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DEVELOPMENT OF THREE BACHELOR PROGRAMMES AT LINKOPING UNIVERSITY ACCORDING TO CDIO

K. Bjerner[1], S. Granath[2]

1 Department of Science and Technology, Linkoping University, SE-601 74 Norrkoping, Sweden
2 Deans Office, Linkoping University, SE-581 83 Linkoping, Sweden

ABSTRACT

Linkoping University has been participating in the CDIO Initiative from the beginning (2000), through the Applied Physics and Electrical Engineering program (Y). The board of the Faculty of Technology decided in August 2004 to introduce the CDIO concept for three programmes at the Bachelor level starting from the academic year 2005/2006. These programmes are Electrical Systems Engineering (ES), Media and Communication Technology (MK) and Logistics Engineering (TL). Two of the programmes (MK and TL) represent new areas for CDIO at Linköping University.

The development of programmes according to the CDIO Standards and CDIO Syllabus is a major task. Therefore the Board of Studies for the Engineering Programmes at Bachelor level has formed a special reference group with members from the faculty, the industry and the student group. The group both takes initiatives and gives feedback on planned activities. Three main areas has been identified:

- Syllabus according to CDIO
- To gain approval for the ideas
- Successful design-build projects

A survey of earlier syllabus according to the CDIO ideas has been performed. The outcome will be used in the development.

We plan seminars about the CDIO Standards and CDIO Syllabus to get the CDIO view of education and programme goals. In order to introduce project courses in a successful way the teaching staff has followed a course on project management (the LIPS model).

The programmes will have a sequence of three project courses emphasizing personal skills, interpersonal skills and the CDIO view of engineering. All projects will use the LIPS Model (developed at Linkoping University) for project management.

An additional evaluation will be done after each semester for at least the first student group.

INTRODUCTION

Engineering Education in Sweden

Nowadays in Sweden engineering programmes are given at the universities and colleges at both bachelor level and master level. The bachelor level has three year programmes distributed to 24 universities and colleges all over Sweden. Around 5000 students per year start their studies on the bachelor level. Admission requires a three-year natural sciences programme (or equivalent background) from high school (upper secondary level). The recruitment has decreased during the last years depending on problems getting a job in industry and fewer students leaving high school from natural sciences programmes. From the top around year 2000 only 60 percent apply to bachelor programmes now.

Until late 1980's there was no bachelor level in engineering in Sweden. The students studied engineering for four years at high school. These students had a good reputation in industry, but around 1988 two-year programmes in engineering were started at universities and colleges. The reason for this was demand from industry that the engineers needed more mathematics and natural sciences to handle more complicated technology. The degree after two years was University Diploma lower level. In the middle 1990's the programmes were extended to three years giving a degree in Bachelor of Science in Engineering.

The engineering programmes are given in traditional areas such as computer engineering, electrical engineering, mechanical engineering, civil engineering and chemical engineering. Each programme has usually also a specialization in their fields. In addition to these five areas there also exist programmes in newer areas such as media technology, logistics engineering, maintenance engineering and many more.

The bachelor engineering programmes have both a strong technical and theoretical educational objective. The training is based on mathematics and focused on engineering subjects. Students completing these programmes are expected to have the capability to both apply engineering techniques already in existence and to contribute to the development of new techniques. In addition, the educational training programme provides students with the competence to use technical literature in English.

A three-year engineering programme includes mathematics, computer science and natural science in total around 25 percent. Technical subjects in their area have around 50 percent including a final project done during 10 weeks usually in cooperation with industry. The syllabus also has courses in non-technical subjects such as writing and presenting technical reports, economy, environmental maintenance, language studies.

Old Project Courses

In our bachelor subjects (courses) at Linkoping University, Campus Norrkoping, the students have completed a number of projects of different sizes in time and depth. This is a popular part of the curriculum and the students and teachers are very satisfied with projects as part of a course. Study Counselor Camilla Hahn at Linkoping University, Campus Norrkoping has interviewed teachers having projects in their courses. What she has found been missing is a more systematic use of projects in the curriculum, so the students increase their ability to run projects more professionally at the end of their studies. In the plan for the different subjects there has not been an increase in the demand on how the students perform their projects. We have not emphasized so much on the team processes and roles in a team and we have not had an overall plan for content of the project courses and what is trained in different projects so the

students ability to run projects increases continuously. In the plan for supporting courses we have not included parts to increase the students ability to run more and more complex projects.

THE STUDY PROGRAMMES

The study programmes are Electrical Systems Engineering (ES), Media and Communication Technology (MK) and Logistics Engineering (TL). ES and MK are modified programmes while TL is a completely new programme. The programmes, with a total of ninety new students every year, will have a core of common courses. All programmes have common courses in Mathematics, Computer Science, Transform Theory, Computer Networks and Signal Processing. All programmes contain Information Technology and Wireless Communication and means such as GIS and GPS are also important.

