INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN
ICED 05 MELBOURNE, AUGUST 15-18, 2005

MAKING PRODUCT DEVELOPMENT STUDIES INTERESTING TO FEMALE STUDENTS

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Keywords: Engineering education, product development, gender issues

1 Introduction

Engineering is a vital function for any advanced society, but in Norway, it is no longer a popular education. Young people are inclined to choose other professions. The reasoning seems to be two-fold: Either they choose professions that have lots of media coverage, like law, journalism or medicine, or they choose professions that are known for high salaries.

Engineering does not fall into either category, and therefore is a looser in the competition for the brightest brains. Adding to the problem in Norway is the fact that mathematics is a looser in high school, so that only a fraction of those graduating from these every year is qualified for engineering studies.

This, of course, presents a problem not only to Norwegian industry, but also for society as such.

2 Background

For the better part of a century, engineering has been one of the most prestigious educations in Norway. The university that is now known as NTNU each year sends out around 1500 engineering graduates, who generally find good jobs in industry in Norway and abroad.

Over the last 15 years, however, application numbers have gone down. This not only reflects a decreasing popularity of engineering as a profession, but also the fact that mathematics and physics have lost popularity in high school. So the number of high school graduated with the required qualifications is now reduced by more than 50% compared to the situation in the 80s.

The engineering education has always had a predominantly male student body. We will not go into the reasons for this, but tradition has played a role. Since half of all high school graduates are female, this has been a large, untapped potential for good students.

Another change is that whereas the prototypical engineering student in the old days had some insight into technical products from bicycle maintenance and other such hobbies, the students of the 90s had little such insight. This could be related to a general change in leisure activities among youth, but could also stem from reduced possibilities since the complexity of everyday products have grown.

3 Changes of the program

Our program has changed in many ways. We will go through two important issues.

3.1 Changes in study methodology

The tradition at NTNU is a program in engineering which starts with basic courses in natural sciences and basic engineering. These courses have been lecture based, with individual home assignments – usually with possibility of assistance from student assistants at schedules times of the week – as the way to gain practice. The argumentation for this type of teaching has been that the students need to learn the basics before they can start to do realistic projects. The latter part of the study has included a couple of individual projects of full semester duration.

Is contrast to this, we now use projects from early in the study. We have found that this spurs curiosity and a "knowledge pull", which results in more motivated students. This motivation means that they often learn the basics on their own, but if not, at least they understand and grasp the knowledge when it is later presented to them.

Does project based education draw female students? This is not readily answered. What we see, is that female students in larger degree than male students tend to not select natural science courses in high school. Also, many of those who do, have less experience with practical technical work than their male counterparts. This means that they tend not to be technically at the peak of their class, although their grades in general are better. For many female students, to be presented with a project early in the study, represents more of a challenge than for some of the male students, although prior knowledge and experience among the boys goes from the very experienced to not so at all.

Another departure from the traditional teaching, and this time based on the lack of prior experience with technology and technical products among the students, is a shift to hands-on product analysis. This starts from day one at university. We see a wide distribution of technical knowledge and experience among the students, and the tendency is less experience every year. We have selected a hand tool of medium complexity, a battery powered drill/screwdriver, as study object for the course. During the course, they are taught how to describe technical products with respect to functions, concepts and machine elements. They disassemble the tool, and must find out how it works, what the different parts are for, how they are connected, etc.

For many of the girls (and some of the boys), this is the first time ever that they do something like this. We see them go from total confusion to a confident attitude towards how such products work, and from not knowing which way to turn a screwdriver, to high manual dexterity in a matter of weeks.

The result of this process is a course in the first semester, called Product modeling. In this, the students form groups of 4 persons, and work one full day a week. Two hours a week are lecture, in which they are taught how to model and represent products and technical systems, and the rest is Product lab, where they disassemble, analyze and describe the machine tool in various ways.

They all learn how to disassemble and reassemble the screw machine, and they learn what the functions of all the various bits in there are. They also learn how to suggest alternative solutions to the ones applied in the product, and they learn how to study users in action, and describe users' use of the product and demands on the product. They thereby learn how to make user specifications for a product. Then they learn machine drawing and modeling of the product in a 3D CAD system. And in the end, each group does a mini project in which they apply all the description and modeling tools they have learned to develop their own alternative product to the one that has been studied.

