Ecodesign education and activities at the Norwegian University of Science and Technology

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1 Introduction

A widespread awareness of a need to continuously improve the eco-efficiency of products, processes, systems and humans to obtain sustainable development, is recognised. Within product design, it is acknowledged that there is a need to develop cleaner and greener products as added value, and eco-efficiency become recognised as key element of competitive advantage. Because of this increasing importance of environmental aspects, ecodesign is now included in product development education. The focus on environmental aspects in today's product development education, and training in useful methods needs to be built up. The objective of the this paper is to give an overview of the efforts to, and the experiences of, strengthening environmental aspects and training useful ecodesign methods within a quite new Norwegian product design engineering education.

2 Department of Product Design Engineering - History

The rapid development of new products is dependent on highly-qualified engineers who are specially trained for this complex task. In many schools of mechanical engineering the aspect of synthesis has lost ground to new and advanced topics of analysis and technology. The old "art of engineering" is not there anymore. Students are trained to comprehend facts, analyse problems and avoid risks. This may be viewed as a rather one-sided development of the left hemisphere of the brain, the tight and sensible part of our intellect.

However, in industrial design education one finds courses which train students in a creative, intuitive way of working, where methods and techniques are used to promote synthesis and development of new ideas. Here characteristics of the right hemisphere of the brain seem to be more appropriate; flexibility, risk taking and artistry.

In 1993 the Norwegian University of Science and Technology, NTNU initiated a new engineering course in product design. One of the basic ideas was the wish to utilise both brain hemispheres and thus combine the skills of synthesis and analysis in the

same professional education. The Department of Product Design Engineering was then formed in June 1994 to develop and complete this new programme of education. The Department is formally a part of the Faculty of Mechanical Engineering and has close contact to the Faculty of Architecture.

After 5 years of intensive studies and a final thesis successful students will be granted a "sivilingeniør" (M.Sc.) degree. A primary objective is to educate product designers to work closely with Norwegian industry in product development and design. Industry in Norway has already shown great interest in this new type of engineer and contributes with financial support and interesting projects.

The curriculum is relatively programmed and involves a comprehensive workload with emphasis on:

- Bringing the knowledge in the sciences that are the basis of all engineering activities.
- Bringing insight into scientific and professional working methods in the sphere of product development.
- Enhancing creativity and developing skills in communication, teamwork and leadership emphasising responsibility on social and ethical aspects.
- Developing understanding of the economic, ecological and sociological consequences of applied technology.

Within this context teaching and research on the subject design for environment is conducted.

3 Teaching ecodesign at NTNU

For students in the 6th semester, an obligatory course in ecodesign is offered. The predefined load is 91 working hours. The groups are relatively small, up to 25 students. The students do not have previous knowledge in ecodesign, but have met environmental aspects of technology within differ-

ent other subjects. The United Nations Environment Program, UNEP, Ecodesign manual [Brezet, van Hemel-97], is used as the main basis, but supported by the use of other methods as well. Projects, where groups of 4 students analyse existing products and propose new solutions with the use of ecodesign methodology, are an important part of this course.

This year, products made especially for children were intentionally chosen. The case products were a children's bike-seat and a family snow raider. It appeared to be a good choice:

- The complexity of these products were just right for the time available.
- The students were familiar with the products.
- The products were motivating, because the students felt that an early confrontation (already as a child) with ecodesigned products may have a positive effect on awareness.

The course was organised with two intensive seminars, and between these seminars the groups worked with their projects. The projects were executed in co-operation with a company. The communication with both supervisor and company was long distance.

The procedure for ecodesign as described in the ecodesign manual [Brezet, van Hemel -97] consists of 7 steps; 1) Organising an ecodesign project, 2) Selecting a product, 3) Establishing the ecodesign strategy, 4) Generating and selecting ideas, 5) Detailing the concept, 6) Communicating and launching the product, 7) Establishing follow-up activities. The students follow these 7 steps of ecodesign, but are advised to choose themselves between different available methods at each step. An example of a tool included in the UNEP-manual is the M(aterials) E(nergy) T(oxicity) matrix, that gives quick insight into the main environmental problems related to a product. A similar tool is the M(aterials) E(nergy) K(chemicals) A (Others) -principles suggested by Olesen et.al.[1996]. A traditional life-cycle-analysis (LCA) often supported by computer programs are mainly too comprehensive to be used at early stages of product development. These methods proved to be useful alternatives. However, the students also get experience of using computer based LCA-programmes, and of evaluating these results. SimaPro was used to analyse the existing products.

Also methods from other areas, such as from the area of man-machine-interface design may give ideas within ecodesign. User descriptions related to users "environmental needs" gave interesting focus within the ecodesign projects.

The UNEP ecowheel is another tool that serves as an optimisation assistant tool for designers when choosing between different ecodesign strategies. It visualises the state of the art, and the aims within the different ecodesign strategies. The strategies in ecodesign treated in the UNEP ecodesign manual include:

- selection of low impact materials
- reduction of material usage
- optimisation of production techniques
- optimisation of distribution system
- reduction of impact during use
- optimisation of initial lifetime
- optimisation of end-of-life-system
- new concept development.

These strategies were followed in the projects as well.

Ecodesign may be performed at four different levels [Stevels, in Støren 98];

1. incremental improvement
2. complete redesign of existing concepts
3. alternative fulfilment of functionality
4. functionality completely fitting into sustainable society.

All four levels were taken into account, within the teaching activities, and also within the projects. In the projects, it turned out that most suggestions were within level 1 and 2, whereas especially level 4 were too scarcely covered. One seminar day was dedicated to this level, containing presentations, discussions and a group assignment, based on a modification of the "back-casting" methodology described in Vergragt [1998]. The problem area for the group assignment was "Sport and spare-time for the active family in year 2040".

