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DESIGN-BUILD-TEST PROJECTS IN AN INTRODUCTORY COURSE FOR TWO BACHELOR PROGRAMMES AT LINKOPING UNIVERSITY

K. Bjerner, D. Gundlegård, D. Haugum and M. Östring

Department of Science and Technology, Linkoping University, SE-601 74 Norrkoping, Sweden

ABSTRACT

To develop bachelor engineering programs to include more practice in engineering the Board of the Institute of Technology at Linköping University decided to introduce CDIO concepts in three bachelor engineering programs at Campus Norrköping. Three design-build-test courses are planned, one in each year of study. In this paper we present the first design-build-test course. This course is called Engineering Project and ran during the autumn semester 2005. We also present the students' evaluation of the course and discuss our experiences and future development of the course. Our most important conclusion is that the supervisor for a project group is very important and it is also important that the meetings between the supervisor and the group are organized as formal meetings with minutes taken. The supervisor must give quite strict guidelines for these meetings to get a good result in the project. The concept of design-build-test projects works well in these engineering programs.

INTRODUCTION

In this paper we describe the planning of the first design-build-test course and the project assignments for the different project groups. We also present the evaluations made by the students after the course was finished. Finally we discuss our experiences and what can be changed in the future.

Linköping University has participated in the CDIO Initiative from the beginning (2000), through the Applied Physics and Electrical Engineering program (Y). The board of the Faculty of Technology at Linköping University decided in August 2004 to introduce the CDIO concept for three engineering programs at the Bachelor level starting from the academic year 2005/2006. These programs are Systems Engineering (ES), Media and Communication Technology (MK) and Logistics Engineering (TL). ES and MK are modified programs while TL is a complete new program. The programs, with a capacity of ninety new students in total every year, have a core of common courses. Two of the programs (MK and TL) represent new areas for CDIO at Linköping University.

For every engineering program the Board of Studies for the Engineering Programmes at Bachelor level have a group of teachers and students, in Swedish LoT-grupp, planning the syllabus for each program. This group has planned how CDIO should influence the three study programs during the academic year 2004/2005. Three design-build-test courses, one in each year, were decided on. Skills from part 2 and 3 in the CDIO syllabus [3] were introduced in other

courses than design-build-test courses. The course descriptions have been rewritten so that learning outcomes are listed in the plan for every course [5].

The first design-build-test course was planned during the spring semester 2005 by a group of teachers and two project assignments were developed for each study program. Requirements specifications were written for each project as well as a temporary project plan. These teachers also followed a course on the LIPS project model [1].

During the fall semester 2005 the students on two of these programs, MK and TL, took the first CDIO course called Engineering Project (in Swedish Ingenjörsprojekt) giving 6 ECTS credits. One part of the course was an introduction to project management, oral and written communication, interpersonal communication and an introduction to the ideas behind CDIO. The main part of the course was to carry out a project in groups of 5 to 7 people. The project groups used the LIPS model to manage the project. Three different projects were done in the course. In the middle of December the projects were presented to the other groups and the projects were evaluated in the middle of January.

CONTENTS OF THE COURSE

The contents of the course can be divided into three different parts. The main part is the project work of the students, where the students address a specific problem, which results in some kind of application solving the problem. Another part consists of the lectures given by teachers from the university to support the project work. A third part consists of lectures given by people from industry in order to give the students some kind of picture of a working environment after they have finished their studies.

The lectures given by teachers from the university are aimed at the parts that are needed for the project to work and not the actual technical problems of the different projects. This includes lectures about the project model used, which is the LIPS project model (Linköping Interactive Project Steering), in the beginning of the course. LIPS is a project model specially designed for use in courses, but has its origin from project models used in industry, see [1] and [2]. There are also lectures about group dynamics which result in dividing the students into project groups of typically six people using a method of making the groups mixed according to different study styles. There are also lectures about oral and written presentations, which is also included in the project work.

