INNOVATION ENGINEERING PEDAGOGIC STRATEGY OF HALMSTAD

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ABSTRACT

At small Halmstad University we have, for the past 13 years, a unique educational program in INNOVATION ENGINEERING. The three-year program provides the candidates with a broad technical and economical education with special emphasise on handling the innovation process and running new product development projects.

An optional fourth year, entitled INNOVATION MANAGEMENT, focuses on leadership, innovation, and the choices of technology in multinational companies.

This is the summing up of 13 years of experience, during which 286 INNOVATION ENGINEERS received an education (even if 22% left with one or two unwritten exams).

EDUCATIONAL PRINCIPLES

* Integration between several disciplines.
* Integrating studies with comprehensive projects.
* Working closely together with personally developed contact network.
* Production of hardware prototype with budget responsibility.
* Presentation in writing, spoken, and public exhibition of project.

Two technical areas are integrated: mechanical engineering with machine design and electronics with automatic control engineering. Futhermore, there is integration between engineering and business administration with marketing. Business and technical English is also studied.

The special emphasis in the program is on handling the innovation process and running product development projects, which entails a study of patent law and project leadership among other things. For instance, lectures are also given in human resource development.

After the first year spent studying basic engineering, the training is mainly carried out in the form of industry related projects, where the technologists make business contacts, are responsible for a budget and conduct their own negotiations with workshops they choose, in order to

develop a prototype. During the past 13 years we have built up good relation with local industry, and all the INNOVATION ENGINEERS, who work mainly in industry, are a great contact source.

This program also intends to give the engineer competence to start and run a company of his or her own, which 18% try according to official records. Actually, 17% of those who fulfil final thesis project state that they run an active company either part or full time, defined as paying income tax on company turnover.

PROJECTS

Half of the studied subjects concern product development in one way or another. The essential projects tied to the main courses are related here:

**** Product Improvement:***
This is part of the subject *Mechanical Engineering*, studied during the third semester. The students work in groups of four. An existing product is picked out in co-operation with an industrial concern. The product is improved in respect to manufacturing economy and/or function.

Concept design, information search, report writing and oral presentation are trained in connection to this project.

**** Product Planning:***
This is part of the subject *Innovation Technique* during the fourth semester. In this project the students work in groups of four and start with an analysis of a local company. Each group works with different companies. The company's profile regarding technical competence, marketing channels, production possibilities, etc., is first analysed.

When different tools for stimulating creativity are studied, the student groups work out ideas for new possible products for the company. Here the student groups often work two and two together, as eight people is the amount, which according to research, is the recommended number for brain storming.

Further more the ideas are also evaluated according to different calculations regarding project economy and future production economy for each idea. The calculations are made according to company procedure and if possible with some new thinking.

A few of the best ideas with a short evaluation are presented to the company representatives. There is training in presentation technique and a written report is presented.

Finally, an attempt to estimate the "innovation climate" at the studied company is made and documented.

**** Marketing:***
Also in the subject *Business Administration with Marketing* a project is carried out. This is done simultaneously with the project *Product Planning* during the fourth semester and is normally integrated with this project as the analysing of the industry is a common part of both projects. A market investigation with inquires is then carried out and a marketing plan is outlined. Finally, the result is presented to the company both at a briefing and in a written report.

**** Product Development:***
This is part of the one year course with the full name *Integrated Product Development with Entrepreneurship.* It runs semester five and six and is the final thesis work in the three year program.

There are two different ways of undertaking this project. One is to get allied with a company, which expresses an interest in a certain well specified market, or in a certain type of product. The other way is that the student has an idea of his or her own. The student then builds up a network which eventually involves a production partner. This final year the students work in groups of two.

The product developing process is carried out according to what is adequate regarding the specific project. An attempt is made to take into consideration every aspect and the idea is to work simultaneously with all aspects and problems, such as:
- studying basic knowledge in appropriate fields, searching for information,
- building up a network of people who might have an interest in the new innovation,
- considering necessary restrictions if any, from approving authorities,
- analysing market demands and possible competitors,
- generating ideas, working out sketches and different principle solutions,
- conclude agreements as to confidential information, etc.
- consider possible patents of invention (22% of former students have applied for a patent)
- choice of material and technique such as machine elements, electronics for control,

