Implementation of a testing ground in Group T University College

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Conference Key Areas: industry and engineering, education concepts specific for engineers, university-business: cooperation and inspiration.

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Keywords: project-based, industry, team work, design.

INTRODUCTION

A testing ground is a project-based course, with reality-based assignments originating from companies. The students can organize themselves in teams, and each team tackles one reality-based problem. The outcome of the assignment is, depending on the subject, a dossier of technical drawings, a proof-of-concept, a demonstrator, or a software implementation. This paper discusses the implementation of a testing ground in the third bachelor year of electronics and electromechanical engineering in Group T University College.

1 ABOUT GROUP T

1.1 Programs

Group T University College (Leuven, Belgium) organizes academic engineering programs with following majors: electromechanical engineering, electronics engineering, chemical engineering and biochemical engineering. These programs are organized in Dutch and in English, reaching a broader international public. The main objective of the University College is education, but also applied research, internationalization and cooperation with (especially small and medium-sized) companies are important.

1.2 The 5E-concept

The mission of GROUP T is ‘educing essence by experiencing existence’. To accomplish this, the focus is put on five domains, the 5E-concept: Engineering (“creating things”), Enterprising (“getting things done”), Educating (“developing people”), Environmenting (“embracing all elements”) and Ensembling (“transcending and including”) [1].

With regard to academic bachelor and master programs in the study domain of industrial sciences and technology, Group T sets as its objective to educate future engineers based on the 5E-concept and this in the context of the four technology fields of Matter, Energy, Information, and Life, in connection with the four basic sciences of Chemistry, Physics, Mathematics, and Biology. As regards engineering, Group T places technology first, always in combination with management and communication.

To implement the 5E-concept in the programs, these do not only contain courses with a typical engineering content, but also courses that put emphasis on the non-technical aspects that are important for nowadays engineers, like personal and interpersonal skills, societal context or consciousness. In the bachelor program, typically about 50 credits out of 60 are devoted to courses with an engineering content core (although other aspects are also involved), and three credits to courses with a non-technical core. The seven remaining credits are devoted to so-called Engineering Experiences [2].

1.3 Engineering Experiences

Engineering Experiences are project-based courses in which all named aspects converge, aiming at experiencing these aspects in a real-life engineering environment. In the master program, the number of credits devoted to Engineering

Experiences increases heavily, due to the master's thesis of 20 credits [2]. Throughout the bachelor program, the Engineering Experiences evolve from studying existing technology in the first year, over implementing existing technology in the second year, to designing a system in the third year. The testing ground is implemented in the Engineering Experience of the third bachelor year.

2 TESTING GROUND

2.1 Definition

A testing ground is a project-based course, with reality-based assignments given by companies. The students organize themselves in teams, and each team tackles one reality-based problem. The outcome of the assignment is, depending on the subject, a dossier of technical drawings, a proof-of-concept, a demonstrator, or a software implementation. Project management is part of the job, and the students can make use of the labs and computer infrastructure in the University College. A coach from the educational team is assigned to each team. Once a week, the coach and the team evaluate the current situation together.

2.2 Aims

Project-based courses and design projects are part of many modern engineering curricula [3-7]. These projects are often of academic nature, with the students following a more or less predefined path to attain a specific result. Industrial projects are often limited to master programs, because the students then have enough knowledge and engineering skills to tackle more complex problems. This paper discusses the introduction of a testing ground in a bachelor engineering program, with cooperation from industry, but with limited coaching effort for the industrial partner.

The main aims for the implementation of a testing ground in the University College were:

- to motivate the students by offering them reality-based cases,
- to promote contacts between the students and professionals, contributing to a more professional attitude,
- to stimulate cooperation between students from different programs,
- to stimulate innovation and to give new impulses to the cooperation between the university college and companies,
- to expand the network of the university college, enabling opportunities towards new projects.

3 IMPLEMENTATION

3.1 Initial implementation

This testing ground has been implemented in the programs of electronics (EA) and electromechanics (EM). The implementation consisted of different steps, taken in three consecutive academic years. In the first academic year, one trial project was set up in the electronics division, with a team of four students. Meanwhile, effort was put in making publicity for the testing ground. This publicity consisted of the design and distribution of flyers and an announcement in professional journals. Specific companies were contacted and visited to find suitable assignments for the following academic year.

In the second year, more than 140 students of the electronics and electromechanics divisions participated in the testing ground. Less effort was needed to identify new assignments for the third year. This was because the testing ground had become more known, also due to the publicity made in the first year, and due to advertisement by word-of-mouth.