In order to couple the course and also the whole program to the work that could be done when finishing the program there are a couple of lectures given by people from industry. These lectures include examples of how the work is done in a project in industry and also examples of projects.

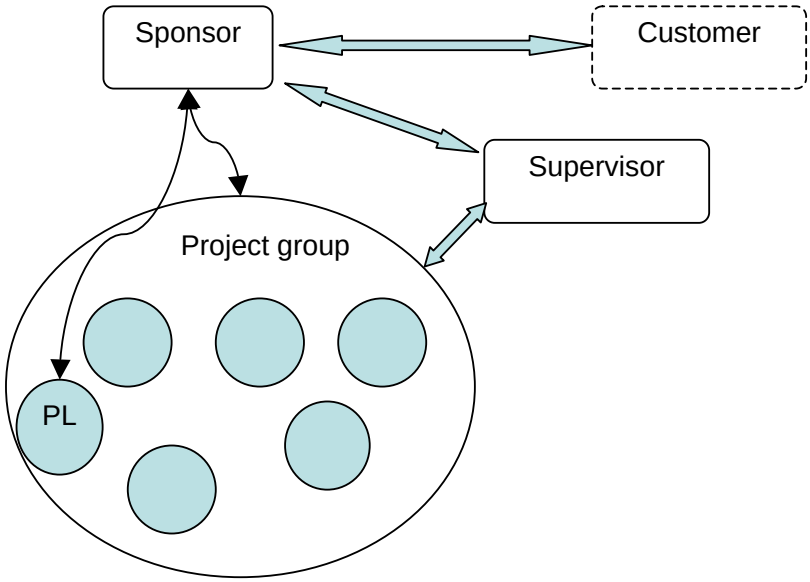

Figure 1: The figure shows the communication with the different roles of teachers and the students in the project group, where one student has the role of a project leader (PL). A wide arrow indicates more frequent communication.

The project work is regulated using documents and the use of the project model. The structure of one project consists of a project group, a supervisor and a sponsor see Figure 1. The supervisor is a teacher who joins the weekly meetings of the project group. The sponsor typically only meets the group at the beginning to define what should be done in the project and when the project group has something to deliver. In the project model these sessions are called decision points. In the project group the students have different roles, for example, one student is project leader. The different roles and their responsibilities are then defined in different documents. Each of the members got at least one field of responsibility. The distribution of the work was mainly made in consideration of the group members' earlier experiences.

There may also be an expert in the subject who the project group can order help or lectures from. In some cases there is also an external (real) customer who could use the application created in the project.

The project follows selected parts of the LIPS project model. The project begins with the students getting an already written requirement specification, which includes what the application or product should be able to fulfil. With the specification at hand the students make the planning of the project including a list of different tasks in the project. During the project work the weekly meetings are documented and when the application in the project is finished there is also the technical report, describing the product, that the students have created. After the technical report there is a reflections report or evaluation of the project process of the course. There is also an oral presentation of the different projects where another project group act as opponents. Examples of projects and their contents can be found in the following section in this article.

The examination is divided into two parts, one is attendance at the lectures which is granted 1.5 ECTS points and another is the actual project work of 4.5 ECTS points. The grades are only pass or fail. The work is done in parallel with two other courses. From the beginning to the end

of this course there are about 15 weeks. The beginning of the course is dominated by lectures and the last half of the course focuses on the project work. During the course the students are scheduled for eight hours each week possibly in addition to lectures.

To get feedback from the experiences of the course a number of course evaluations have been made. There is the electronic version for statistical use, where each student answers separately. There is also the reflections report, mentioned above, written by each project group, which is also discussed at a project meeting with the supervisor of that group. The reflections report is included in the course. Not as a part of the course, the students also make one written evaluation from each program. In addition to these sources of evaluation made by the students, the teachers involved in the course have made a self evaluation. More of the students' points of view of these evaluations can be seen later on in this article.