The ES programme provides basic courses in Circuit Theory, Electronics and Computer Hardware. Computers and modern electronics are used everywhere to control different types of technical processes. To develop and operate such systems calls for good knowledge in programming and real time systems. The education is oriented towards Industrial IT-applications.

The MK programme provides basic courses in Electronic Publishing, Usability and Visualization (especially small interfaces). Software development and computer science are important parts of the education and they are emphasized in the modified programme.

The TL programme provides basic courses in Economics, Telecommunication Systems, Logistics (especially from a technical point of view), Optimization and Infrastructure. Communication via Internet, radio, mobile- and satellite systems are important resources for identification, control and supervision of goods and transports. The planned curriculum for the TL programme is given in Appendix A.

THE SYLLABUS

As mentioned earlier many courses are common for all three study programmes. We hope this fact will make it easier for us to implement some of the CDIO skills [3] in a more structural way, especially those concerning interpersonal skills but also for example external and societal context. In our old programmes we have had optional courses covering for example, communication, man-technology-organization, leadership, environments maintenance, quality control and more advanced economics. In the new study programmes we plan to integrate more of this in the regular courses. Many of the CDIO skills are covered by three design-build-test courses, where the first one also contains an introduction to engineering. We also will try to follow the good example from Royal Institute of Technology (KTH), concerning how to write course descriptions with learning outcomes [1], [4].

DESIGN-BUILD-TEST COURSES

There are three design-build-test courses in the curriculum. The first one (6 ECTS) is in the first semester. It is programme oriented and is also meant to bee an introduction to engineering. In the first project the LIPS Model [2], developed at Linkoping University for project management will be introduced.

The second project course (9 ECTS) is in semester 4 (spring 2007). The development of the course will start in autumn 2005. At least for some project we will try to form project groups from all three programmes in order to get the working situation more realistic, since the different students can act as “experts” in their areas. In this course the students will themselves formulate the detailed description of system requirements and they also will develop their use and understanding of the LIPS Model.

The last design-build-test course (9 ECTS) is in semester 6 (spring 2008). According to our present planning we will try to realize as many of the projrcts as possible in cooperation with the local industry. So far we have not discussed if the project members will be collected from different programmes for these projects too. It is our hope that the students at this moment are so familiar with the LIPS Model and project work that they are able to realize the project with limited supervision.

For all the design-build-test courses we are of course inspired and influenced by previous work at Linkoping University concerning the Applied Physics and Electrical Engineering programme (Y).

First Design-Build-Test Course

From fall 2005 three different three-year engineering programmes start their first semester with a course called Engineering project (in Swedish Ingenjörsprojekt), for course plan see Appendix B. This course is 20 percent of the curriculum for the first semester and it goes on for the whole semester. The aim of the course is to give the students an idea of how engineers work and an introduction to their study programme. Alumni will be invited to tell the new students what they can expect on the labor market after graduation and also what is their view of the study programme after some years. We will also organize study visits to companies, so the students will get an idea what the work of an engineer can look like.

The students will use the project model LIPS during the project. The course will also give an introduction to group processes and working in a project group. Written and oral communication is also an important and some lectures will cover that area. The project group will have a supervisor and every project has an orderer for whom they present the result and also discuss with of they want do changes in the requirements of the project. There are many documents to be written during the course such as project plan, project report, minutes from project meetings and so on. A group of eight teachers have created six different project assignments, two in the field of every programme. They have written a requirements document for every project. This document will be given to the project group at the start of the course. For every project there are a number of requirements to be fulfilled during the project. The teachers have also written a project plan for every project to see if the extent of the project is reasonable. Both the requirements document and the project plan are written according to the guidelines for LIPS. The suggested projects are the following: Building an alarm system, controlling an industrial process, localization of a storage site, optimization of transport routes, video production and mobile web access. The students have to study theory for their project and learning software etc.

In the end of the semester every group will present their result for other groups. They shall also write a technical report to the orderer. This report will be examined by a language teacher so that it is written in a correct way with a good style.

Description of the Project Assignments

1. **Alarm System**
   The students are going to construct an alarm system built around a PC with a data acquisition card. To the system will a movement detector, a web camera, smoke detectors and so on be connected. In the PC they will create an interface and the programme will tell what kind of event has happened in the system. When the alarm is released a SMS will be sent to two telephone numbers and a mail too.

2. **Controlling an Industrial Process**
   In the lab an industrial process will be built and the aim of the project is to control the process. This will include to study some control theory and also apply mathematics. A visit to e.g. a paper mill is also planned.

3. **Localization of a Storage Site**
   The programme for Logistics Engineering will have a project for to decide the best localize a storage to minimize the distances between customers and producers. The application is thought of to be accomplished with a spread sheet programme.

4. **Optimization of Transport Routes**
   Many power plant in Sweden are heated with bio energy. One such source is what is left when timber is cut in the forests, roots, branches and tree crowns. An application will be constructed for a pocket PC for calculating the volume of organic material and the location via GPS. From routes for trucks will be presented in a PC.