- making product calculations with due consideration to different production series,
- making project calculations considering different alternatives for the future,
- searching for financing
- construction design, redesigning, modifying
- buying workshop labour
- negotiations and closing settlements of different types
- carrying out tests
- working out budgets, time schedules, plans, reports, etc.
- building up a prototype
- presenting the project to the public with a prototype at an exhibition

It is easily seen above that no activity can be fulfilled without considering the others. Every aspect has to be dealt with at the same time. This is why it is called simultaneous engineering. And the list above is far from complete. From this you realise that there is very little time to plunge too deep into uncertain technical solutions. One year is actually a far too short amount of time to develop a new product. This is why we try to avoid too much technical risk-taking demanding laboratory resources and consulting of specialists and scientists.

Of course the product is normally not ready for entering the market when the student has worked his year with the project. We are happy that the student enters the market himself. However, some projects go very far and do enter the market, especially if it is a low-tech product, which actually is to be preferred for pedagogical reasons. Some projects also start as an improvement project and are worked on for two years time during the study program.

The main purpose is that the student must document a total plan for the future of the product (or show that the project should be closed down). Showing how to handle all the complex aspects of a new product development project is more important than to build up competence in some very specific technical branch.

PEDAGOGICAL REMARKS

There is one pedagogical principle behind the program. Give the students freedom, encouragement and trust and let them set there own goals, and they will surprise everybody, including themselves!

A closer discussion on last year's final thesis work will be done. An innovation is defined as an invention with economical potential. Handling the innovation process is the only thing our INNOVATION ENGINEERS

are supposed to be specialists in. Otherwise they are expected to consider and handle all other technical, economical, administrative, financial, legal, etc., aspects.

The students' self-confidence is built up. The role as a project leader is emphasised. The student must be willing and have the ambition to deal with all sorts of problems. He or she must identify with the project, which he or she must choose out of own free will and carry the responsibility for. Therefore, he or she must be the owner of the project or, if the owner is a company, the student must be the one who gets all the credit or is the only one to be blamed if anything is not going the most right way. This is achieved by making the teacher almost invisible in the relations built up around the project. Many such relations are built up in order to find financing, getting a reference group representing the market or future selling partner, finding different specialists to collect various information and so on.

Each week the teacher demands an oral report from each student group and offers advice. The meetings are compulsory, otherwise only the most successful students show up (in order to be admired). The meetings with the teacher are done in discussion with two groups at the same time for mutual benefit between the groups. The student is given great freedom in setting the goals and deciding upon what is to be done. The teacher's role is to demand that the student actually structures the work, produces reports and shows some advancement every week. Experience shows that it hardly ever happens that the student is not ambitious enough. On the contrary, the teacher must often warn that he or she is too ambitious. It is always a battle against time.

We try to avoid high technology, which demands the need for research and laboratory work demanding more time and money. Even the development of a simple product is very time consuming. Normally there will not be time to fully complete the drawings adapted to a specific manufacturing workshop considering a larger series of products and handling other manufacturing conditions such as inquires for purchase of details and so on. The simpler the product is, the further the process can be driven.

It is essential that the student has got good working conditions. He needs a writing-desk, copy machine, telephone, telefax, drawing table, computer with word-processing program and programs for concept design and CAD, printer, plotter, quick reference library, bigger library with data base information searching facilities and so on. In short he needs an engineer's place of work or office very much like what is needed at his future position in industry.

CHALLENGES

Of course reality at our University is, that too many students get squeezed into one room, that too many have to share the same telephone etc., but all the time we have been happy to see our resources growing. The third year students now have satisfactory premises, but the second year students have not. Some difficulty arises from lack of money due to the specific need of this unconventional education, not foreseen by the economical frames of the state, but fortunately we now have a better platform to stand on. On the other hand our university is expanding very fast with other more conventional educational programs and a growing difficulty is to maintain our privileged situation, which no doubt is a condition for this education.

With a growing department, more teachers come into the picture, and they naturally lecture in their speciality, meaning that they teach our INNOVATION ENGINEERING students part time and more conventional courses part time. These teachers of course have their ambitions tied to their specific subjects. Naturally enough they tend to increase demands in their subjects and there will be a difficulty to guard the necessary balance and also to find space in time schedules to expand "the generalist subjects". With upgrading demands in specific subjects there might be less slack time for innovative procedure. My judgement is that optimum time to tie up the students in a time schedule is somewhere between 15 and 20 hours a week. Above that, they either tend to have too little time for own work and studies or they tend to avoid following all lectures. When it comes to the last semester they should not be bound to a time schedule more that two or at the most three days a week. They work day and night both on weekdays and weekends with their projects. They must have time to travel and to meet their network, which in modern product development is growing more and more important.

