

# How to enhance collaborative student-industry projects with theoretical perspectives

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**Collaborative student–industry projects are a key component of the three-year Computer Engineering programme. The question we wanted to explore by redesigning a well-functioning project course was: Can the understanding and insights gained through a practically orientated trial and error process be enhanced by a more theoretical approach while retaining a high level of student engagement?**

**A number of articles and books focusing on three key aspects—process, teamwork and quality—were introduced into the course to help achieve these goals. Our endeavours were to integrate the theoretical aspects tightly with the more practical project tasks. The redesigned course resulted in a high level of student activity, not only during project activities, but also in class discussions and exercises. Student evaluation pointed to a high number of satisfied students.**

**Engineering education, Integration of theory and practice, Project processes, Student–industry projects**

## I. BACKGROUND

**T**HE project course Proj AK 3 is a vital part of the three-year Computer Engineering programme. The objective of it is to allow students to prepare for their future professional careers and to facilitate their introduction into industry. More specifically, the students should be able to work in teams and to take an active part in a project-driven environment. In relation to a specific project, students must adapt workflows and project models in order to meet project requirements and solve problems effectively. Proj AK 3 relies on collaboration with industry in order to achieve the objective. In its survey among graduate engineers, the Swedish Association of Graduate Engineers concludes that study programs should be more closely involved with industry, providing students with an understanding of their future professional roles [1]. Proj AK 3 is a step in this direction. Students attending the course are divided into project teams. Each team is assigned to a company and presented with a problem formulated by the company. The course involves a number of different companies, and each project team works with a unique problem.

Students value the course because it offers insights into their future professional role and allows them to work with a real problem. Course evaluations also show that students enjoy the responsibilities inherent in the project process. As teachers, we find that students willingly engage in the project activities, and invest considerable time and effort in producing

viable solutions to the problems. Similar experiences have occurred elsewhere [2].

Proj AK 3 is well established, has a defined role in the programme, and teachers, as well as students, find the course well functioning. So why effect a change?

Undoubtedly, a practically oriented trial and error process entails valuable experiences for the students. However, our ambition with a redesign is to add to the experience by allowing students to develop a more generic understanding of how to plan and manage project processes, and to gain a deeper insight into the complexity of project processes. The obvious solution is to introduce more theory into the course. The challenge is to do this while retaining the values of the existing course.

## II. THE REDESIGN

In its original incarnation, one of the characteristics of Proj AK 3 is a high level of student activity, probably inspired by the conceived importance and urgency of the project task. The sense of importance stems from the students' desire to meet the company's expectations and to distinguish themselves in a professional context. The sense of urgency is a consequence of the need to deliver a result within the designated time frame in order to satisfy the company. Our aim with a redesign is to add theoretical perspectives to the course without impeding the momentum of the project process.

In order to achieve this, we focus on three aspects:

- Course structure
- Literature
- Integration of theory and practice

## III. COURSE STRUCTURE

After the redesign, Proj AK 3 is divided into two overlapping parts (Fig.1). The first part of the course consists of lectures and student activities. It is here that the theoretical groundwork for the course is built. This part of the course can be described as teacher-driven. In this context, teacher-driven indicates that all activities are designed, initiated and scheduled by the teachers. As the project develops, the number of teacher-initiated activities decreases. The second part of the course is student-driven and focuses on project assignments. Although the project assignments are created by teachers and company representatives together, ownership of the projects is transferred to the student teams as soon as the teams are established. The student teams bear the responsibility for all

communication with the company. They are also responsible for planning the project, and for implementing and testing the outcome. During this part of the course the teachers function as supervisors.

In the transition zone between the theoretical and practical parts of the course, students are presented with a simple test called the “Quiz”, which they must pass in order to continue with the project. The Quiz is a tool employed primarily to motivate students to read notes and literature thoroughly. Halfway through the development process, projects are presented in class for discussion. At the end of the development process the result is presented. Finally, the teams evaluate the process in a post-mortem seminar and produce a project report.

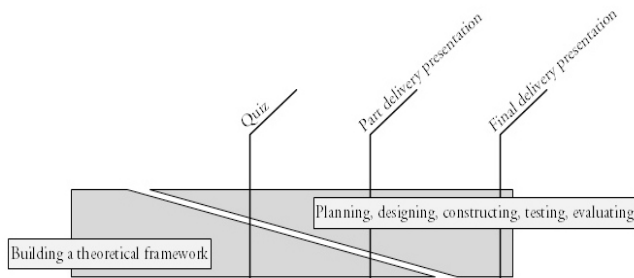


Fig. 1 Proj AK 3 is divided into two overlapping parts

#### IV. LITERATURE

Proj AK 3 has three main themes: Process, teamwork and quality. Each of these can be divided into a number of specific topics:

##### Process

- Development processes
- Comparing process models
- Modifying/combining models
- Choosing models in specific contexts
- Domain knowledge
- Interaction with stakeholders
- Target groups
- Usability

##### Teamwork

- Building a team
- Roles in a team
- Working as a team
- Conflicts

##### Quality

- Planning, estimating and follow-up
- Documentation
  - Risk analysis
  - Post-mortem analysis

A number of books and articles [Appendix 1] relating to the course topics form the theoretical framework for the course. Books and articles are used both directly as course literature and indirectly as context for lectures and exercises.