3.2 Changes in case products

To get to know technical components or machine elements has been a mainstay of mechanical engineering education from the onset. Pumps, pressure vessels, joints, breaks and such has been studied, dimensioned and calculated for verification. This has always been seen as useful and has in many ways been a characteristic of mechanical engineers.

However useful it may be, changes in society require changes in education as well. We have seen the number of companies manufacturing typical machine elements in our part of the world go down, and at the same time we see that these elements do not motivate our ever more demanding students.

This is why we decided to go for a totally different approach in our projects early in the study. The factors that were decisive in choosing what the students should work with, were:

- that it should be a complete product, not an element
- that it should be an everyday product that most of the students could easily relate to
- and still it should not be too complex for student groups to handle

Based on this, we selected bicycle as the case product. It fulfills the requirements by been a complete product, it is something that 99% of students can relate to, and it is not overly complex. The product is without bias when it comes to gender; bicycles are equally used and valued by both sexes.

The outcome of this is a course in the second semester of the study, which is called Product development. Again we use an entire day, morning till night, with first a couple of hours of lecture on design methodology – and here we try to make this a simple as possible, by peeling off many less crucial aspects and concentrate on a practical methodology that will be useful for their project.

The rest of the day is used, again in groups, to do a development project of a new bicycle. The student groups do themselves make the specifications for the bicycle; they mimic a market study, and decide where the potential for a new product is highest. Then they make decisions on functions and other features that they want their product to have. After this, they go through a creative phase, and find multiple, alternative principle solutions to their specification. The choose one to develop further, and they go through all the relevant phases to come up with a fully detailed design.

One special feature of the bikes, are that they are required to have a mounting for a small jet engine. We have two of those engines, so they have to borrow them when it should be used.

In addition to the design, they are asked to make strength calculations for the frame, and calculation of speed achieved with the jet engine, and the fuel consumption of the jet engine.

At this point, they are brought into the workshop, where a large heap of bicycle parts are available for them to use in the project. By that time they have all been through a short course in welding, turning and milling, so that they are able to handle the tools in the workshop. Then building the bicycle is the next task. This is a rapid learning experience for most of the students.

As part of the building, they make small prototypes of the windscreen they have designed, and run them through a small wind and smoke tunnel, to see how the airflow goes and to get an estimate of the drag.

And then, the grand finale: A run between the teams, where they are clocked with and without jet engine.

The result of all this, is course which integrates product development methodology with practical training in product development and in technical skills.

We find that the course is highly motivating, and that it brings those students that lack prior exposure to technical issues up to a level of confidence that we never saw in the old model. We also find that this course is a major selling point for the program as such.

These two courses have made it possible to keep application numbers at an acceptable level for the program, partly because it draws female candidates. Over the last couple of years, the percentage of female students in the program has been around 25%, which is quite an improvement.

However, bringing in female students is only half the story. Since our program contains production engineering and thermodynamics as well as product development, we need to convince them that our courses later on in the study are the right ones for them.

Again we use practical projects, but that is not enough to convince them. Our department, which is responsible for product development teaching, has had a strong focus in two areas: car components and equipment for oil fields. These areas have often been determining the areas for projects in the latter part of the study. And here we see that we lose the female students. Car interest is unevenly distributed, but with a much higher score among males. And the oil industry and the oil field development industry have always been very male dominated. We find few female student with an urge to go into those areas (although they do exist).

Therefore, we have developed a third focus area: Medical products. This is very new, and we do not have many results yet, but right from the start we saw that this attracted female students. So much so, that in the short time we have made projects in the field, the majority of students have been female.

4 Results: Do we attract female students?

It is found that project oriented design work is not in itself enough to ensure interest from female students. With a predominantly male teacher body, projects tend to be concerned with

products that are more interesting to male than to female students. The change to a project based program therefore in the first phase led to an increase in interest from male students, whereas female students were only moderately attracted. The important issue of product focus in the courses was then taken into account, and a change in gender distribution was almost immediately seen.

5 Conclusion

Changing a lecture based program into a project based one, does not automatically make it more appealing to female students. Such a change means that the focus is very much on the products they work on in the projects, and the choice of product group seems to be of great importance. There seems to be a clear difference between genders regarding which product groups they are interested in working with. Choosing the right products, and presenting companies with the interesting products as cases, is a key to attracting female students.

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