FIRST YEAR PROJECT IN ELECTRONICS ENGINEERING USING CDIO

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Abstract
A first year student does not usually have much knowledge of what an electronics engineer does, and why such courses like mathematics and physics are studied so much. Specific to electronics is that building even the simplest device requires a relatively great deal of theoretical knowledge. A design-build based CDIO project using many disciplines distinct from one another has therefore been established. Since electronics is developing very fast, lifelong learning skills are important. Also working in groups is essential because problems in electronics are usually complicated and a multidisciplinary and a cooperative learning method like Problem Based Learning is required.

Keywords: Integrated Teaching, Project based Learning, PBL, CDIO

Introduction

Students enter the school straight from high school or from vocational studies at the age of 19. They suffer from the lack of practice in electronics before studies although one third of the students coming from vocational studies have some experience in electronics. High school students have a better knowledge of mathematics, physics and foreign languages but even their skills are normally far too modest for electronics engineering studies. Students, totally about 70, are divided into two groups depending on the skills in mathematics and physics. First and second year studies are similar to all degree program students. By the end of the second year, students choose a specialisation option. Specialisation options are Electronics, Radio Communications Engineering and Communication systems.

Electronics focuses on the design and manufacture of electronic circuits that are essential components of household appliances, cars, television sets and communication equipment. The number of electronic devices in everyday use is still increasing. Expansion in the field also increases the need for skilled professionals. Studies in electronics concentrate primarily on mastering systematic design methods in microelectronics and electronic circuits.

Radio Communications Engineering is an orientation with the objective of providing a good theoretical and practical knowledge of wireless telecommunication including mobile phones, satellite communication and high frequency electronic design. The students specialise in high frequency electronics planning in theory and practice. A major part of studies focuses on planning software, measuring technology and the operations, and the use of measuring devices in the branch. Studies mainly concentrate on systems planning, circuit technology and components in the VHF and UHF areas.

Communication Systems is a specialisation option with the objectives of providing a thorough knowledge of communication systems. Studies focus on the basics of electronic data transfer in optic fibres and radio, the functions of mobile telephone networks, and the grounds of planning. Communications systems studies go very well together with radio communications engineering and electronics studies, and give a basis for working in different systems level tasks in the area of optic and electronic communications systems networks, and in the planning and building of mobile phone and satellite systems.

