

# THE METROPOLIA ADAPTATION OF CDIO IN ALL 20 OF ITS ENGINEERING STUDY PROGRAMMES

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## **ABSTRACT**

In this paper we explain the main steps we have taken in Metropolia to adopt the CDIO approach in our engineering programmes. We do not expect that our choices would necessarily be the best practice in other institutions, but report our work to give others reference and support in their own processes, as we have found this important change highly demanding. One important additional comment to make from our experience to date is that one cannot underestimate the commitment that is required. This extends from the involvement of top management, as well as that from individual teachers, especially as the actions being undertaken are mainly being made, not by adding resources, but by keeping them at the same level, or in some circumstances even having to decrease them.

## **KEYWORDS**

**Adaptation, stakeholders, curricula, self-evaluation, quality**

## **INTRODUCTION**

Many institutions have adopted CDIO perhaps for one or two programmes, or for a specific department. However, in Helsinki Metropolia University of Applied Sciences we have started to re-think and develop our engineering education programmes by adopting the CDIO concept and applying it to all 20 of our engineering study programmes. Our aim has been to find our own "Metropolia spirit" by using the strong involvement of different stakeholders, following national and European quality assurance processes in higher education and spreading the mission to all of our engineering degree programmes.

## **ADOPTING CDIO STEP BY STEP**

The process of adopting CDIO started at the 2005 SEFI conference, held in Ankara, Turkey, while some colleagues attended a presentation on CDIO. On returning home they organized the first steps:

1. gathering knowledge about the CDIO initiative;

2. sharing this knowledge of the initiative

After these steps the work focused more on the degree programme level:

3. organizing support for those who were interested in piloting the initiative;
4. collecting knowledge – what has been done already – what is new/different from our established methods;
5. identifying what might be better when undertaken in the new way, what would be best retained from the old and what should be developed in a third direction;
6. encouraging the faculty to make an honest analysis of their most important development requirements. That self-evaluation was completed in May 2009 for the first time, and the results were reported at last year's CDIO conference in Singapore [1];
7. following the availability of results from the first evaluation, a second evaluation; focusing on 1<sup>st</sup> and 3<sup>rd</sup> year projects was undertaken to provide more concrete knowledge and practical ideas. The results of this will be presented in the paper.

After these actions a broader view is required, with connections needed both 'bottom up' and 'top down'. This was provided with the following steps:

8. The internal evaluation has to support any external assessment or even rankings made by any other stakeholder. With that in mind we also decided firstly to make a deeper study of current trends in evaluating and accrediting engineering education – how to make the whole undertaking match, support and encourage better results. Currently the tendency in Europe is not to go for some international or continental-wide system, but rather to build a European framework. An organization called ENAEE (*“European Network for Accreditation of Engineering Education”* created by the most important engineering organizations of Europe) has launched “EUA-ACE” , a label that can be given by the organizations accepted by ENAEE.
9. Secondly we also decided to conduct a study of “where we stand with respect to Finnish nationally agreed definitions for a good campus of engineering higher education”.
10. Finally we have started a benchmark exercise between some Nordic study programmes – to increase our knowledge of these matters at a deeper level.

Following these studies, concrete actions at the level of specific study programmes are being supported by the CDIO engine team. Above that team, there is a steering group, which represents 'top down' involvement. This steering group consists of Metropolia directors, experts, industrial representatives and students. To support the “fieldactivities” there is a ‘key-persons’ network, which includes participants from all study programmes and is open to all of those who want to participate. Additionally all documentation produced from these activities is made available for interested staff members and students.

## **SURVEYS TO SUPPORT THE ADAPTATION**

As was explained in the previous chapter, we have undertaken several surveys to support the development. These surveys can be categorized into three groups:

- stakeholder expectations
- execution surveys
- quality assurance

In this chapter we introduce an example from each of these.

