CHRISTMAS LIGHTS STUDENT PROJECT

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ABSTRACT

The Christmas Lights Student Project was carried out during the fall 2010. It was done by the first year electrical engineering students. The target of the project was to learn about the electrical circuit design. In Finland, Christmas time is the darkest time of the year. The sun is barely seen in the northern parts of the country. During this time of the year, people like to decorate their homes with Christmas lights. These bright coloured, beautiful decorations bring some light to the darkness and promote the 'Christmas feeling'.

At Kemi-Tornio University of Applied Sciences (KTUAS) the first year electrical engineering students began their path towards Christmas in September 2010 by starting the Christmas Lights Student Project. This CDIO project was designed to offer the students practical learning by doing experiences in the field of electrical circuit design, programmable logic controllers and team (project) work. This paper together with the poster represents the learning objectives of the project, the project work itself and the results which were also introduced at the school event in December 2010.

The Christmas Lights Student Project was managed by three teachers. Ten student teams were working on the project. Each student team had four members and they were allowed to use their imagination and design their very own view on Christmas Lights. For the first year electrical engineering students, it is important that electricity, electrical circuits, electrical components and the difficulties or challenges related to real world design become visible and concrete. The theory lessons on the electrical circuits are more easily forgotten than the practical construction work. It was also seen in this project that the students really enjoyed the design of their Christmas Lights. The project also affected the team spirit positively and the learning outcomes were good.

So, this paper (and poster) represents the Christmas Lights Student Project and gives some ideas on how a successful student project can be carried out. It also introduces the institution of Kemi-Tornio University of Applied Sciences and its participation in the international CDIO conference for the first time. The KTUAS has planned to join the CDIO initiative during the year 2011. Hopefully this paper and the poster presentation together with a strong participation in the conference will offer the school a good CDIO starting point.

KEYWORDS

Project, electrical engineering, product design, teaching.

INTRODUCTION

Kemi-Tornio University of Applied Sciences (KTUAS), department of technology, is a small engineering school situated in Finnish Lapland, by the Swedish border. KTUAS has totally ~2600 students and the staff of ~240. The cities of Kemi and Tornio have a long history and the industry on the area can be considered quite traditional. The main industries include paper & wood processing, steel manufacturing, mining and related engineering work. The engineering department of the school provides education for young and adult students leading to Bachelor's and Master's degrees in mechanical, electrical and industrial management engineering. It can be said that the department of technology of KTUAS is one of the most northern schools in the world giving education at this level in engineering. The distant location and the sparse population in Finland have forced the school to develop the education towards more student friendly direction. Modern technology, possibilities for eLearning, small group sizes and skilled staff together with good contacts with the local Lappish industries can be seen as strengths [1].

Several studies show that, during the recent years, engineering education in Finland has faced challenges. The attractiveness of engineering education is not as high as it used to be – the younger generation may not consider engineering as an interesting field of study. On the other hand, the secondary level education has changed and therefore the capabilities of the applicants have changed. It has also been said that the graduation times of the engineering students tend to be too long and the number of dropouts needs to be decreased [2]. Nevertheless, the main duty of KTUAS as an engineering school has remained the same - it is a continuous challenge to develop the education to meet the requirements of the surrounding industry. Engineers are needed in the region but the skills required are versatile. Today graduates have to, besides good knowledge and skills in technology, be able to co-operate, be international and have good communication and interaction skills. These things (among others) are also pointed out in the CDIO approach [4].

So, what has KTUAS done in order to make the school more appealing and the education more inspiring? One thing is to take a step to the international 'market' - make education more international and participate in the international networks. Participation in the educational conferences, exchange programs and projects funded by the European Union (e.g. Interreg IIIA) has given the school a lot of publicity, new skills and possibilities. The pedagogical and interaction skills of the staff have been further developed by arranging courses and workshops for the teachers and R&D people. Renewing the curriculum has been considered an important task as well. The CDIO framework was found approximately three years ago. It was soon found out that the CDIO way of thinking could offer excellent possibilities to the school. The idea of open architecture of CDIO was very appealing [3], [4]. So, it was decided to collect more information on the CDIO initiative and today the CDIO way of thinking is part of the daily life at the department of technology. In this paper and poster one of the CDIO projects of the first year engineering students is introduced.