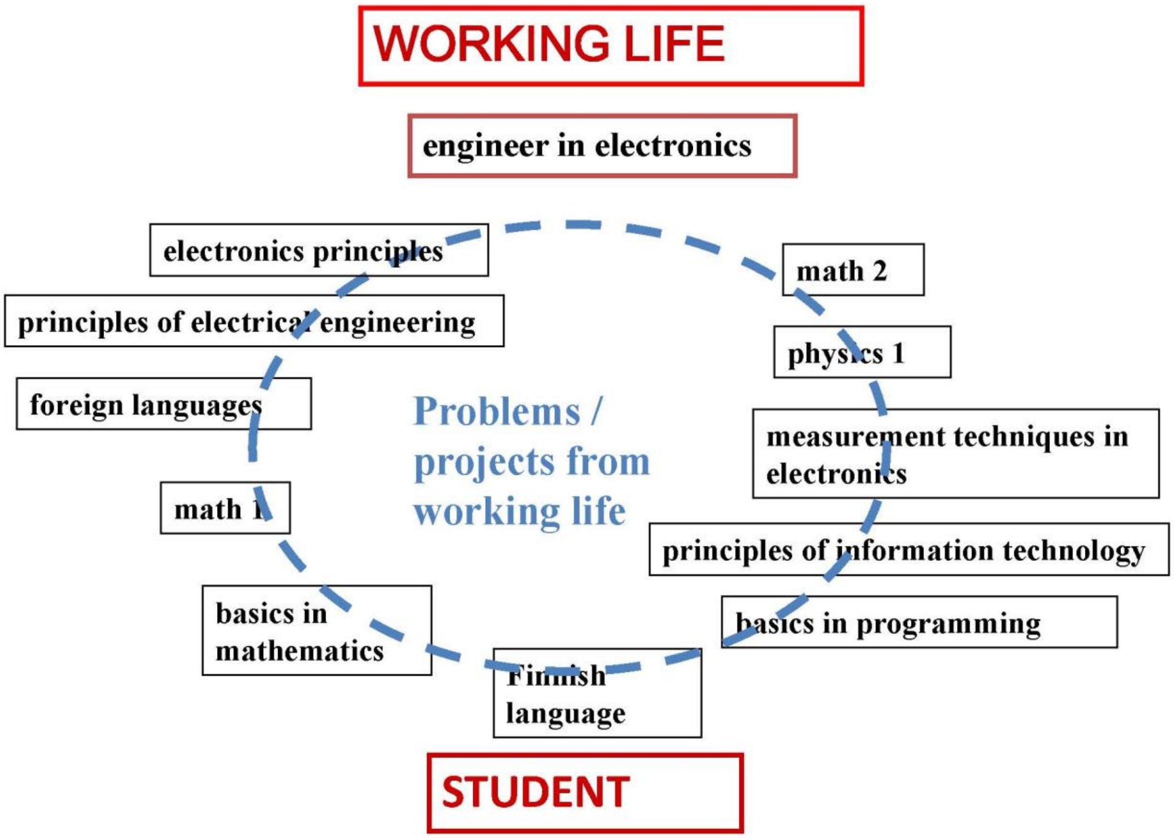

Figure 1. With a design-build-project it is easier for a student to understand the connections of different study modules if they all are needed in the project.

All the above-mentioned specialisation options need a remarkable amount of knowledge in mathematics and physics, and required lessons have been spread over the period of the first two years. The curriculum is built for four study years, but normally it takes five years to become an engineer, sometimes even six years. Another big problem is the large number of students interrupting their studies especially during the first two years. In the end only about half or even less of the students entering the school will graduate. In the past a preceding obligatory one year work placement in electronics ensured that students were motivated and they knew what the role of different disciplines in the curriculum was. At present, students need more knowledge about working life and why so many different subjects have to be learned. The connections between distinct subjects in the curriculum are blurry for students, and learning results are not as good as they should be (see Figure 1).

Technological development in electronics is huge and learning skills have to be developed because of lifelong learning. In the industry there is also an increasing need for group work skills and in addition, high quality education is broad because of working life. Besides students, neither do teachers usually know enough of the working life and of other teachers' subjects. On the contrary, students at Turku University of Applied Sciences are keen on practical working and this should be exploited. In 2006 the faculty moved to a new building with many laboratories and three universities working with ICT. Most of the teachers have active connections with electronics industry, e.g. Nokia Corporation, and a final year project is practically always done with an industry. The work placement is also executed with the surrounding industry during the second and third year lasting 20 weeks altogether. The Degree Program started working with PBL in 2003 and joined the CDIO-community at the end of 2007.

Implementation

In the first year a student does not usually have much knowledge about electronics and working as an engineer, so it is difficult for her/him to understand, why such a subject like mathematics or physics has to be studied as much as they are directed in the curriculum. Therefore learning how separate subjects are tied together and how these subjects are all needed to build an electronic device, is important. Consequently a design-build experience is unquestioned. According to the CDIO-principle the target for the first year student is to build a working electronic instrument. One particular difficulty in electronics is that to design even the simplest circuit a rather large amount of theory has to be studied. This is the important difference from other technical fields. Depending on the circuit or device many special facts in mathematics and physics have to be learned. The theory and skills needed are quite often not included in conventional courses at least with an adequate extent. Extra lessons have to be arranged and they cannot quite often be part of an existing content of the course. In this case the required facts and skills are learned using a Problem Based Learning method (PBL) [2]. At the same time students will get life-long learning and group working skills which are particularly important for an electronic engineer in the very fast developing field.

The project begins with dividing the students into eight small groups so that in every group there are about eight students. In the beginning a PBL-method is learned and as an application a couple of exercises about an engineer's work will generally be produced. The tutors in the PBL-tutorials are partly teachers who are not experts in electronics but, e.g., mathematicians or language teachers. After about two months from the beginning of the studies a CDIO initiative is introduced and a first electronics project is established. The purpose of the project is to design and build a working electronic device which can be e.g. a light pulp reacting to sound with requisite controlling circuits and sensors (see Figure 2). In addition, a product document of the device is required. The document should describe the design process and the building process of the project. For many students this project is the first opportunity to work with an electronics circuit or arrange components in the printed circuit board and solder them. If the purpose is, for instance, to use sound as a driver for some action, it is necessary to teach physical properties of sound and a decibel scale and a logarithmic scale in mathematics right here. For this purpose a PBL-problem and a tutorial is arranged for the physics of sound and for the mathematics of logarithms advised by teachers in question. These parts of the task will affect the evaluation of the subject at issue (see Table 1).