### ***Stakeholder Expectations***

As the stakeholder view is very essential in the CDIO approach, it was decided that when re-designing the curricula during the forthcoming year, the stakeholder opinion will be emphasized. It was decided that before actually starting the redesign of the curricula, surveys among the relevant

industry representatives will be performed. At present some programmes have already completed the survey while in some other programmes the survey is still pending. Some programmes have not even started yet.

The programmes are free to choose how they want to conduct the survey. As an example, a typical CDIO based survey among the industry representatives is being presented.

This example is from the Degree Programmes of Electronics, Electrical Engineering and Automation Engineering. These programmes combined their efforts and conducted a survey together.

In the past these programmes had already been cooperating with the industry. The major employers for graduating engineers of the geographical area and other stakeholders have been invited to join an advisory board in each programme. These advisory boards sometimes have participated in the design of the curriculum of the relevant programme and in addition to this the advisory boards always approve the new curricula. The problem with the advisory boards is that the number of persons in the boards is quite limited.

As the survey was done in cooperation with several degree programmes it was decided that the Technical Knowledge and Reasoning part of the syllabus would be left out.

The questionnaire was done as an e-form by sending it out to members of several vocational associations. Unfortunately some associations could not respond in a timely manner and could not send the questionnaire on such short notice which led to a situation that some of the association members did not have the possibility to answer the survey.