PROJECT ASSIGNMENTS

The assignments are developed with the students' future working role in mind. Expected important engineering areas for students on the different programs have been identified and the assignments are designed to fit into one of these areas. For MK two different projects were carried out, one with focus on media technology and the other on communication technology. For TL one project was carried out, focusing on storage localization.

The LIPS project model can be used at different levels depending on the level of the course. Since the target course is an introductory course the first level was used. Utilizing the first level of the LIPS model can for example involve the following documents [2]:

- Requirement specification
- Basic system drawing
- Project plan
- Weekly minutes
- Status reports
- Technical report
- Reflections

The requirement specification is handed to the students at the beginning of the project. With the requirement specification as starting point, the students should plan the project and document it in the project plan and the system sketch. Every week a meeting is organized by the project leader. The supervisor should attend the meetings and minutes are written for documentation. The sponsor collects status reports during the course. The outcome of the project is documented in a technical report and evaluated in a reflection document.

The purpose of the TL project was to develop a decision tool for storage localization. The decision tool is developed in Excel and can be used to support a storage localization decision. Storage localization is a common logistics problem and it is likely that the students will face similar problems in their future career as TL engineer. The decision tool should be able to handle a general storage localization problem, i.e. suppliers and customers at different locations with different supplies and demands. The decision tool should handle both quantitative and qualitative aspects of the localization; the qualitative aspects are however quantified in order to be used differently. Furthermore the tool is used to locate a storage in different scenarios. The tool should be able to support input of localization constraints, which serves as a way of introducing basic optimization thinking to the students.

The purpose of the MK project focused on communication technology was to develop a client-server based system for controlled mobile access to selected services. The project introduces client-server programming, mobile communications, computer networking and user interfaces, which are important areas for an MK engineer to handle. The server is developed in Ada in a Linux environment. The user interface is web based or developed in Ada. In addition to Internet access, the server should grant access to streaming services such as web radio.

The purpose of the MK project focused on media technology was to produce a video film. The film should deal with the special traffic security problems round a specific school, and the target group is school children at an age of 10-12 years. In the project the students worked with external customers as representatives from the community and the actual school. A film production is a project with great complexity which almost follows a fixed chronology. The students used project models to deal with the whole chain from idea and narration, recording, editing to the finished product.

STUDENTS' OPINION

In this section we present the results of evaluations of the course made by the students. After a course the students fill in their opinions in a form on the web. In this course the groups have also written a document with their reflections from the course. In this document there are a couple of questions to discuss and answer.

The majority of the students were satisfied with the course. The content and the effort generally corresponded to their expectations. All the students think they have gained a better knowledge in working in groups and a many think they have obtained better skills in oral and written presentation.

The project plan was subjected to several revisions during the work, because the different stages took much longer than first assumed. The technical problems which appear can mostly be referred to a lack of knowledge in the actual field. Most of the problems were solved after lectures and literature studies.

The co-operation in different groups worked for the most part well but turned out to be on an informal level. This might be a problem because in an informal meeting it is easy to forget important tasks related to the project plan and other documents. The students worked with their project plan and requirement specifications. But when they were finished with these the documents did not take part in the process as it was originlly intended to.

Some groups have experienced indistinctness between the roles of customer and sponsor.

The main conclusion of the students is that a more uniform distribution of lectures and lessons will improve the course. Some of the theory for the project needs to be presented earlier. Furthermore it is important to start the project as soon as possible. This should be supported better by the teachers. Formal weekly meetings should take place every week.

EXPERIENCES AND REFLECTIONS

In this section we will try to look at what we have concluded from the evaluations and our own experiences. We will focus on points that we think are important for this kind of course.