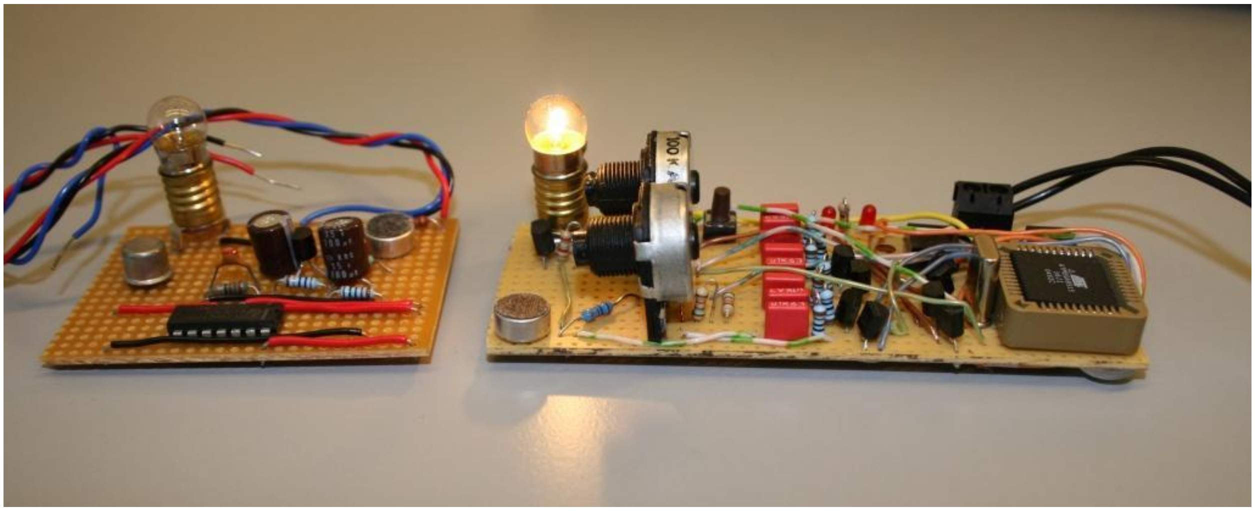

Figure 2. Two electronics devices switch on the light with a signal. The circuit on the left made by conventional electronic components and on the right side a more complex circuit with a processor.

The main PBL-tutorial lasts two hours and is held fortnightly. After one week there is a one hour long meeting where students are checking the situation. After two weeks a shared document or a report is produced and the group evaluates each member's activity and group's action. The project day substitutes the normal day timetable and the project day is shifted cyclically from Monday and Friday. After the tutorial meeting there are lectures and learning points arranged by the experts and at the end of the day students gather to specify their problem and to deliver tasks with each other. Finally, when the project is ready, an examination is held.

Conclusions

In the project almost all the groups of students succeeded in building a working electronics device. During the designing and building process, some of the groups, however, needed relatively much guidance, and sometimes students could not simply ask the right questions thus slowing down the project. Still in this very case the device was finally ready but not necessary working reliably. In order for the project to be successful, the admittance into the laboratory facilities should be free for all students, and measurement and soldering instruments should be available. Laboratory staff or teachers should be around every now and then for giving advice. The guidance of students and the introduction of the whole project in a sufficiently large scale beforehand were one of the most important things that had to be considered. The partial problems concerning, e.g., physics that had to be solved in advance before the building phase started, did succeed, but many times the "copy and paste" method was used. Some of the students did not like to write reports or did not want to work together in the groups, and because the project was working life based, the student did not pass the course then. Generally speaking, cooperation and thus working together for the same goal was an important part of the work and helped students to get motivated for the project. The brainstorm phase in PBL is useful when looking for a solution to a complex system. At the same time every student in a group can participate even if having quite modest facts and skills. Continuous self evaluation in written form directs the student's activity.

To train a whole faculty to exploit the PBL method is a demanding and rather expensive task and requires some extra funding. Later on the use of the method is necessarily not more expensive than using conventional methods. Workable facilities are, however, needed and in the new school building these things have been considered. It should be emphasized that teachers are learning at the same time from each other's study modules and working together will increase. To get familiar with the CDIO-method is important also for understanding the entirety and purpose of the project.

Table 1. Basic studies of the Degree Program in Electronics. First year project is underlined with a blue background.

BASIC STUDIES, 132 ECTS	**ECTS**	**A07**	**S08**	**A08**	**S09**	**A09**	**S10**	**A10**	**S11**
Common Studies of DP in Electronics	**55**								
Study Skills and Professional Growth	5	2,5	1,5	0,5	0,5				
Finnish Language and Research Communication	4	3						1	
Swedish Language	3					3			
English Language 1	3	1,5	1,5						
Physics	15	3	3	8	1				
Mathematics	20	4	6	5	5				
Entrepreneurship	5							5	
Basic Specialising Studies of DP in Electronics	**77**								
Signal Theory	7					2	2	3	
Electronic Principles	10	3,5	6,5						
Electronics	10			6,5	3,5				
Electronic Production	7	2	2					3	
Electrical Circuits and Applied Electromagnetics	20	5	3	4,5	2,5	3	2		
Programming	10	1,5	3,5			3	2		
Principles of Data Transfer	13			2,5	2,5	8			
Total	**132**	**26**	**27**	**27**	**15**	**19**	**6**	**12**	**0**

References

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[2] Woods, Donald R. Problem-based learning: How to Gain the Most from PBL. Hamilton, Ontario, Canada (1994).

Biographical Information

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