The Christmas Lights Student Project was carried out during the fall of 2010. The purpose of the project was to provide a positive kick off to electrical engineering studies and, on the other hand, to offer the students practical learning by doing experiences in the electrical circuit design, programmable logic controllers and team (project) work. This paper (together with the poster) represents the learning objectives of the project, the project work itself and the results which were also introduced at the school event in December 2010.

TOWARDS CDIO AT KTUAS

This chapter provides a short history of some educational activities and methods which have been used at KTUAS during the past few years. The department of technology of KTUAS has quite a long history in project based learning and it has been used in several engineering programmes (information technology, electrical engineering etc.). Other things that are presented in this chapter are the design office model (mechanical engineering programme), summer training and Bachelor's theses, which are without exception carried out in the R&D projects and in the surrounding companies.

Project Based Learning

The project based learning has been part of the engineering education at KTUAS for several years. Single case projects, industrial case projects, laboratory development projects etc. have been carried out in practically every engineering programme. However, the project based education started in the international degree programme of information technology in 1999. In the beginning the programme was called cross-border engineering programme and later on the same concept was adopted to the Finnish IT programme that started in 2001. The number of projects in the whole Bachelor's programme of 240 ECTS accounted for nearly 40% (including Bachelor's thesis, 15 ECTS). Approximately 50% of the time at school was project work. Project/problem based curriculum was established in 1999. There were several CDIO type learning objectives including communication skills, multidisciplinary team work, solving complex engineering problems (tasks with the specified preconditions), taking responsibility and putting theory into practice [4]. During the years, the department of technology of KTUAS has been able to develop project based pedagogy (including the curriculum) and to create teaching and learning methods to meet the expected competence requirements of the graduates.

The project based learning from our point of view means more student centered, interdisciplinary and long term learning activities compared to the traditional lecture based learning. It is also generally expected that with project based learning methods the students learn to transfer knowledge or information from one context to another more efficiently [6]. The main objective of the project based learning is to train students' learning skills, problem solving skills as well as social and group working skills. Learning is typically organized around projects which are built around real industrial case projects. The assessment, guiding and study environment are developed to meet the expected requirements of both the students and the project owners.

Design Office Model

The design office model at Vocational College of Lappia and at KTUAS is part of the mechanical engineering education. This model can be considered an industrial simulation. The design office model combines secondary level education (Vocational College of Lappia) and higher education (KTUAS mechanical engineering for Bachelor's degree). Students of the secondary level study and learn practical skills in a real manufacturing facility. Teachers guide them to learn various practical skills in metal work, manufacturing, machine automation and plant maintenance. The design office model brings together three important industrial branches including manufacturing, engineering design and plant maintenance. The Vocational College of Lappia takes care of the practical subjects and KTUAS mechanical engineering programme is responsible for the engineering design. Mechanical engineering students design the ordered products, create the manufacturing documents and follow the manufacturing process that is carried out by the secondary level students. This model creates a genuine win-win situation where engineering students gain practical experiences

and see how the work really is done in the manufacturing plant. The secondary level students learn how engineering work is carried out in the design offices. The design office model supports learning at both secondary and higher levels. It is also generally expected that this kind of 'do-it-together' model encourages the students from the secondary level to continue their studies at higher levels (e.g. KTUAS) [7]. Figure 1. below shows the main concept of this model [5].