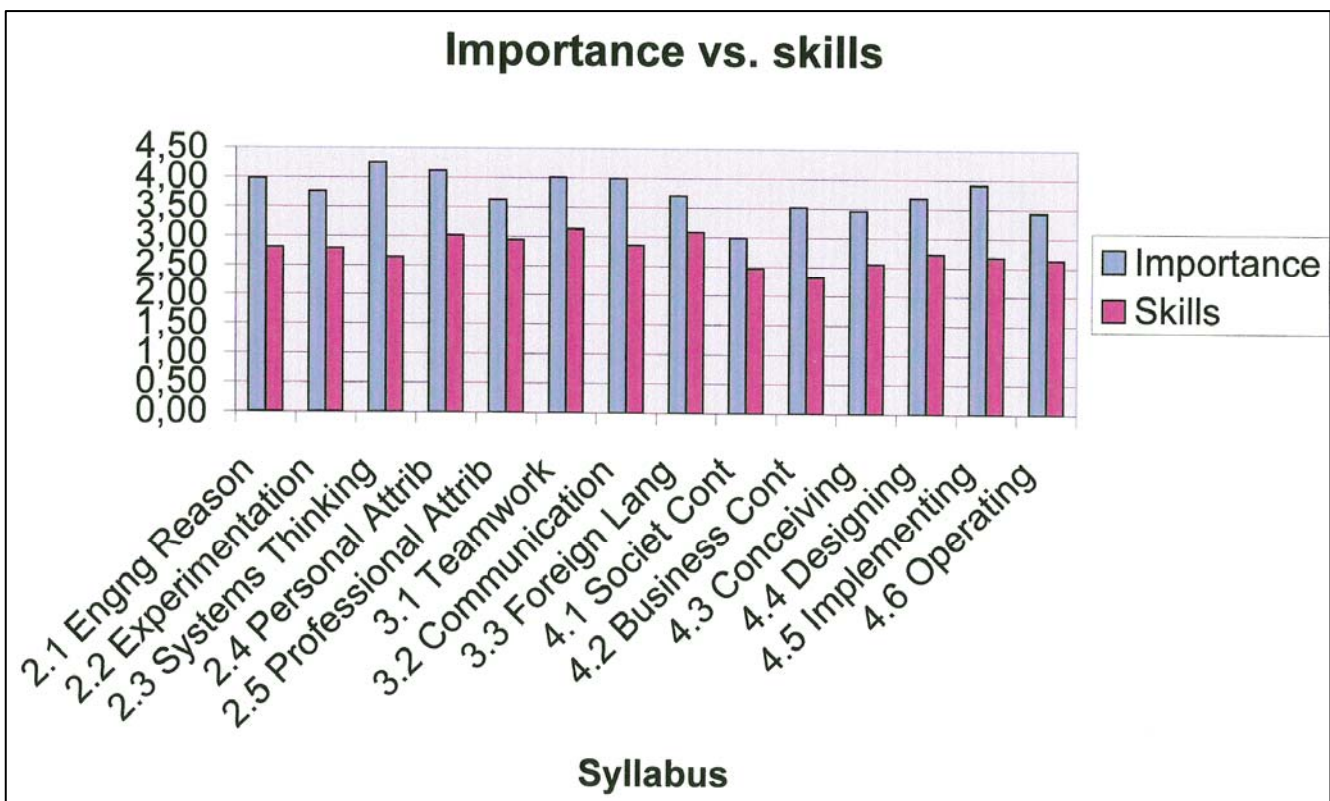


Figure 1. The importance and level of qualifications based on stakeholders survey

The aim of the survey that was executed in late December 2009, was to find out how the employers see the newly graduated engineers fulfil their expectations in the chosen fields based on the CDIO syllabus.

The questionnaire consisted of open-ended questions as well as accurately defined questions where the respondents were expected to indicate the importance of a certain knowledge and skill on a scale from 1 to 5, five being the best score. The same scale was used when the respondents evaluated the level of the knowledge and skills of the newly graduated engineers respectively. It can be argued that the evaluations are not comparable but surely this gives a picture of the present situation.

The survey was sent out to some 3600 persons and some 150 responses were returned. That equals to 4% of the sent out surveys. The majority of the respondents represented a particular field of industry and/or employers and unfortunately the other fields were so poorly represented that the analysis could not be done per industry sector.

The importance of the knowledge and skills of the second level CDIO Syllabus were evaluated to be between 3 and 4.3. The industry representatives ranked highest in the proficiencies *Engineering Reasoning and Problem Solving (2.1)*, *Systems Thinking (2.3)*, *Personal Skills and Attitudes (2.4)*, *Teamwork (3.1)* and *Communications (3.2)*. All these expected proficiencies scored an average of 4 or higher.

When evaluating the knowledge and skills of the newly graduated engineers, the averages were somewhat lower than the averages of the expected proficiencies. The actual knowledge and skills of the newly graduated engineers were evaluated to be between 2.3 and 3.1. The highest ranked knowledge and skills of the newly graduated engineers were the following CDIO Syllabus second level topics: Professional skills and attitudes (2.4), Professional skills and attitudes (2.5), Teamwork (3.1), Communications (3.2) and Communications in Foreign Languages (3.3). The average grades in these skills and *knowledge ranged* from 2.9 to 3.1.

When comparing the actual skills and *knowledge* to the expected proficiencies it can be seen that there is a gap of 25% compared to the expected proficiency level.

### **Execution Surveys**

As an example from the second group, we undertook a survey about how the plans for 3rd- year programmes were developed to take advantage from the CDIO framework. The survey covered all of our engineering programmes. Some of the programmes have such close mutual cooperation that it was appropriate to combine the outcomes. That was the case for example in information technology, taught in two programmes: one in English and another in Finnish.

The motivation for the survey arose from the fact that we needed to understand how far away the present mode of action is from the goal. As this is the first time the engineering programmes are officially running the CDIO concept, we wanted to:

- find out how close the old system is to the CDIO concept;
- what kind of changes or developments should be undertaken;
- how the programmes can benefit from each other's experiences.

To gain a clear understanding in a simple way, the survey was executed as an interview. To structure the interview, a form for it was developed to be completed by the interviewer while the directors of the degree programme were explaining their views.

In general it turned out that most of the programmes had done a great number of projects. The teaching had been felt beneficial in real working life experiments. Lack of cooperation between teachers in integrating different courses proved to be a mutual challenge to be addressed. The possibility of making practical training a more integral part of the tuition emerged as a viable option. The fact that many students are working part time during the semester and full time during the summer- gave rise to a discussion about what the differences between school projects – work-based projects – customer project and training are, which of those should or can be used and for what purposes.