Scenarios were described on:

- What kind of activities?
- How are the activities organised?
- What effect may each scenario have on the availability of products?
- How may the company meet these scenarios?
- How may our habits change?

The students were very positive to this assignment, but did not develop the ideas further in relation to

their projects. They were still too bounded by the existing products.

In our education we seek to support the "Quality Education" principals described in [FLUX96]. An interesting guideline is "Recognising each learner as a teacher, and each teacher as a learner- no authority is absolute; life is a never-ending learning process".

Our teaching activities and research activities are closely related to each other, and they thus continuously influence each other's development. The search for new environmental design tools and adaptation of such tools to the methodology of product design is emphasised,. The research is mainly in the area of applied research. The development of the education itself is a main objective. Central questions are 'Does the method lead to increased awareness and motivation from the students? Does the method result in concrete, environmentally beneficial, improvements in the product design?'

Further, a data-lab for conducting LCA-analysis is built up at our department. Also in relation to this work, research and development is being conducted.

At present, a central activity is closely attached to the EU-project ELCE2000 (Environmental Life Cycle Engineering), where our department is an active partner.

4 ELCE2000

This project is developed as part of the European Union SOCRATES programme, in order to produce a set of 4 European Modules on the basis of Open and Distance Learning (ODL) principles, focusing modern perspectives of the implementation of the "Industrial Ecology" concept.

The background is an urgent need to improve the engineering curricula towards a more life-cycle oriented approach where important environmental aspects and working tools are truly integrated parts of non-environmental engineering disciplines, and towards the European dimensions where students are challenged to learn about how such issues are dealt with in different countries.

The general aims of the ELCE 2000 project are to demonstrate how environmental life-cycle engineering principles could be built into the university curricula in a way that strongly emphasises the European dimensions of how to implement modern environmental engineering strategies. The objectives are:

- To develop 4 European Modules on key components of the life-cycle approach;
- To integrate the modules in university curricula, i.e. to offer possibilities to students of the partner universities to follow modules as elective part of their curricula,
- To design the modules in a way that specifically addresses flexibility and accessibility with respect to student recruitment, and comparative aspects with respect to awareness-raising on national differences in environmental strategies and boundary conditions, by combining traditional lecturing, learning by project, and the use of ODL technology, and finally
- To disseminate project outcomes and to offer similar modules on a broader scale (students at other universities, professional engineers and teachers) by use of ODL infrastructure.

The main target group is students from the partner universities, particularly in the project's first phase, in parallel to the development of the modules. In the full implementation period in the later phases (1999-2000), and onwards, external participants and teachers shall be a high priority target audience.

The four modules are:

1. Sustainable Management and Technology
2. Product Ecodesign
3. Process Design for Cleaner Production
4. Waste Management & Recycling Technologies

Norway has participants within the project groups for all four modules, and our department is an active partner within the second module, Product Ecodesign. The module is built up with the seven steps of ecodesign from the UNEP manual as a backbone, and the user may choose between different guided tours through the material. The theory and methods are supported by cases, examples and interactive questionnaires.

Students attending these interactive courses may also visit one week of intensive seminar. They further have to execute a project in groups together with other students, also foreign students. The first seminar within module 4 was held spring 98. A draft version of the module was then under construction, and the first version is now available.

The ELCE module 2 material will also be used within the course in ecodesign offered to our own students.

5 Results

This section reviews the experience from running the ecodesign course, and results on student motivation and learning, and company advantage are summarised.

The evaluation is based on written response from every student finishing the last course. Some of the statements are summarised and shown below:

- The methodology was interesting and seemed to be well-developed.
- I learned a lot, not only about environment, but also about processes and methods, and how they may be implemented in a project.
- The learning process was a nearly only positive experience.
- This course has made me believe that it is possible to do something.
- Lots of valuable information that will be suitable in other projects as well.
- I have really been inspired to work further within this area.
- As product designers we do have a nearly scaring influence and responsibility.
- It is very motivating to learn how to do something for the environment rather than always to have a bad feeling because you as a product designer support materialisation.

As the statements above show, the students were mostly very satisfied. What they did not like was to have a supervisor abroad, only present during the seminars. They did not communicate very frequently using e-mail. This may be because they were not used to it, and they also did not expect it. The use of ODL within the ELCE project may show another result, because the students attending that course are motivated for a long distance learning course.

The ELCE-module 2 was not finished and could not be directly brought into use this year. However we got some experience by active use of the net in search for information, and we got some reactions on the use of internet in environmental education:

Some mentioned advantages were:

- the possibilities to constantly develop the teaching material, and to always provide updated material.
- the flexibility, and the available knowledgebase.
- less transport of knowledge persons.

Some disadvantages were

- the isolated way of learning,
- displeasing working conditions (to read from the monitor is difficult),
- too much information and easy to loose the track.

It is also impossible to see the total amount of information available, against a book which has a limited thickness.

Many possibilities were pointed out, and the use of interactive learning by the use of internet was seen to be a good supplement to traditional teaching activities. But it was also pointed that the high speed and high requirements to efficiency supported by the internet should rather be slowed down in an environmental perspective.

Both books, [Brezet, van Hemel -97] and [Olesen et.al. -96] were good, they accomplished and complemented each other, and a broader view was obtained. A broader view was also achieved by the use of other material; articles, internet sites, examples.

In evaluating the course, the students were very satisfied with getting real products and contact with a company. However, they had expected that the company already was involved with ecodesign activities, and that more product data were available. This was not the fact, and thus also the company had new experiences by the co-operation.

Totally seen, the reactions from students were mostly very positive, and some promising product concepts were suggested. Many of the students have chosen to proceed their work within oncoming projects as well.

6 Literature

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