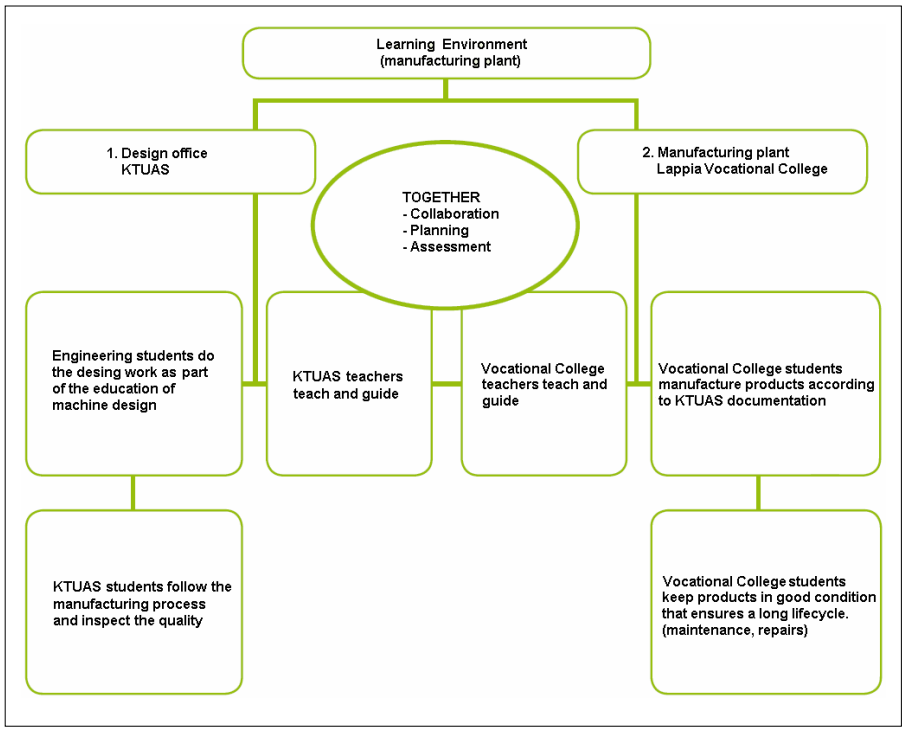

Figure 1. The main concept of the design office model [5]

Summer Training and Bachelor's Theses

The KTUAS engineering students need to have 30 ECTS practical training before their graduation. The amount of practical training may be even 60 ECTS in production oriented programmes. Students normally get training credits during the summer time while they work for the surrounding companies. Summer training is one good way to get real industrial experiences. KTUAS offers training positions at the school too. It is important to ensure that every student has a possibility to get the training credits. A typical training position is in the local process industry (wood, paper, steel). During the first two summers students usually work as process operators. After that they may work as foremen or supervisors. The companies in the area of engineering design offer training positions mainly for students close to graduation. During the summer training the students write a list (memo) of their work and compile a training book (portfolio). This documentation is reviewed and approved by the training secretary who works at the school. Summer training may also lead to a Bachelor's thesis project and even to employment.

Bachelor's theses are usually commissioned by the surrounding industry. The companies co-operate with the school and the students in order to find suitable thesis case projects. Another possibility is to get the thesis project from the school's R&D department. The The bachelor's thesis comprises 15 ECTS and the project usually takes 3 to 5 months to complete. A typical thesis project includes three key parties – the student, the teacher and the supervisor from the company. These three parties communicate and co-operate with

each other, have meetings and try to take the project from start to finish. The communicative culture between the school, the companies and the students has helped KTUAS to develop itself. The local industry becomes more familiar to the teachers and the companies can more easily give feedback to the school. Smaller project cases can become school projects (e.g. cases for project based learning).

Applying CDIO to Engineering Programmes

At KTUAS, the CDIO approach has now been applied to engineering programmes for approximately 2 years. CDIO deals with and helps to recognize similar issues to those KTUAS has faced. The CDIO corresponds to our thoughts of the future of engineering education quite well. Especially learning by doing, problem based approach, project oriented methods and a strong pedagogical grasp are the main reasons why the CDIO framework seems to be a good choice for KTUAS [4]. Currently, the whole department of technology of KTUAS is applying CDIO to the engineering programmes. The CDIO approach can be seen in the curricula as well. There are two main CDIO project courses and several other project type courses that can be seen as part of CDIO way of thinking. The first CDIO project course is for the first year students (=preliminary/orientation project). This project lasts the total of 160 hours (6 ECTS). It has both formal engineering classes and do-it-yourself (with a team) type of construction work mixed together. The CDIO standards are followed and student feedback is collected. The Christmas Light Student Project is one of the preliminary projects. The main idea is to offer the students engineering introduction and teach them to work as groups/teams. Learning new ways to study will ease further studies which are more often completed as a team work.

The second CDIO course is more specialized, wider and longer. It is called an advanced CDIO project. This project is part of the 15 ECTS module and the project itself comprises the total of 9 ECTS (240 hours). The advanced CDIO project takes engineering to a more professional level. There will be partners from industry and thus real case projects. Local industry as well as the community help the school to find case projects. Approximately 30% of the project is dedicated to conceiving, designing and planning type of activities. 30% is operative actions and the rest is mainly reporting and communication. The students work as teams, and several case projects can be started annually. Together with case projects supporting lectures are given and the teachers' roles are mainly to guide instead of teaching.

