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UNIVERSITY-INDUSTRY COOPERATION AND STUDENT DRIVEN PROJECTS: A MODEL FOR EDUCATING DESIGN ENGINEERS

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ABSTRACT
Cooperating with industry to create "real life" projects for students is a 30 year old tradition at the Department of Human Work Sciences at Luleå University of Technology (LTU). This paper describes the approach to university-industry projects at LTU, illustrates benefits and problems in the interaction between students, industry and the university.
The students´ practice their abilities in product design and project management. This is also a confirmation of the demand for their education in the industry. By being able to practice their future profession strengthens the student's confidence and gives them a feeling of being competent. During the project the students are given good opportunities to start building their professional network. The projects also act as key features in their CVs and portfolios.
These projects serve as a display window for the MSc program Industrial Design Engineering at the Department of Human Work Sciences when recruiting new students as well as for marketing the design engineers to the industry. When employed in the industry, design engineers from LTU often hold key positions where they are excellent contacts for establishing new collaboration. Often these former students contact the university with proposals for cooperation. During the years, many student projects have developed into collaborative research projects. In this way we have created a self generating mechanism where new collaboration is created with former students who themselves have worked in these kinds of projects during their own education.
A win-win-win situation is created where university, industry and students all benefit from this.

Keywords: Design engineer, cap stone course, university-industry cooperation, product development

1 INTRODUCTION

The "Engineering Design" program results in a Master´s degree at Luleå University of Technology (LTU). The program started in 1983 and contains two areas, Product Design and Production Design. The students graduating from the program are attractive to the labour market, thus, seldom have difficulties in finding employment after graduation. This program was also awarded the Best Swedish Engineering Program in 2005 by the Association of Swedish Engineering Industries. The program is a classical engineering program with an additional focus on the human role in the collaboration with technology. During the development of this program, close contact with the industry played central role and this paper describes a successful change made in 2002 to the final project course, "Advanced Product Design".
This course is the final course before the Master´s thesis is to be conducted and is a project based course where the students´ knowledge is supposed to be applied to a more practical problem. The original layout of the course was not as open-ended as we had wanted it to be. The students were supplied with prepared assignments which the sole teacher had prepared in advance. The assignments were fictitious and only vaguely connected to real life problems. The industry was not involved at all at this stage. The assignments were mainly product development problems and were designed to fit into the educational program as well as possible. Meaning that the projects coursework, as well as the outcome, was more or less known in advance. The students worked either alone or in groups of two with each group having separate assignments during a period of twenty weeks. The main objective was to find solutions to the presented problems. The teacher played the role as the assigning

"company". At the same time was the teacher both the supervisor and examiner. The course finished with an oral presentation along with a written report.

2 THE PROBLEM

Through the years it was observed that the course did not help the students prepare for the workplace in the extent we would have liked because the course situation differed from what they encountered in the workplace. When expected to take responsibility for a project, handle diffused, and complex problems, the freshly baked engineer experienced difficulties. The layout of the course "Advanced Product Design" resulted in limited insight to the complex reality where there were a lot more factors to consider, i.e. competition, production capabilities, economy, etc. The fictitious assignments were prepared and limited to make the course administration a bit easier. The objective for the university is of course to educate and produce as good engineers as possible and with the course layout described they only experienced stagnation in their knowledge development. If the students are educated for a changing reality, the education must also change. Hence, the problem is how to keep the education up to date and how to best prepare the students for their role as engineers in real life. The purpose of this paper is to show a successful approach from the program of Engineering Design at LTU regarding the above mentioned problems.

3 APPROACHES TO THE PROBLEM

These problems have been identified at other places around the world and there are several different approaches to solve them. A common method is to involve the industry where the main objective is to let the students face real life projects with an external assigner. In these projects the students are also expected to manage the projects as if they were their own. To succeed in this it is important to have a stable course structure. [2] This structure does not necessary have to be visible to the students, a certain amount of uncertainty could help keep the students alert and on their toes. At the same time, academia and industry's cooperation could promote an increased understanding between one another, partly the industry could get insight in how the educators work and partly academia could learn more about the needs from the industry. [3] In this way one could achieve greater consensus between academia and industry. Rohatynski [4] uses a questionnaire approach to identify possible future needs from the industry and emphasizes the need for taking the industry's need into account in the academic education. An extensive survey made at Stanford University, among others, shows that design courses could be categorized in a 2x2 matrix depending on if the course is either individual or team oriented and if it is content or process oriented. [5] Looking at course characteristics in this way one could say that the course at LTU falls in the quadrant team oriented and process oriented. In this type of course one has identified the importance of having meaningful (and doable) open-ended problems to work with. [5]

