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Implementing interdisciplinary projects in engineering education – challenges and opportunities

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***Abstract*—In this workshop we will share experiences and discuss challenges of implementation and operation of project courses with teachers and students from several disciplines. Looking at the students' and teachers' collaborations in the light of the definitions of multi- or interdisciplinary, might unveil challenges and give directions to possible strategies / interventions. The aim of the workshop is to, based on our shared experiences, find ways and methods to operate interdisciplinary projects in a sustainable way for all parties, students, teachers and university.**

***Index Terms*—interdisciplinary projects, challenges, faculty development**

I. Introduction and Background

A. Engineering education transformation need

OVER the past decades engineering education has gone through a transformation. From programs built up on single disciplinary blocks in i.e. mathematics, physics, chemistry, mechanics, materials, electronics, the engineering education has changed to be more *integrated* between disciplines and the learning more *activated*, via different initiatives, e.g. the CDIO Initiative, Problem and/or Project Based Learning, PBL, [1], [2]. *Integrated* is here used in the sense that knowledge of single disciplines does not 'create' an engineer; the field of engineering requires integration of the involved disciplines. *Activated* is used in the sense that studies are to be less individual, with more work in discussions, teams, projects, problem solving. The opportunities of these learning methods are increased deep learning and practice of generic skills and abilities.

The driving forces for the transformation of engineering education are based on needs of engineers with ability to integrate several disciplines in problem posing and solving, and decision making and, maybe most important; with generic skills such as communication and leadership, project and team work in multicultural settings, critical thinking, reflexivity etc. This is verified by feedback from stakeholders, e.g. future employers [1].

Hence, to better prepare our engineering graduates for their future profession there is great need of broader project courses. This indicates projects where students from different disciplinary backgrounds work in teams and solve complex tasks together to simulate their future as engineers, in the 'safe environment' as the university can offer.

A. Degree of integration - Present status

Most often the education transformation has resulted engineering programs with *integrated curricula* including a couple of project courses each. The integrated curriculum could mean collaboration between two to three disciplinary courses, e.g. linked assignments and problems in mathematics, MatLab programming and mechanics and so forth. In the project courses students work in teams and solve a problem, present and defend their work in reports and presentations. Sometimes they might reflect over their teamwork, their individual and co-members contributions, and, most often, they receive feedback on their performance. The projects could consist of design-build-test, DBT, or research related tasks.

B. Increased degree of integration and collaboration

Industries' need of engineering graduates well trained for their future profession call for an even higher degree of integration. This integration requires increased collaboration at teacher and student levels cross disciplines. These projects are rare, but existent, see specific examples from Chalmers below.

This discussion requires more precise definitions of different kinds of disciplinary collaboration.

II. A Brief Note of Disciplinary Terms

In relation to educational programs, Meeth [3] has defined the different – disciplinary terms as follows:

Multidisciplinary programs – "involve faculty from several disciplines, each of which offers a different perspective on a common question or theme. Each discipline contributes its own knowledge or approach with no attempt to integrate or interrelate ideas."

Interdisciplinary programs – "involve an attempt to *integrate* the contributions of several disciplines to a problem." Hence the term, "integration in interdisciplinary studies" needs an explanation;

Integration in interdisciplinary studies - "bringing interdependent parts into harmonious relationship. It involves relating part to part, part to whole and whole to part."

In this workshop we relate these concepts to collaboration within projects.

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III. Examples and Experiences from Chalmers

At Chalmers we have implemented quite a few project courses within our engineering programs training generic skills in a progressive ways through the grades. We also have a small number of interdisciplinary projects. Students solve system biology problems designing intelligent machines, build formula-one cars or autonomous cars and compete in student design competitions like iGEM, Carolo Cup and Formula Student. We attended the Solar Decathlon with a solar-powered house in 2013, a project we would like to incorporate in our educational programs in architecture, civil and electrical engineering again, but right now find difficulties to start up and integrate. The last few years we have offered the students a master thesis within Challenge Lab. In Challenge Lab, the intention is for the students to work as change agents together with stakeholders in industry, academia and society solving a well-defined task addressing sustainable development challenges in the Swedish West Coast region.

The interdisciplinary projects are run as courses hosted by one program and encourage students from different engineering programs to apply; e.g. to build electrical formula cars there is a need for students within industrial design, mechanical areas as aerodynamics, vehicle dynamics, materials, drivetrain and electrical for motors and energy storage.

The courses are popular, receive quite many student applications and are becoming increasingly established and recognized by future employers in industry / society. The recognition and the positive support, often leading to collaboration in many ways between industry and the project, mean a lot for the educational programs that host such a project and are prerequisites for long term operation.

However, there are many challenges, whether we look at the ‘one program projects’ or the interdisciplinary projects. In the ‘one program projects’ we have had issues with split courses, where the technical and communication activities are experienced by students as separate. In the interdisciplinary projects, we have had difficulty with composition of teacher teams cross disciplines, and to involve proper training and assessment within generic skills. In this workshop we would like to focus on the larger interdisciplinary projects and find better methods for their operation in a sustainable way.

IV. Problem Statement / Issues

Looking at our experiences of degrees of success in project and course, in the light of the defined disciplinary terms above, we see one important influential factor: the nature of collaboration. This refers to the teacher- and student teams’ internal collaborations as well as the collaboration between the students and teachers.

-How does multi- and interdisciplinary teacher collaboration influence the student project- and team-work?
-What are the benefits and challenges?
-How does multi- and interdisciplinary student collaboration influence the project- and team work?
-What are the benefits and challenges?
-How are they related?
-How do we measure progress and how do we develop strategies to improve?
-How do we reach sustainability in operation of integrated interdisciplinary project courses?

V. Workshop Objectives and Activities

In this workshop we will share experiences of integrated interdisciplinary project courses. The aim is to discuss challenges, mainly from a teacher perspective, and to find strategies to run these courses in a sustainable way for all parties involved. After a short introduction, where we describe the background and experiences from Chalmers, participants will work in small groups of 3-5 persons, with the problem issues above to define and decide on the most important challenges. Then we switch to be creative innovative in our ways to find and/or design strategies/interventions to address them. The workshop ends with a final discussion aiming at a summary listing the most important challenges and their interventions.

References

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