One part of the course consisted of lectures. From the lectures given by industry, presenting the project model used at different companies, it is clear that they all have a lot in common. Not only with each other but also with the project model that we use in the course, which hopefully gets the students motivated when using the LIPS project model. Although we saw this as a positive feature some of the students did not like that almost the same information was repeated and there were also some comments about having common lectures for all programs, which meant that some lectures were not exactly relevant for every program. In order to get acceptance for these lectures we think is important that the expectations of the lectures are correct. These lectures show in some way that the engineering concept is general in many different areas. Another way is to differentiate the lectures from industry according to the different programs, but in our opinion this limits the engineering perspective of the students.

Some of the lectures given by teachers from the university focused on the project model. For students, who have never worked with a project model this involves a lot of new concepts and information. We think it is better to focus only on the parts of the project model used in the course and leave the rest for the next design-build-test course. In that course they then have the experience from working with a project model in a previous course and we think that this makes it easier to learn more about the project model. We also think that it would be better to have lectures on different parts of the project model, when the students are about to start working with these parts. For example, this could be the project plan in the beginning and lecture about the technical report later in the course.

There are several documents describing the contents of the course and also rules and directives. From a student perspective, taking into account that this course is one of the first courses, it could be confusing to have a vast number of documents which have also almost the same name and overlapping parts. Could it be possible to make all these documents into one document?

During the course there has been a lunch meeting with the teachers involved in the course every second week, which has been valuable in coordinating the communication and demands between the students and the teachers.

Looking at the projects the general outcome of the implementations was good. The students performed well and their feedback was overall positive. However, a number of issues could have made the projects even better for both students and the teaching staff. As usual in a project work it is important to have a good start to the project, in this particular case it is especially important since the working methods will be a crucial part of their definition of how a project should be carried out.

The project gave the students 4.5 ECTS credits when passed. The time spent by the project groups on the project was around 110 hours per group member and it is less than what we have planned. Generally we expect 1 credit to correspond to 40 hours study per week. The students reported spent time for every week to their project leader. During the project much more time was spent during the last weeks than at the beginning. To get a better distribution of time spent the supervisor plays an important role.

The project “kick-off” is important in order to establish a well defined starting point to the project. Students in the TL project had difficulties to grasp the main ideas in the assignment. This could be improved by putting more effort into explaining the background and purpose of the assignment in the introduction lecture. However, it is important not to take away too much of the process where the students translate the project description to what they actually should do.

The group contract is important since it gives the student a possibility to define early in the project the internal rules of the project. A discussion of how they should act as project members, complemented with project management and group theory provided by teachers, might render a good understanding of the responsibilities as an individual project member.

In our opinion the formal meetings are an important tool to start off the project in a good way and to maintain the work load at a suitable level during the course. Since the students have little or no experience of leading project meetings, it is important that the first meeting sets a good standard for how the meetings should be carried out. This might include the supervisor being responsible for the first meeting and running it in an efficient way. Regularity of the formal meetings was an important factor for successful projects, in our projects at least once a week. Another important part of the formal meetings was the agenda design. What the project members have done so far, what they should do before the next meeting together with both person and activity time follow-up, i.e. person/activity status report, should be a mandatory part of the agenda. It is worth mentioning that our Excel documents that were used for time reporting were constructed in a way that made activity time follow-up difficult and hence this follow-up was poorly performed.

Document management and communication constitute a relatively large part of the project work, both for students and teachers. To succeed in the project work, it is important to have a structured way of communicating between the different actors in the project. A current bachelor thesis is developing an ad hoc communication and document sharing system for the LIPS projects, which might be useful for project and documentation management in future projects.

CONCLUSIONS

One conclusion is that the role of the supervisor for a project group is very important. It is also important that the meetings between the supervisor and the group are organized as formal meetings with minutes taken. The supervisor must give quite strict guidelines for these meetings to get a good result in the project. To get a good start the project “kick- off”, the group contract and the project plan are key factors to do well. The project model has been very useful in structuring the work for students and staff. Another experience from this course is that a design-build-test project also works well in non-traditional engineering subjects. However, it is important to put effort into the design of the different projects so that the projects work as inspiration and preparation for a future engineering role.

ACKNOWLEDGEMENT

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