In the third year, 20 students of the electronics program (which was 40% of total), and 176 students of the electromechanics program (which were all students) were involved in the testing ground. Not all students from the electronics program are involved in the testing ground because the teachers also provide in-house projects with topics e.g. from the research groups, acting then as a company providing an assignment. For the next academic year, the objective is to have the same involvement in the testing ground.

3.2 Practical organization

In the months before the course starts, the coaches, members of the educational staff, look for suitable projects. The search starts by contacting companies as mentioned in section 3.1.

The project starts with composition of the teams. These teams are composed by the students (the EA approach) or each student chooses a partner, and two duos are put together by the coaches (the EM approach).

After that, the projects are presented to the students and the student teams hand in a ranking with their preferred topics. Whenever possible, the preferred topics are assigned to the teams. Also coaches are assigned to the teams. The task of a coach is not to provide the students with a solution, but to guide them through the project giving feedback. They also attempt to enhance the cooperation within the team and are available for (well-defined) questions. However, the team of students itself is responsible for both the process and the technical solutions. The coaches are also evaluators of the teams.

During the project, the students have to apply the knowledge they have obtained previously, and also gain new knowledge. This new knowledge is partly project-dependent – the coaches guide the students towards the source if they cannot find it on their own, and partly useful for everybody. For the latter type, a series of seminars is organized, containing topics such as design, safety regulations, advanced technical drawing, etc.

Because of the different programs in EA and EM, the projects are one-semester projects in EA and 2-semester projects in EM. The total number of man-hours per student is however the same for both programs. A total number of 200 hours per student is the expectation.

4 GRADING

4.1 Grading in EA

Table 1 presents the elements counting for the course score, used in the electronics program in the academic year 2012-2013. The students work in teams of four students. For the team scores, following elements are scored: technical skills and knowledge, critical thinking and intellectual input, team work and time management/paper work. The first deliverable is the plan of approach. Weekly updates of the project plan are expected. The students have to hand in a technical report, but the final deliverable is here a working demonstrator. The students have to proof the operation of this demonstrator in a final presentation.

Table 1: Scoring elements in the EA program

Evaluation element	Evaluator	Team/individual	Score	Weight
Process and results	Professors	Team of 4	(0-20)	10
Final project presentation, demonstration and defence	Jury (Professors + company)	Team of 4	(0-20)	10
Maximum score				**20**
Peer assessment	Team members	Individual	Bonus/malus max. ±2 on total score	±2

4.2 Grading in EM

Table 2 presents the elements counting for the course score, used in the electromechanics program in the academic year 2012-2013. These elements contain both team scores and individual scores. The first deliverable is the plan of approach, with the analysis of the design (functional decomposition, list of requirements, project plan). The student teams are then split up in duos, to generate conceptual designs. The reason for this split-up is that the authors tried to enhance the creativity of each student. The concept report is the second deliverable. After this step, ten concepts were selected in consultation with the company, and the teams were rearranged: three duos cooperated to work out one concept in detail. The final deliverable is here a project report with calculations and technical drawings. The students hand in this report a first time three weeks before the final deadline. After one week, they receive an extended feedback to this report. Then, they hand in a second version of this report. In this way, the students get a formal feedback on their work.

Table 2: Scoring elements in the EM program

Evaluation element	Evaluator	Team/individual	Score	Weight
Plan of approach	Professors	Team of 4	(0-20)	3
Conceptual design	Professors	Team of 2	(0-20)	5
Process and results, including report	Professors + company	Team of 6/individual	(0-20)	12
Test	Professors	Individual	Pass/Fail	
Maximum score				**20**
Peer assessment	Team members	Individual	Bonus/malus max. ±2 on total score	±2

4.3 Detecting non-participating members

One of the possible drawbacks of team work could be the fact that some students try to succeed in the course, making use of the work of their team members. Although this is only the case for a slight minority of students, this risk has to be counteracted, especially when working with large student groups. Indeed, it can be the base for conflicts in teams, and could even lead to a negative perception of the students towards team work [8].

To prevent this, the authors do not only use the weekly coaching moments, but also make use of two formal mechanisms to detect this behavior.

The first mechanism is the use of peer assessments. Twice during the project, the students score their team members on three elements: commitment, intellectual contribution and team spirit. These peer assessments result in a bonus/malus of +/- 2 (on a total of 20) for each individual student. The second mechanism is a written test at the end of the project. With the individual test, the student has to prove he was a full participating member of his team. This test has a pass/fail result.