The CDIO has now been chosen to be the main orientation of the curriculum of the department of technology at KTUAS. The curriculum will be renewed by 2012. The learning environment is also changing towards a more communicative direction. Small laboratories have been built for team work and the number of group work facilities has increased. An important part of the learning environment is the well equipped library in the middle of the renovated school building for the students to study and work on projects.

CHRISTMAS LIGHTS PROJECT

The Christmas Lights Project course started with 40 students in the fall of 2010. Organizing the course was a challenge because of the large number of students. The main targets of the course were stated as follows: Introduction to electrical engineering and engineering studies (especially in the field of circuit design), motivating and getting familiar with the other students and the staff, building up the team spirit and thus make it possible to develop systematic thinking and engineering state of mind in a real case project. It was expected that the targets mentioned would help the students to form their own attitude to the engineering field and help them to work with each other in their future studies as well. The main task of the project was stated freely in order to emphasize creativity and imagination. It was also the time of the year that affected the project topic. So, it was now time to start a project producing colourful electrical Christmas decorations to cheer up the students, the staff and the whole school when the days were getting shorter and shorter.

Planning the Project

The previous orientation projects had given positive learning experiences and built a firm base for further development of project based learning. A lot of positive student feedback and good practices were available. In this particular project, unsatisfactory results were avoided and the course was developed mainly from the students' point of view. The feedback from the previous projects shows that, generally, the students were not happy if the project included too many theory lessons, neither possibilities for learning by doing nor hands-on tasks and not enough time for social interaction, team work, communication or other soft skills. The student feedback also showed that the teacher of the project course should pay more attention to giving individual supportive advice, help if needed, training and more repetition (especially the important topics), allowing students to ask also dummy questions, celebrating success together with the students and just being present with an open mind and having fun with the students. These among other things were taken into account while the course plan for the Christmas Lights Student Project was created.

The Project Start-up

At the beginning of the course the main objectives of the project and other important things were presented to the students. Studying and learning in a project requires some knowledge of the project work itself but also of the common framework, rules, timetables, goals and documentation. The following subjects were covered at the beginning of the course in order to clarify the project:

- team forming, roles of the team members, team tasks and team agreement
- project plan including resource planning, timetable and cost evaluation
- concepts and ideas to be developed further
- communication (memos, weekly meetings, presentations)
- design guidelines, basics of electrical circuit design and calculations
- information sources (Internet, books, datasheets)
- selecting criteria for the components (how to compare products and technical data)
- decision making, design freeze and other ways to proceed
- study environment including laboratories, safety, tools and other workshop hardware
- finishing and verifying the designs (visuality, surface coatings, testing equipment)
- instructions for presenting the products at the end of the project (session, open-door-day, voting for winner, stands, final presentations, local media etc.) and
- final report, feedback discussion, evaluation, grades.

It was decided that there would be ten freely formed teams - each with four members. The only rule in team forming was that in each team there had to be students with vocational college and high school background. The team also had to choose a team leader. At the beginning, introductory lectures and some theory lessons were given to the students, but after some weeks the teams were working freely in the school premises. There were supporting lessons in CAD design, sensors and PLCs and electrical circuit design simultaneously with the project. A course in communication was also taught at the same time. The preparations for the final session (school event) were done by the staff and the students. The idea was to take the final products to the school lobby and the restaurant to delight the people at the school. The products were there for two weeks and the vote for the winner took place after that.

Engineering Communication

There were communication sessions during the project. For example, each group presented the concepts and ideas briefly after the project began. The audience evaluated the presentations and the students gave feedback to each other. In communication, attention was paid to several aspects including:

- reading from the paper
- introducing oneself
- focusing on the topic and use of voice
- eye contact with the audience
- PowerPoint presentation and the slides and
- information contents and clear messages.

The quality of presentations at the early stage was surprisingly good even if the most students did not have former experience in presenting technical presentations. It was also good for the students to share information, know what other teams were working on, see different types of presentations and have possibilities to comment the work of the others. Generally, these communication sessions were ranked as one of the best moments to share knowledge and to learn from each other. After seeing other people's work, new ideas arose and the teams were able to develop their designs further more easily.