It is also obvious that it is difficult to find competent teachers in the most important subjects with connection to product development. One obvious demand is the importance of industrial experience, which normally is not combined with research competence, something the academic system encourages. Teaching these special subjects is most thrilling, but also most exhausting.

It is important not to lecture too large classes. When it comes to conventional subjects it is difficult to argue for not having normal groups. I have to point out such subtle factors as building up group solidarity. Actually group dynamics is a tangible force to use in this education.

When it comes to lecturing in unconventional subjects, such as product development, innovation technique and all those subjects where it is vital to keep up a dialogue with the listeners, it is devastating with too large an audience. According to my experience you cannot fully compensate this dialogue with having separate discussions in smaller groups. The message has in some way lost its actuality when brought up again. Now, what do I mean with large groups? I judge an amount of 32 to be a good compromise. For some time now we have handled classes of 48. This is possible, but not recommendable. We now have a class of 66, which I do not hesitate to say is too large.

Finally, I would like to stress the importance of what I call the inheritance from one student generation to another. In order to stimulate this, you have to make the students of the lower classes listen to the reports given by students in higher classes. This has to be organised, which is more difficult than it sounds, as all students have a very tight time schedule for their own briefings. Again this demands an understanding of the importance of this inheritance among both students and teachers.

SPECIAL RESOURCES

During the last semester before graduation the student can apply for economical assistance for covering costs for application of patents of invention and even for consultant assistance if the matter seems too complicated to be handled be the inventors themselves. Of course, projects with the highest economical potential are given priority. This funding comes from The Swedish National Board for Technical Development (Nutek) and The Regional Development Fund. Some of the projects can also get full financing from the same sources during their studies. Otherwise this is where companies and private inventors can apply for support, but we have build up a direct channel into these organisations. Actually, one of our earlier graduated INNOVATION ENGINEERS is in charge of these matters at The Regional Development Fund in Halmstad.

Even if it is not the purpose of the education, it is of course of great interest that as many projects as possible find a future after the student has graduated. A local board for supporting industrial development in the area called Nfo (Stiftelsen för Teknisk Utveckling i Hallands Län) is closely connected to our University. This is where spin-off companies can, for some limited time, be supported after the students have finished their studies. Here the new companies find a creative atmosphere and exchange experience and service with one and other. Also a new

company can be supported with reduced rent for office, telephone etc., and sometimes with a small starting up contribution in financing. The idea is to increase possibilities to support the new concerns with competent people sitting in on the new company's board.

ENCOURAGEMENT

All kinds of encouragement are of course important. We have local scholarships, and we urge the students to take part in national competitions concerning innovations, such as the Innovation Cup, etc. Our students actually have been lucky enough to achieve several quite prestigious awards. Out of all the former students (286) who have passed the final thesis project 20% have received some official honour concerning innovation. This figure however includes our local scholarships, which roughly accounts for half of this figure.

Another way to inspire the students is to arrange project work abroad. So far 24 students out of a total of 286 have been involved in final thesis projects concerning the two developing countries Sri Lanka and India, including two trips for each student to the country in question. The first stay is always at least 60 days according to rules set by the financier, The Swedish International Development Authority. Another 22 students have fulfilled their *Product Improvement* project also to the benefit of one of the above mentioned countries. In this less extensive activity only 6 students have travelled, but with an equally long stay. Next year 7 students will undertake a final thesis project concerning pollution control for the Baltic States. 4 students have already spent a week in Estonia.

Of course the most important encouragement is the project work in itself, providing that the consulting teacher inspires the student with confidence. Also there is the inspiring chance to carry on and make a future living on the final project.

FINAL REMARK

The new European Community is making it more important that we can give our students an academic title instead of the very local term INNOVATION ENGINEER. New rules are now to be settled by government authorities as to the B.Sc. and M.Sc. So far we see no difficulties in giving our students the title *Bachelor of Science in Innovation Engineering* after the three year course. We are now working on making the forth optional year focus deep enough on innovation and product development to qualify for *Master of Science in Innovation*, or a similar adequate title.

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