A MODULAR CURRICULUM TO SUPPORT CDIO IMPLEMENTATION IN METROPOLIA

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Abstract
Two universities of applied sciences in Helsinki area will merge in August 2008. All engineering programs will follow the CDIO approach and the curriculum design is based on project courses, integrated curricula, active teaching etc. All the engineering programs have already had project based courses in their curricula, thus the actual implementation of the required CDIO-based design-build projects is not a major problem in the program design. The key point, however, is how to get all the teaching staff working based on the same educational principles and towards the learning objectives of an engineering program. In the new curricula all the individual courses from mathematics and languages to advanced detailed technical subjects are integrated together to support the actual engineering learning objectives. The solution is a modular curriculum in which the learning objectives of an individual engineering program are first of all divided to yearly learning objectives and then to learning objectives of the so-called study modules consisting of a set of courses to be integrated together based on these objectives. The key issues in the curriculum design and course integration are presented in this paper.

Keywords: curriculum design, modular curriculum, course integration

Metropolia Helsinki University of Applied Sciences

Two major universities of applied sciences in Helsinki metropolitan area, EVTEK and Stadia, will be merged in August 2008. The programs and curricula of the new university, Metropolia, will be profoundly renovated. It has been agreed that all the engineering programs will follow the CDIO approach. In order to fully implement CDIO throughout the university it is required that the curriculum framework will support that objective focusing on project courses, integrated curricula, active teaching etc.

Curriculum design

Most engineering programs in the two present universities have already a long tradition in organizing at least some project courses or project based learning within their studies. Also the teaching staff has been traditionally encouraged to emphasize on active teaching methods. One of the key problems, however, is how to motivate all the staff to work according to CDIO principles and how to integrate the curricula in a way that the teachers of different subjects could work together for the common learning objectives instead of lecturing their own courses independently. The Conference Program Committee reserves the right to edit titles and descriptions for language and style.

Modular approach
The solution is to implement a modular approach in the curricula. In practice this means that each year of study (60 ECTS credits, 40 weeks) is divided in four periods (15 credits, 10 weeks) and the individual courses in one period are integrated together to support a common theme and common learning objectives. According to ECTS principles each year of study has a common theme and a set of yearly learning objectives. In this approach these themes and learning objectives are then divided to objectives and themes of each period. Each period consists of 3 – 5 different courses, which are integrated to form a teaching module within that theme to support the learning objectives of the theme.

Course integration
The courses to be integrated within one period may be courses in engineering, non-technical studies (languages, economics etc.), mathematics, physics, etc. It is required that for example the mathematics courses in one module should support the engineering subjects there and that in the language courses the presentations etc. should be given in the topics of the engineering courses. It is emphasized that the non-engineering studies should support the engineering learning objectives as well. The courses in one module may have common exercises, laboratory assignments, projects etc. It is however decided that the individual courses within one study module will be assessed separately in order for the future employers of the students (for example) to have a more detailed view on the contents of the students' diploma.

Course integration example
In all engineering programs in Metropolia the duration of studies is four years (240 credit points). The studies are divided into basic studies (75 credits), professional studies (105 credits), optional studies (15 credits), industrial placement (30 credits, equals 20 weeks) and the final year project (15 credits). The individual courses of the basic and professional studies are implemented in 12 modules (~15 credits each) in which these studies are integrated. The 12 study modules in the program of electronics engineering (as an example here) consist of 8 common modules for all the students in the program, 2 alternative modules depending on the specialization of the student and 2 optional modules (in the field of electronics).

In the first year all the study modules (4) are common to electronics students. The topics of these four modules are: 1) orientation to electronics studies, 2) basics of circuit theory, 3) basics of electronics and 4) electronics project module. The contents of the latter two are given as an example:

Basics of electronics (study module #3)
- Circuit analysis 2 (4 credits)
- Analog electronics 1 (3 credits)
- Differential calculus (3 credits)
- Finnish communication skills (3 credits)
- Computer aided design in electronics (3 credits)

The core of this study module is the first course in analog electronics covering operational amplifiers and their applications (the first course of digital electronics already implemented in study module #1). The analysis methods of AC circuits required in the circuit design are included in the parallel second course in circuit analysis. The two teachers of these courses have to work closely together in order to meet the common learning objectives. Similarly the course in differential calculus then covers mathematical problems and tools related to AC circuit analysis. The main objective of the course in computer aided design is printed circuit board design as well as circuit analysis using modern software. All the small design projects and practices within that course are related to operational amplifier design and the project reports are prepared and presented in the course in Finnish communications skills. In practice this means that the teaching staff of this module have to organize weekly meetings to plan their teaching with respect to one another.

Electronics project module (study module #4)

- Project in electronics; i.e. introductory project (6 credits)
- Analog electronics 2 (4 credits)
- Laboratories in electronics manufacturing (3 credits)
- Project management (3 credits)

The course that binds the goals of this module together is the CDIO introductory project organized in the spring term (fourth period) of the first year. The actual project in the electronics program is a relatively simple design project in which the students design and manufacture a device based on the knowledge from the previous electronics courses. The project includes as well the printed circuit board design using surface mount technology. The actual manufacturing, testing and operation of the device will be carried out in a separate parallel electronics production laboratory course using modern manufacturing and testing methods. To support the actual design work the second analog electronics course and a course in project management are integrated to the introductory project.

Project courses

The introductory project will be organized in all the programs during the first year. It is suggested that the project is integrated for example to supporting engineering courses, project management course (as above) or to a language course (English o Finnish). The final design-implement projects will be organized during the third year. These projects will be organized as well within one compulsory study module and integrated to other courses respectively. These projects will be organized in the Metropolia innovation platforms which are R&D-focused units on different subjects. The innovation platforms are preferably not linked to one engineering program only, but combine the knowledge of different programs. Therefore there will be students from multiple programs (maybe from non-engineering programs as well) working in each of the design-implement projects.

Implementation in the near future

Teaching at the Metropolia Helsinki University of Applied Sciences will start based on the new curricula in September 2008. The actual implementation and integration of the first modules require detailed planning and this work is currently taking place in all the engineering programs.

Besides these activities all the staff has to be coached carefully to the new teaching methods including CDIO principles, thus there will still be lots of actions to be done before we are ready to fully implement CDIO, but the new curriculum framework will facilitate that implementation in all the engineering programs significantly.

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