4 OUR APPROACH TO THE PROBLEM

Besides the approaches described previously one can identify a few other characteristics in the LTU course that makes it successful. To avoid the problem of having prepared and fictitious projects that are not as complex as reality, the assignments now are gathered from companies in the industry. They have real problems with real expectations and demand outcomes. To find suitable projects when the course was first given in its new form, former students from the program "Industrial Design Engineering" were contacted. Advantages with working with alumni from the same program are that they know the course and can therefore find suitable tasks for the student projects within their organisation. They also have an emotional connection to the university and the program and often have a genuine interest in helping out. Together with the representative from the company, the teachers involved in the course formulate project assignments that are presented to the students. Project groups are formed by letting the students choose between the different assignments available but the size of the groups are held between 4 and 8 people depending on the level of complexity of the assignment. By keeping the groups this size one ensures that the students have to divide work amongst themselves thus creating sub-tasks which demands a more advanced project management technique.

Another successful change was that the students received much greater freedom in managing their projects together with the company representative. Now the students now are responsible for defining the details of the project with the company involved. They also have to maintain contact with the

company representative(s) during the project. In this way one gets a greater challenge and more open-ended design problems. [1], [5] The teachers at the university act more like coaches and follow the projects without directly acting in them. The students always have the possibility to contact the teachers for guidance and the teachers also will intervene if they realise that a project is not going well. The number of teachers involved has also increased. From being a course with only one teacher it now has five teachers that guide/coach one to three groups each. In this way it is easier for the teachers to keep up with the groups and to offer adequate guidance to all groups.

5 OUTCOMES

The course change brought with it several good effects. By surveying the course evaluation, one can see that the students, overall, are more satisfied. The course evaluation used at LTU is the EvaSyS course survey based on Ramsden. [6]. This evaluation form can be completed, either as, a paper evaluation or a web based evaluation. Our experience is that the paper based evaluation is preferred because the response frequency is otherwise very low. We chose to use the shorter version of the survey because this makes it easier to get complete answers from all the students. The forms are scanned and the result is presented as in figure 1. Four questions were used based on a five grade scale, where one is the worst grade and five is the best. The course received an overall grade of a three which is average. The following results were, The overall impression is that the course was a good course (2.1), The course literature has been relevant (2.2), The way the course was taught has given me a better understanding of the course content (2.3), and Do you think the workload in this course has been reasonable compared to the course points (2.4) See Figure 1.