There are the two dimensions to the outcomes of the base of evaluation: learning outcomes and project outcomes. A fundamental issue is which of these are the dominating evaluation criteria for the success of the studies?

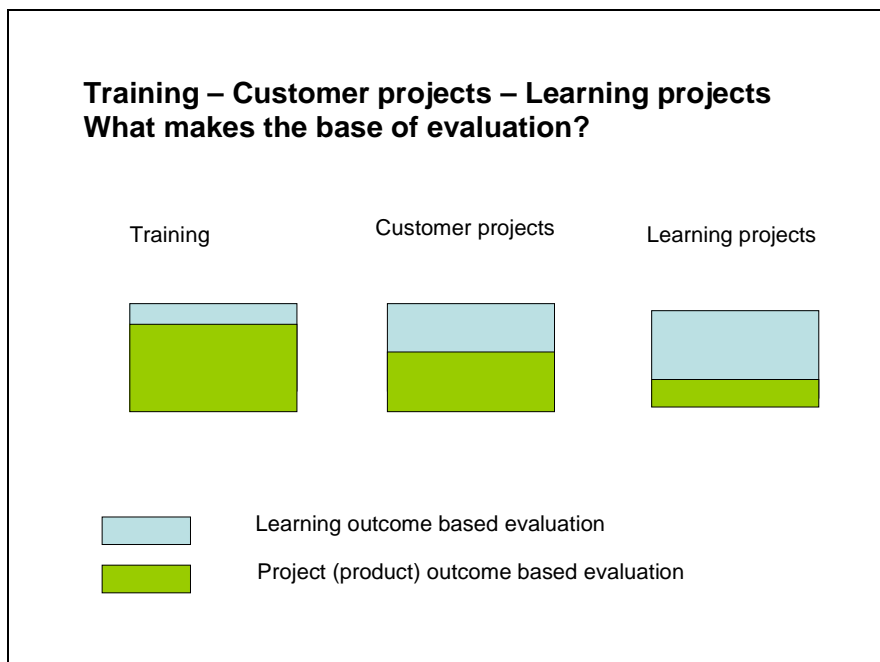


Figure 2. Comparison between learning and product outcomes

Another big difference between these two different kinds of outcomes is that the students engaged in the projects are working together in groups, whereas in practical training the students are team members in real working environments. The question then arises, how early are the students ready to be participants of real teams? Some of us think, why not immediately? That's the way to grow into the profession. The first challenge lies in finding placements for vast numbers of students and the second in how to evaluate the learning outcomes and tailor the missing parts to fulfill the degree requirements.

Many critical questions arose from the survey:

How to support the students in entering the engineering profession?

Whose responsibility is it to create project seeds?

Whose responsibility is it to develop the seeds into project plans?

Whose responsibility is it to put together different people, different subjects, different disciplines and create CDIO projects covering/serving several degree programmes?

When are external partners/stakeholders needed?

Could a vast project, shared across an entire university of applied sciences be made?

Could every engineering programme have their own real learning platform like some of them already have?

How well are the existing ones working?

The future discussions and experiences that will be gathered during next year will hopefully give some answers to those questions.

### **Quality Assurance**

Since autumn 2009, Metropolia has participated in a joint development project with DTU - Technical University of Denmark, KTH - Royal Institute of Technology and coordinated by TUAS - Turku University of Applied Sciences. The project is called Quality Assurance in Higher Education and funded by a Nordplus Framework programme in Higher Education. The objectives of this one-year project are:

1. to define the self-evaluation process steps and criteria
2. to build a supporting system for documentation
3. to enact the self-evaluation process in the selected degree programmes
4. to conduct the pair-wise cross-evaluations between the degree programmes
5. to refine the results of the evaluation for use in development programs
6. to share the best practices of quality assurance.

The intention is to continue this quality assurance work after the complementation of this first phase.