These two formal mechanisms leave no room for discussion if a student does not receive a credit for this course. In the current academic year, 5% of students failed because of these mechanisms.

5 EVALUATION

5.1 Feedback from the students

Together with their final report, the students were invited to hand in a process report of their project. This included an overview of the tasks of the different team members, and also their idea on how they had perceived this project.

Apart from team specific results, two remarkable results came out of this survey. A first result was that the students were very positive towards the participation of the companies. Especially the fact that this was a real-life problem, and that the design was really to be used in a company, was very motivational for the students. Also the intermediate feedback of the industrial partner was found to be very useful and motivational. The industrial partner was an extra cause for the students to take into account all aspects of their design, not only technical, but also economic, practical, commercial aspects. This positive effect was particularly observed at the start and at the end of the project.

On the other hand, the second remarkable result was that the students were generally uncomfortable with the fact that the coaches did not provide the students with 'the correct' solution. In their previous years, the students were used to follow a more or less predefined path to come to an optimal solution (e.g. solving an exercise, or applying an algorithm). The freedom of the design process was for the students not always easy to deal with. This effect was particularly observed in the first half of the project.

5.2 Other outcomes

The implementation of the testing ground also had other consequences. One of the projects has led to a research project, two projects have led to cooperation between the students of EA and EM, and two companies have indicated to have opportunities for master students. Hence, the testing ground also gives new impulses to the cooperation of companies and the University College.

6 DISCUSSION AND CONSEQUENCES FOR NEXT YEAR

Due to the positive influence of the cooperation with industrial partners, this testing ground will definitely be continued next year. However, the comments of the students of EM pointed out that they initially feel uncomfortable with the freedom of the design process. That result was in some way unexpected because the students have had project-based courses in their former years. Also design tasks are part of their curriculum. However, considering these projects in more detail, it shows that all the teams followed more or less the same strategy to come to a technical solution.

To deal with the comment of the students, the educational team has decided to make a few changes to the process, both on the short term as on the longer term. Firstly, the team will try to change the mindset of the students towards the design process. The educational team will spend more attention in the beginning of the project, on teaching the students what they can expect of this project, on putting more emphasis on the fact that a design can have different operational solutions. Secondly, the team will give the students more and earlier feedback in the concept phase. The purpose is to make them more confident in their skills, and to let them perceive the design as a challenge rather than as a risk. Thirdly, there is also a change on the longer term. The team will try to close the gap in this matter between the second and the third year. This can be done e.g. by stimulating more freedom in the designs of the second year, and by putting emphasis there on the fact that the result of different designs can be equal. The students starting next year will not have taken advantage of this change, hence this is a change on the longer term.

7 FINANCIAL SITUATION

The implementation of the testing ground was financially enabled through European funding (Interreg IV A project) and local funding (Province of Flemish Brabant). This extra funding was necessary because some extra expenses were connected with the introduction of the testing ground (e.g. publicity and extra coaching).

Initially, the industrial partners participated in this testing ground for free. There was no financial support from the industrial partners. However, one of the conditions for Interreg financing, was that there was a limited co-financing from the participating companies. Therefore, a limited financial support of € 500 to € 2000 per project was received. This sum depended on the size of the project (manhours of students and coaches). As a result of this co-financing, the involvement of the companies in the project increased. There was an increased contact between company and students, more feedback sessions and also the presence of industrial partners when the students presented (preliminary and final) results, increased. Because of these positive effects, financial support of participating companies will remain in future.

8 CONCLUSION

This paper discussed the implementation of a testing ground in the third bachelor year of electronics and electromechanical engineering in Group T University College, introducing real-life assignments from companies. The participation of the companies was a very motivational experience for the students. In particular, the fact that the results were to be used in reality, the feedback from the company throughout the project and the highlighting of commercial and practical aspects, have been experienced as very stimulating.

Although the students of electromechanical engineering already experienced project-based courses and design tasks in their former years, it was observed that they felt initially uncomfortable with the freedom of the design process in the testing ground. To cope with this observation, the educational team has decided to try to change the mindset of the students towards the design process, to give them more and earlier feedback to support the confidence in their own skills, and to try and close the gap between the former years and the third year. The latter can be done by introducing more freedom in the design courses of the previous years, instead of promoting a similar strategy.

Because of the overall positive influence of the cooperation with industrial partners, this testing ground will be continued next academic year.

9 ACKNOWLEDGMENTS

The authors wish to thank the Interreg IV A program (Crossroads project) and the Province of Flemish Brabant for their support that enabled the introduction of a testing ground in the University College. The authors also thank the participating companies for their interest and support.

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