#### V. INTEGRATION OF THEORY AND PRACTICE

A robust course structure and a pool of relevant literature are unquestionably important parts of the redesign, but the core of the redesign is the tight integration of theory and practice. The goal is for students to perceive the presented theory as a tool for solving practical project activities rather than as a time-consuming impediment. Lectures and literature are generally used as a starting point for an activity pertinent to the student team’s own project. This means that course topics and the parallel project processes must be synchronised, and theory must be carefully portioned out in order to give immediacy to the theoretical aspects. A short example serves to illustrate this approach.

A topic from the process category is “Choosing models in specific contexts”. One of the short course cycles relating to this topic is structured as follows:

1. A class discussion starting with the students’ conceptions of a sequential project model, which they have experienced in a previous course. The class will describe the model, and explore its strengths and weaknesses.
2. A lecture using the students’ conclusions as a takeoff point. The lecture will then give an overview of project process models and discuss their applicability in different contexts.
3. An exercise where student teams are presented with scenarios. Each team is asked to analyse the scenario and choose a relevant project process model for the scenario.
4. A presentation in class, where student teams present the chosen project process model and argue for their choice.
5. Literature: Relevant chapters in the book—“Software Engineering” by Sommerville and articles; “Iterative and Incremental Development: A Brief History” by Larman and Basili; “A Spiral Model of Software Development and Enhancement” by Boehm; and “Embracing Change with Extreme Programming” by Beck.
6. An assignment: Each project team analyses their own project, and based on the analysis, the team chooses or adapts a project process model for their project assignment.

This short cycle first attempts to engage students by using their own experiences to anchor the lecture. The next step is to activate students and let them use the concepts presented in the lecture as a basis for choosing a project model. The literature becomes a natural stepping stone to choosing a project process model for their own project. At the end of the cycle, the student teams are immersed in their own projects, making decisions that directly influence their own work.

The following course cycle focuses on the student teams’ revision and further development of the chosen project process model. This cycle begins with a guest lecture given by an experienced project leader from industry.

## VI. DISCUSSION

When redesigning a well-functioning course, it is essential that the values of the original course are retained. From a pedagogical point of view, the central values of Proj AK 3 are highly motivated students and a high level of student activity, leading to stimulating learning conditions. The students' engagement is driven by their wish to meet the company's expectations. Therefore, they welcome tasks that they perceive will further this goal and balk at those seen as slowing down their progress in the project assignment. In introducing more theoretical perspectives into the course, we must make these time-consuming activities legitimate in the eyes of the students. In other words, every new activity and demand must appear pertinent to the ongoing project. In Proj AK 3, the solution is a tight integration of theory with practical project tasks. This demands meticulous timing, as well as a discerning eye when selecting literature and lecture content. This is perhaps a goal to strive towards but never to be fully reached. Yet, with the redesign, Proj AK 3 has come considerably closer to the goal. As teachers, we note a high level of student activity, not only during project activities, but also in class discussions and exercises. The students' course evaluation after the redesign shows a high degree of student satisfaction [Appendix 2].

## REFERENCES

- [1] "Nya ingenjörer om utbildning och arbete", Sveriges Ingenjörer 2009, Sweden, 2009
- [2] Regnell B. "Praktikprojekt och näringslivssamverkan för motivation och djupinläring" In proceedings of the 2<sup>th</sup> Pedagogical conference at the Faculty of Engineering, LTH, Lund University, 2005

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## Appendix 1

### Reference literature to Proj Ak 3

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## Appendix 2

### Student evaluation of the course

After completing the course students were asked to anonymously evaluate the course. The students were presented with a questionnaire consisting of three open ended questions (What was satisfactory with the course? What was less than satisfactory with the course? How could the course be improved?). The questionnaire was handed out in connection with a final discussion with all students present, a situation which led to an answering frequency of 100%.

#### What was satisfactory with the course?

All students chose to answer this question. The students largely agreed on a few areas, which they found satisfactory: Teamwork and taking responsibility were mentioned by 50 % of the students. Gaining experience of and insights into project processes were mentioned by 40%. Working with real problems was mentioned by 25%. 20% of the students commented positively on gaining knowledge and 20 % mentioned lectures and exercises as a positive experience.

#### What was less than satisfactory with the course?

25% of the students chose to leave the question unanswered or wrote "nothing".

40% pointed out that the work load was too heavy or that they were expected to produce too much documentation. 35% found that the delimitation between Proj AK 3 and the "Kravkurs", given the same term, was unclear. Other less than satisfactory areas pointed out by one or two students were: That the attitude of their supervisors was not supportive; that the students should form project groups themselves without restrictions from the teachers.

#### How could the course be improved?

15% of the students chose to leave the space blank. Otherwise answers differed widely: More meetings with the group's supervisors, fewer courses given the same term, either a clearer delimitation between courses or a larger degree of integration, more exercises, more material on the course home page, more time, less documentation, improved schedule, larger degree of integration between theory and praxis.