Working in the Project

The project work was carried out by the teams. The students were able to decide on the duties by themselves inside the team. Some team members sought information on the Internet while the others wrote reports, programmed PLC or built mechanical structures and frames for their products. Some teams did everything together. The teams shared information efficiently and everyone was aware of the status of the project. Theory and practice were both in use. The teams had to make calculations of electrical currents and power dissipation, for instance. They made the printed circuit boards by themselves and applied many other practical skills. The teams cut, painted, polished, soldered and used several laboratory tools. The safety regulations were followed and the atmosphere in the workshop was positive. After a few months, the work was accomplished and the products were taken to the school lobby and to the restaurant. The exhibition lasted for two weeks and the winner was voted by the staff and the students at the beginning of December 2010.

Figure 2. Pictures taken during the project

Figure 3. Circuit board and RGB- led- ribbon installation

The Voting Day

The voting day was a general doors-open-day at the school. The staff and the students from other schools (mainly from the secondary level) visited KTUAS. The visitors could fill in the voting ticket and vote for the best Christmas lights. Each project team had their own stand and the visitors were able to discuss their products and the designs with them. The local media was present as well. The voting day was a big day for the project teams. The teams had to be prepared for any questions of the product. At the same time, they were able to tell the visitors about the engineering studies and their feelings about the school. During the day the students had presentations, they discussed with the visitors and gave interviews to the local media. After the day the voting results were revealed. The three teams whose Christmas lights got the most votes were awarded. The picture of the winners is shown in figure 4.

Figure 4. Top three teams posing

Feedback

At the beginning of January 2011 a feedback session was held. The evaluation and the grades were already given and the students were asked to discuss the project as a whole. Most of the students were satisfied but the evaluation criteria were not clear to everyone. In February 2011 the feedback was collected again. Generally, the feedback was very positive and it showed that the goals of the project were well achieved. The students were still able to remember the project goals clearly and they reported that the CDIO type project is a very good way to study and learn new subjects. Basically, the only negative feedback concerned the evaluation criteria. The students hoped that the criteria should be more clearly stated at the beginning of the project. From the teachers' point of view, the project was quite demanding. However, a successful project like this has a lot of positive impacts and motivated the teachers. The project also created community spirit inside the department. The criteria for evaluation have to be described more accurately in the future projects. Evaluation should concentrate on the process, not on the final product. The criteria should also be simple enough for the the students to understand.

The development plans for the fall of 2011 are ready. Next fall the amount of self evaluation of the teams will be increased. The teachers of the project course will work more closely with the teachers of the supporting courses. The real customers will be linked to the project. Having a real customer will very likely make the project more appealing for the students. The evaluation criteria of the project will also be clarified.

SUMMARY BY THE STUDENTS

Mr. Matti Räisänen and Mr. Jouni Virtanen, Kemi-Tornio University of Applied Sciences

"In the CDIO way to learn, we think that the main point is that the teachers will give us a problem or a task that we should solve by ourselves. We have to find the solutions and figure out what we're going to do and how we're going to do it. This project gave us a great opportunity to start our electrical engineering studies and especially it was good for the students who were coming from high school. However, the students with a vocational school background hoped that the technical side of the project should have been more difficult."

"During this project we had learned a lot of new thinks about the project work. We have learned of designing, reporting, problem solving, project management and the team work generally. Learning by doing is a great way to learn of different phases of the project work. It will support the other studies too. The Christmas lights student project was a really good way to get known to each other. The team spirit still remains after the project and it is now more easy to ask and get help from the other students when we need it."

"After the project we discussed a lot of what we actually learned and how we feel about this kind of way of studying. The most of our class members are thinking that this was the best way to learn project work and orientate to our electrical engineering studies. In the future we hope that maybe we can do this kind of projects also with the real working life."

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Biographical Information

Lauri Kantola, 33, works as a principal lecturer for Kemi-Tornio University of Applied Sciences. He has completed his university degree (M.Sc. and Lic.Tech.) in mechanical engineering (mechatronics and machine automation). He worked earlier for different product development units and carried out research work at the University of Oulu (Finland). International experience he has gained in various conferences and while working as a visiting scientist at the University of Massachusetts – Lowell (USA). He has also worked in the Shanghai area (China) seeking suppliers for mechanical components and products. His educational career began in 2008. After that he has studied pedagogical subjects in the school of vocational teachers (graduated 2010) and taught engineering students as part of his every day job.

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