The evaluation criteria and guidelines for the self-evaluation report have been worked out, and the process to carry out the self-evaluation has been started in the bachelor degree programme of Information Technology

In our perspective the major objectives to establish CDIO as context in the program comes from the fact that

1. The general context of engineering education must be aligned to the general business processes we observe in industry.
2. Approaches similar to those used in industry should be applied to our education process. What we mean is that we must train our students in a business environment similar to where they will enter after graduation.
3. We have implemented a set of courses for introduction to studies and engineering.
4. We are planning to implement the concept of Capstone project
5. We are in the process of integrating general disciplines like mathematics, sciences, physics, and communication into the professional engineering studies. Part of this has been achieved by switching timing schedules of courses and changing responsible teachers in order to better match their expertise.

We see that the most essential challenge lies in implementation of third-year capstone projects. The issues were discussed in details in the previous chapter. At universities of applied sciences in Finland, a very efficient and well-running system was established years ago. This means that students carry out each their project while in placement/internship/traineeship/, which mostly takes place in companies or other working life organizations. The company management is responsible for leadership and supervision and students are even paid for their contribution. The learning outcomes may not be strictly defined but they are most definitely relevant to working life. The teachers assess the learning outcomes of work placement, while the business life defines the product outcomes.

If the capstone projects are carried out on the campuses under the supervision of teachers, the learning outcome can be defined well and in details but the product outcome may not be valid any more. There is a keen interest to find out a solution to meet both interests of the capstone project, but obviously there is also a risk of conflicting interests.

## **ENTICING STUDENTS WITH THE 1<sup>ST</sup>-YEAR CDIO COMPLETION – AN EXAMPLE FROM LAND SURVEYING ENGINEERING**

The Danish style project-based learning context had been adopted in some degree programmes. In the merger phase of the universities of applied sciences it was considered to be too radical for all the 20 degree programmes. The experiences of project-based learning were mostly far from satisfactory. It was, however, clear that something had to be done to enhance engineering education.

The commitment of students (or lack of it) is a real challenge for Finnish engineering education. There are plenty of opportunities to study and in some degree programmes there is practically no numerus clausus nor tuition fees. When a new student enters the university, the staff has about one semester to entice the students to fall for his or her degree course. Such a task was given to one very experienced lecturer. Of course, there are students who are motivated from the very outset. They usually know a great deal about the engineering profession when they enter the university, but there is also too large a portion of students lacking all prior knowledge about their professional expectations. Those students are in the greatest risk zone of dropping out.

The idea of a first-year project is one of the excellent tools of CDIO for increasing the students' motivation and commitment. The traditional first-year maths and physics overdose has been in some degree avoided. Our experiences have been very positive. The students are enjoying doing "real things" and the feedback is encouraging. The theoretical level of these projects is not demanding – the subjects are basically introduction to the areas of their branch of engineering. Another great advantage has been achieved by adopting a first-year project in our degree programmes. The colleagues have to meet with each other for discussions on how to make the projects successful – a new experience in some departments but obviously of great benefit for the whole university.

### **CONCLUSIONS**

Despite all these activities, we are facing huge challenges in integrating all the different initiatives to develop a sound unified engineering education imbued with 'great spirit'. Making people see all the activities capable of advancing the goals of creating a successful engineering education, is helpful in welcoming new ideas to be integrated as appropriate into the Metropolia concept.

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### ***Biographical Information***

Katriina Schrey-Niemenmaa holds M.Sc (E.Eng) degree and MQ (Master of Quality) from Helsinki University of Technology. She is currently working as senior lecturer and project manager for engineering education for the Schools of Engineering in Metropolia. She joined as project director the EVTEK University of Applied Sciences 2001. Prior to that she has worked for 20 years at the engineering education and industry - university co-operation interface focusing on competency management, life-long learning issues, quality in education and new learning solutions. This has included positions with Nokia, The Finnish Association of Graduate Engineers, TEK, and Kone Corporation.

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