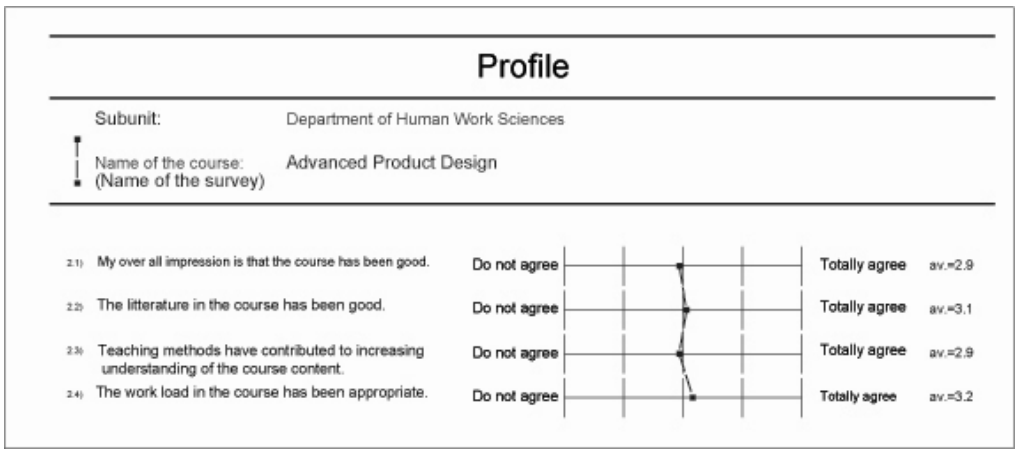

Figure 1. Course Evaluation before change

The evaluation for the reformed course shown in (Fig 2) resulted in grades just over 4.0 except for question 2.3. Compared to the old course this is an obvious improvement. The lower grade for question 2.3 depends on that this is a project course. The appropriate literature studies have been done in the first year courses and the nature of the course requires varied levels of literature between the groups. The students´ written evaluations resulted in comments there they appreciated in working in real projects with very close ties to reality, something they will meet after their graduation. They also show appreciation in seeing the methods they have studied are applicable in the real projects. The teachers in the course have also noticed an increased engagement in the new course. Students earlier perceived as underperformers, grow and show increased engagement and performance. A feeling of "We can!" characterises the teams. This also improves the teaching environment. Teachers only need to have brief meetings to decimate information during the process. The teacher can, if they see a need, present information about where to find new knowledge and information, along with some dialogue about the use of different methods. The teacher takes a role of coaching, a role similar to Schon´s ideas "we are insiders that know the practice". [7] Working in groups can be a work with conflicts. This is also something students as far as it is possible have to deal with and solve, which is, good experience for their future. When it is not possible to solve group dynamic problems teachers must get involved and help out to reach a solution. Dealing with group dysfunction is sometimes necessary. Groups can be dysfunctional for different reasons. Fortunately, for us, this has been very rare. [8]

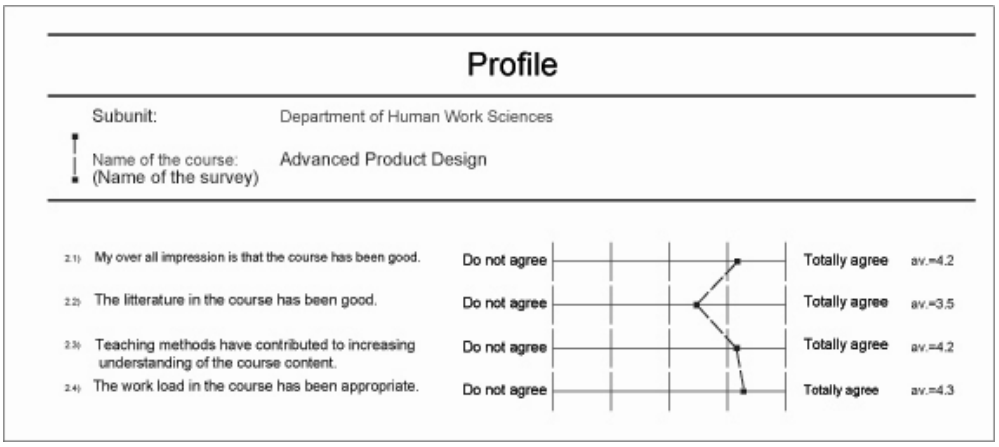

Figure 2. Course evaluation after change

In reality things change faster outside the university, by participating in courses with projects very close to reality, new knowledge is gained naturally, both for the students and the teachers. This increase of knowledge is also of a wide and disparate nature. Teachers also have a need for feedback and confirmation whether the course layout is good or not. With this model there is also a natural feedback from the industry weather the education is relevant for future employment. With this model Industry gets an excellent opportunity to meet with the next generation of perspective employees. It is also a good opportunity for industry to reveal what they can offer these students after graduation. The university also has a great chance to show a good education program with their well-qualified graduates. One thing that seems quite unusual is the "lack" of supervision the teachers provide the students. Although the students are kept under observation the teachers keep very low profiles in telling the students what to do, thus they act more like sports coaches. [9] This is initially experienced as very scary by the students but at the same time it forces them to obtain necessary information on their own. The element of risk serves as a motivator for all the involved stakeholders. At the end of the course the students are very self-sufficient and need very little guidance and supervision thus more prepared to meet the workplace.

