CURRICULUM DEVELOPMENT FOR CLEAN TECHNOLOGY

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ABSTRACT

We will need technological solutions which use less energy and utilize materials more efficiently than existing ones. Engineers are one of the key actors for planning environmentally sustainable technology. In addition, more and more services are designed alongside aiming at extended life cycle for products. To be able to design clean technology, new knowledge and skills are needed for next generation engineers. Here, clean technology means all products, processes, systems and services, which harms environment less than their alternatives. Clean technology brings added value to the customer and at the same time either directly or through the value chain reduces the harmful environmental effects. We present here Cleantech Engineers - project aiming at developing a new operation model for integrate clean technology knowledge and skills into the curriculum of the engineering. At present project has been underway for a year. Here we present results from the workshop organised for teachers from the faculty of technology aiming at define clean technology needs from their degree program point of view. In addition, an interview of a student group involved in clean a technology project in last academic year is presented. The relevancy of the CDIO framework to promote clean technology subjects is discussed as well as the expected outcomes of the project.

KEYWORDS

Clean technology, engineering, sustainability, CDIO

INTRODUCTION

Limits of growth on earth were more or less recognised in 1970s when demands of more sustainable living were presented. However, the guidelines for economically, environmentally and socially sustainable life are not easy to give. Rogers and co-workers have found 57 definitions, 19 principles, 12 criteria, 4 conceptual frameworks and 28 sets of indicators for sustainable development [1]. Clean technology is younger concept than sustainable development. Likewise, several definitions can be found for it from the internet having a common message that clean technology is something else than “green technology” or “environmental technology”. According to one definition, “Clean technology means all

products, processes, systems and services, which harms environment less than their alternatives. Clean technology brings added value to the customer and at the same time either directly or through the value chain reduces the harmful environmental effects".

As a concrete outcome of United Nations's conference on sustainable development in Johannesburg, years 2005-2014 were declared as a Decade for Education for Sustainable Development [2]. Schools and universities have environmental management systems and subjects of sustainability are included in the curriculums. To be able to design clean technology, new knowledge and skills are needed for next generation engineers. Still, the interesting question is, how should the sustainability issues taught, as a part of other studies, for example projects or as a separate course? Should they be voluntary or compulsory courses? The subject has been discussed in this CDIO forum also in previous years [3], [4], [5].

THE CLEANTECH ENGINEERS PROJECT

The aim of the Cleantech Engineers project is to develop an operation model for inserting clean technology knowledge and skills into the curriculum of engineering. In Lahti University of Applied Sciences (LUAS) the degree programs in focus are information technology, material technology and mechatronics. The degree program of environmental technology is also involved. We are not developing a new "Cleantech Engineers" degree program in this project but instead are trying to find a way to integrate clean technology subjects into curriculums of "the old ones". The idea is that clean technology needs are different in every degree programs and also the learning objectives will differ.

The methods to collect information about clean technology needs from teachers, company people and other stakeholders are workshops, seminars and discussions. Students are involved in clean technology focused projects and thesis work as well as practical training. The CDIO (Conceive-Design-Implement-Operate) framework and PBL (Problem Based Learning) will be utilized. The Cleantech Engineers project is co-operation between local companies, Lahti University of Applied Sciences and its international partner schools as well as Lahti Science and Business Park, which is the leading Cleantech technology centre of the Nordic countries. The project is funded by European Social Fund, Regional implementation and development centre (Centre for Economic Development, Transport and the Environment), Lahti University of Applied Sciences and enterprises. The project implementation period is 1.5.2010-30.4.2013.

CLEANTECH NEEDS RECOGNISED BY TEACHERS

In May 2010 Cleantech Engineers project organised a workshop for teachers of Faculty of Technology at LUAS. The object of the workshop was to think, discuss in teams, and list clean technology needs from the every degree program point of view. Although there were no company people participating this first workshop, all the teachers have good networks where they had collected the necessary information.

All workshop participants identified a number of energy-related development targets in their own degree programs. Most of the participants had already experience in the implementation of energy-efficient solutions. However, the identification of individual development activities is not enough. Energy efficiency must be involved into all activities throughout the product lifecycle, and it is necessary to include energy-efficient practices also into all productive activities. Changing the mode of operation requires especially a new way of thinking.

In addition, material efficiency, life cycle thinking as well as environmental audit systems and certificates was recognized as important subjects. Also, ideas of implementation of quality standards, development of logistic and subcontracting and improving after sales functions and post-marketing were introduced. Further, exploitation of biotechnology (the use of enzymes, production of plastic materials, environmentally friendly chemicals) was suggested by the teachers and other experts in material technology. Virtual learning and negotiating tools diminish the need for traffic and presentation of environmental data to consumers in a user-friendly way helps people to follow state of their environment. Both can be considered as green-ICT applications.