5. **Video Production**
   In this project the students will make a video for Norrkoping community dealing with traffic security for children on their way to and from school. They will study the way to school for some pupils and find the dangerous spots on the way to school. The video shall describe for the pupils how their way to school can be safer.

6. **Mobile Web Access**
   Here the idea is that a café want to give its customers a possibility to wireless surfing to local applications and internet. A server with some applications and a client has to be developed by the project group. The customer must be verified by the network. The students will need an introduction to networking and programming. Programming is studied in a parallel courses during semester.

APPROVAL FOR IDEAS

It has been easy to get approval for the ideas of CDIO among the faculty. People think that this is in the same direction that we have worked for quite a long time, but we will emphasize more on the student to become more professional engineers when they have finished their studies. We have started to include more precise learning outcomes for the students in the plans for every course in the syllabus. So far we have done this for the courses in the first semester. This work will proceed during next autumn for the courses in year 2006. We have found no problems to convince the teachers to present the plans in this way.

ACKNOWLEDGEMENT

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REFERENCES

1. Edström, K, ”Instruktioner för målformulering”, Royal Institute of Technology, 2004.
2. Svensson, T and Krysander C, "The LIPS Project Model", Linkoping University, 2004.
3. CDIO syllabus www.cdio.org.
4. CDIO principles www.cdio.org.

APPENDICIES

A. Syllabus for Logistics Engineering
B. Course description for TNIU01 Engineering project

Appendix A

First year

Autumn 2005, decision March 2005		Spring 2006, decision November 2005	
Calculus, 12 ECTS		Linear Algebra 6, ECTS	Applied transform theory, 6 ECTS
First design-build-test course, 6 ECTS		1 Industrial economics, 6 ECTS	2 Telecommunication Systems, 6 ECTS
Digital Electronics, 6 ECTS	Programming Principles, 6 ECTS	Database Technology, 6 ECTS	

Second year

Autumn 2006, decision November 2005		Spring 2007, decision November 2006	
3 Logistics engineering, 6 ECTS		5 Optimization, modelling and planning, 9 ECTS	
Object-Oriented Programming, 6 ECTS	Computer Networks, 6 ECTS	Second design-build-test course, 9 ECTS	
Statistics and Probability, 6 ECTS	4 Infrastructure, 6 ECTS	Spatio-Temporal Systems, 6 ECTS	Digital Signal Processing, 6 ECTS

Third year

Autumn 2007, decision November 2006		Spring 2008, decision November 2007	
Telecommunication, 6 ECTS	Mobile Communication, 6 ECTS	Third design-build-test course, 9 ECTS	Bachelor Thesis, 15 ECTS
6 Logistics engineering, advanced course, 12 ECTS		Optional course, 6 ECTS	
Optional course, 6 ECTS	Optional course, 6 ECTS		

APPENDIX B

TNIU01 Engineering project, 6 ECTS credits.
/Ingenjörsprojekt/

For: ES MK TL

Area of Education: Technology
Subject: Other subjects

Advancement level: B

Aim:
The course will give an introduction to the engineers work. The course will develop an understanding of what engineering is all about, especially model for project work and project management. The student will get an experience of working in a project group, training in written and oral communication. After the course the students will be able to: - using the project management model LIPS – describe the different phases in LIPS – write a project plan from a requirements document – make a time plan for the project and register time used – run project meetings, write minutes – describe different roles in a project group and their duties – describe a groups phases and different learning styles – write a group contract – do oral presentations – write a user manual – write a technical report – use computer software for documentation – evaluate the result of the project.

Requirements: Be able to use a computer.

Organization: Lectures, lessons, and project work including project meetings.

Course contents:
Lectures - Introductory lecture, CDIO, project descriptions, situating the engineering profession, Group dynamics when working together, Model for project work at LiTH, Communication. Industry related guest lectures. The engineers role as a communicator. Analysis of and adaptation to receivers. Written presentation. Linguistic and formal aspects of technical documents: instructions, reports and descriptions. How to prepare and execute an oral presentation.
Project work - The projects are aimed at presenting the engineering working situation and in addition give the students training in team work and communication. The project work is performed in groups of 5-6 students. Each project takes 2-4 groups. The groups are put together by the course management, which also assigns a project to each group. -All projects are described in brief on the course homepage. The person responsible for the project presents a more detailed introduction during the first meeting with the students. During the work the students have a given maximum time for supervision. In addition, some help to use information search tools will be provided. -The projects have in common that they follow the Model for project work at LiTH, which is introduced during the lectures and also presented in a compendium. Also the examination follows a common pattern for all groups and projects. -The project work should be documented during the work, and at the

end presented in the form of a demonstration and a written report. Both the demonstration and the report is a part of the examination.
Course literature: Compendia in Model for Project work at LiTH, LIPS, and Written presentations.

Examination:

UPG1	Active participation at lectures, exercises and presentation of project.	1 p
UPG2	Project work	2 p

Grades are given as ‘Fail’ or ‘Pass’.