6 BONUS EFFECTS

Besides the obvious positive effects a number of bonus effects have also been observed. It has become more and more common for the companies involved in these projects to engage students from the project groups in continuation in their Master thesis work. During the project, the companies and the students get to know each other, thus, it is easier to find a working relationship for the Master thesis. Another by product is that the companies involved in these projects are exposed to the students during the projects, which has, lead to several students being offered employment by their project supervisors companies every year.

Since this approach has turned out to be very successful, former students which now hold key positions in industry, now contact the university, wanting to start student projects for this course. To the university and the teachers, a network of contacts has been created which has been useful in a lot of other applications as well as for finding projects for coming years. It is a win-win situation where every year, the university supplies the industry with new engineers and, on the other hand, industry supplies the course with new project assignments. In a few cases cooperation started with a student project, then continued with a Master's thesis, and finally the students ended up with employment at the company. Our cooperation has gone so far that there are now several research projects there Ph.D. students´ work on issues developed during some of the student projects.

This has turned out to be a self-generating system where all benefit from it. See Figure 3.

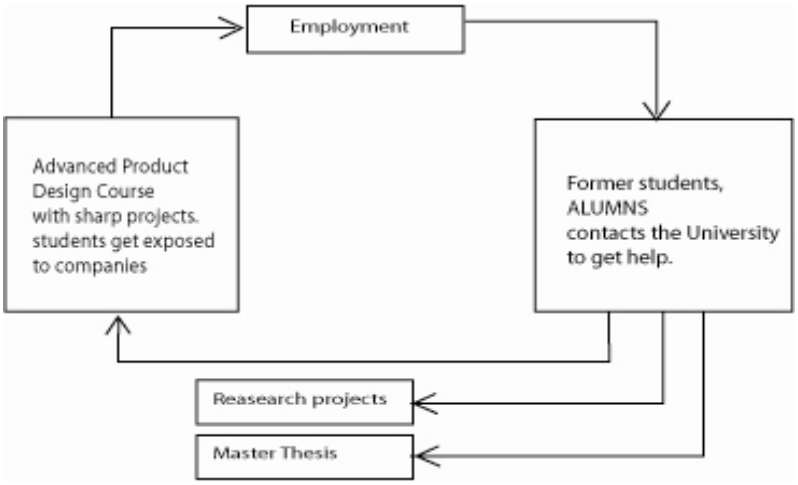

Figure 3. The Recycling Model

7 A SUCCESSFUL EXAMPLE

To exemplify this cycle one example is described here. The cooperation started with the teachers searching for new exciting projects for the final project course. During that process we came in contact with Volvo Car Corporation (Volvo). A project regarding the design of the driver environment was discussed and the focus of the project was driver controlled support functions, e.g. radio, fan, navigator, etc, and the controls for those functions. The project was successful and ended up in a functional prototype of the layout of the controls, and two of the students involved in the project were recruited by Volvo to do their Master thesis work on the same subject. After the Master thesis work one of the students got employed by Volvo with the task to work at the department of Driver Information and Interaction Design. This cooperation on a student project level continued, giving a few more students opportunity to be employed by Volvo. Finally, research cooperation was formed, in which, Volvo and three Swedish universities participated. In this cooperation LTU contributes with two Ph.D. students and senior researchers and Volvo contributed with specialists, project management, and two Ph.D. students of their own. This example shows how an initial approach of searching for student projects leads to research cooperation.

8 CONCLUSIONS

To sum this up one can say that the key benefits are that the university gets meaningful assignments for this project course. This also leads to a natural exposure of the university towards the industry. By cooperating with the industry in the education process, the students increase their chance of getting a better Master thesis project from the companies involved. These projects in many cases lead to employment at the company and in some cases to research projects where the university and the company once again work together. The real life demands of the projects force the students to stand on their own two feet even while at the university which helps prepare them for the workplace. The benefit to the companies, is that, they can hire engineers that are self-propelled from day one. Students get employed, and then they contact the university for getting help with projects from a new generation of students. This next generation gets employed and contacts the university for new projects. In some cases the university has re-hired the former students, now in the industry, as Ph.D. students in research projects, once originating from student projects. In this way we have created a self-generating mechanism where new collaboration is created with former students who themselves have worked in these kinds of projects during their own education. A win-win-win situation is created where university, industry and students all benefit from this.

Figure 4. Win-win-win

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