects to support presentation and self-presentation skills and communication
5. complex electronic support and knowledge testing system – centralized and problem oriented portals including all the information on courses and study plans, knowledge on-line testing system, webcasting, database of problems and assignments, references
6. intensifying of practical experience in the educational process (in both university and company facilities) – upgrade and new equipment of laboratories, experimental tasks, software applications, excursions into companies, internships, part-time jobs, testing of companies products within training of students
7. realization and evaluation of new study plans.

The role of industrial partners (both Czech and international companies) in the project realization is irreplaceable. The companies (e.g. Siemens Electric Machines, ZDAS, Honeywell) are responsible for:

- providing practical experience by the means of short-time practices, students` excursions, diploma projects setting, consulting, experts` lectures, trainee programs
- offering jobs for our graduates (in rate between Bachelors` and Masters` graduates 15 to 85%)
- supporting our students (part-time job, scholarship, sponsorship, students competition, etc.).

2.4 Realization problems

At present, the project is in the first year of realization and four of the above mentioned key activities are being now solved. Some of the problems have already been identified:

- lack of teachers being qualified and interested in this educational method (especially when the teacher should be more manager or facilitator than expert in the subject area)
- too many students in Bachelor`s study programs in proportion to experienced teachers,
- reluctance to creative activities, teamwork and cooperation among some students in case when the study groups are too large
- insufficient language knowledge and soft skills
- lack of appropriate problems and practical tasks on different levels to deal with
- shortage of devices and equipment to be used for practical learning.

We cope with these problems by many ways. First, we are directed towards young colleagues-teachers who seem to be most interested in new teaching methods, are able to do the time-consuming work of new curricula preparation and are open to new partnership with the students. Lectures and seminars of experts outside the academic area are a great help for us (Fig.3). On the other hand, some method of selection among the students in the large groups of the undergraduate Bachelor`s study is necessary to find and motivate those who show necessary initiative and interest in the new forms of learning. The problem of laboratory equipment and devices is improved in last months (Fig.4) partly by the ESF Projects funding, partly by better exploitation of other sources (Czech Ministry of Education, commercial subjects participation).

Figure 3 Experts of Skoda-Auto in FME labs

Figure 4 New computer labs

3. CONCLUSIONS

The first experience with the concept of Problem Based Learning in engineering education at the FME shows a necessity of deep change of traditional role of the teacher as an instructing authority, student as a passive object and the education as a pre-fabricated process with a small proportion of individual creative contribution on both sides. It will be a long-termed and complicated process. We believe that the whole process brings expected results, which can be judged only after a longer period of exploitation of the project outcomes and their evaluation by graduates and employers.

4. REFERENCES

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