In degree program of mechatronics, PBL has been used as a pedagogic strategy for 12 years. Clean technology is implemented with project works and also integrated into some courses like electrical engineering. In degree program of material technology the curriculum has been updated during the last academic year by combining three degree programs (wood, plastics and textile and clothing technology). The new material technology curriculum will include a module which is focused on environmental management issues (15 ECTS). In the degree program of environmental technology the curriculum has been updated during the last academic year as well. Energy issues have been upgraded to be one of the three main subjects. In Information technology green – ICT has been adopted as a focus area both in RDI work and in education.

FEEDBACK FROM STUDENTS

Group of six students from degree program of mechatronics were interviewed. This group designed an automatic testing system for ground source heat pump as a PBL project work in 2010. Previously the testing has been done manually. Sensors of the new system enable to locate the problem which in turns makes handling of reclamations easier. One final thesis work “Performance measurement of heat pumps – preparatory work for the improvement of a test stand” was also finished and accepted in January 2011. The new system will be constructed and introduced in June by the company Oilon Home Oy. The company aims to help their customers find environmentally-friendly and sustainable heating solutions that are suitable for each customer's home [6].

An hour group interview was based on the following questions. The answers are synthesis of the discussion.

Question 1: *Did you have a discussion about sustainability or clean technology before starting the project?*

Answer 1: There was no official discussion about sustainability or clean technology before starting the project. The solutions company is providing to their customers were introduced to the students. The project was done in Energon, which is a research centre for renewable energy in Lahti. However, there were discussions about renewable energy solutions among the student group. Reason for that was mainly one exchange student from Austria joining the group in the autumn. He was specialized in renewable energy solutions and shared his knowledge with the group. Another member of the group is HVAC engineer as his previous education and was also able to provide his knowledge and experience for the group.

Question 2: *What did you think about sustainability and clean technology before the project and was there any change because of the project?*

Answer 2: Sustainable development as well as clean technology sound like political terms. It is matter of course that energy efficiency requirement are considered in the planning process.

Question 3: *What makes your project a clean technology project?*

Answer 3: The testing system, which was designed as a project work, saves time (and money) for the company. However, during the project, different heating systems based on renewable energy become familiar.

Question 4: *How do you think that clean technology knowledge and skills will be part of your future jobs?*

Answer 4: Environmental challenges are global. In engineering, the clean technology is something concrete, like calculations about energy efficiency, energy loss etc .

Question 5: Do you see conflict between engineering and environmental aspects?

Answer 5: The economic feasibility is always the most important thing. Still, it makes sense that products is designed so, that they are as energy efficient as possible.

Question 6: Do you think that clean technology or sustainability is an added value in education?

Answer 6: The reason for engineering studies is interest in technology. A very important thing is that the school can provide the newest technology for students. However, clean technology things makes no harm.

Question 7: How should we teach sustainable development; is a specific course or inside the project wok? Is clean technology easier to understand and be familiar with than sustainable development?

Answer 7: If there is a specific course, it should include for example calculations about energy efficiency or loss etc. and be integrated in mathematics and physics. There are clean technology subjects integrated in other courses but they are probably not recognized. Clean technology is also mentioned in description of the curriculum. The projects have to be real cases from the companies, not made- up ones. One project few years ago aimed at only energy efficiency. If clean technology issues are needed in designing, they will be included. There are also projects with no connection to clean technology.

DISCUSSION AND FURTHER PLANS

Lahti University of Applied Sciences joined CDIO network last year and the standards will be implemented gradually to individual degree programs and faculty. In Cleantech engineer projects the clean technology needs are now recognized in different degree programs and also included into curriculums. The implementation of CDIO standards gives an opportunity to implement also clean technology issues. The CDIO framework provides an opportunity to emphasize environmental issues using active learning methods, for example group discussions and debates (Standard 8). Design – build experiences (Standard 5) can be clean technology- focused. Further, clean technology knowledge can be considered as one of the learning outcomes (Standard 2). However, clean technology issues should fit into the course or project work naturally. If inserted artificially, it will turn against the matter. This was a clear message from the interview of group of students. Similarly, the aim of the project work has to be clean technology focused because of the company involved. The integration of energy related calculation into mathematics and physics courses or integration of them into clean technology course was a concrete idea from the students. More or less empty marketing speech of clean technology or sustainability is not working because the main reason to choose engineering studies is interest in technology, at least according to group which was

interviewed. Company people and other stakeholders can give valuable information about clean technology knowledge and skills which are needed in working life. Student opinions are valuable when thinking about how should these issues be implemented.

The expected outcome of the Cleantech Engineers project will be an understanding about the essential clean technology knowledge and skills which should be included into curriculums and how to implement them. The Cleantech Engineers project has been underway for a year. The next event will be a seminar focused on green-ICT, several benchmarking trips and development of energy related modules using at least partly subcontracting. Further, clean technology related project aims are collected from the companies.

Discussion about sustainability or clean technology in engineering is important although one or final solution is impossible to find. The role of student opinions and suggestions in the development work is valuable. In this CDIO forum we are both benchmarking and discussing how to use CDIO standards to implement clean technology subjects in education of engineers.

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