DEVELOPMENT OF CDIO SKILLS THROUGH THE CONCEPT OF 'SMALL BUSINESS PROJECTS' IN ELECTROMECHANICS

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ABSTRACT

Bachelors in electromechanics at University College Ghent receive a broad training during which they have to develop several projects. In the second year, they can choose a generic project, proposed by the teaching staff, or they can start their own "small business project" (SBP), in cooperation with Flemish Young Enterprises [1].
During a SBP students learn to create, manage and develop their own junior company which they use to market their own original idea and product. The whole business is based on their junior business plan, which is coached and checked by real business people, 'godfathers'. The students decide themselves about their service or product after an intensive brainstorm workshop, a market exploration, a profound marketing study and a brief financial study. The chosen service or product fits in their curricula. The students have to organise every aspect, every management division from financial to the general management on their own, just like in a real business. They even have to create their own profit! Every SBP project group has the support from their own teachers, an SBP-coordinator and a business-godfather [1].
There's a match between the philosophy of CDIO and the philosophy of small business projects. The paper shows how students can get real life experience in entrepreneurship during their training. At the same time they get the broader scope of the CDIO lifecycle.

KEYWORDS

CDIO skills, electromechanics, small business projects, project based learning.

ABOUT THE PROFESSIONAL BACHELOR STUDY PROGRAMME ELECTROMECHANICS AT UNIVERSITY COLLEGE GHENT

University College Ghent is a Flemish autonomous institution of higher education. Its 13 faculties offer a wide variety of study programmes ranging from fine arts and music, over teacher training, health care and science to translation studies. This range is the widest in Flanders [2].

University College Ghent has 24 professional bachelor programmes, 14 academic bachelor programmes and 21 master programmes on offer. Nine of these study programmes are unique in Flanders. With its 15,257 students in the academic year 2007-2008 it is now the largest college in Flanders.

The Faculty of Technology is one of these 13 faculties. It offers 6 professional bachelor programmes: Chemistry, Wood Technology, Textile Technology, Fashion Technology, Real Estate and Electromechanics [3].

These professional bachelor degrees are mainly practice-oriented study programmes, which prepare students directly for specific professions in industry and commerce. During their training students acquire the necessary general and specific knowledge, skills and competences.

The professional bachelor study programme in Electromechanics leads to the degree of bachelor in the field of applied engineering and technology. The programme links up with secondary education and consists of 180 ECTS-credits, which corresponds to a traditional three-year curriculum. On average the study programme welcomes 350 students spread over the three years of the entire study programme.

The professional bachelors in Electromechanics receive broad training in the disciplines of mechanics, electricity and electronics. After their first year students have three main subjects to choose from: automation, electromechanics or heating-ventilation-airconditioning-cooling.

Within University College Ghent the professional bachelor degree in Electromechanics grants access to a master programme on condition that a bridging programme is undertaken first (66 ECTS-credits). This bridging programme comprises course units helping the students to acquire the general scientific competences and the basic scientific knowledge necessary to undertake the master programme. After successfully completing the bridging programme students receive a certificate giving access to the corresponding masters in applied engineering.

PROJECT-BASED LEARNING WITHIN OUR STUDY PROGRAMME

After the restructuring of higher education (bachelor-master) in Flanders the Faculty of Technology thoroughly revised its vision on education. In this new vision (2006) emphasis is put on:

- competence-oriented education,
- interdisciplinary approach,
- practice-oriented learning,
- self-reliant learning.

In collaboration with the education development specialist of our faculty, this new approach was developed, implemented and refined [4].

Within the Electromechanics study programme the concept of project-based learning plays an important part. For this reason interdisciplinary projects have become specific course units in the first and in the second year of the programme.

Through this project-based learning students acquire knowledge, (interpersonal) skills and attitudes by analyzing and solving problems in an active way. Moreover they also have to rely on competences acquired in other course units. Theoretical and practical knowledge obtained during lectures and laboratory practice is applied to real-life problems.

The interdisciplinary projects are organized in the first as well as in the second year of the curriculum, both in the second term (twelve weeks) of the academic year. One day per week is exclusively scheduled for project work. The Electromechanics programme has a pool of approximately fifteen project coaches (lecturers) who guide the project groups during the

whole process. For their technical coaching students can rely upon two technical advisers, consultation happens on a voluntary basis.

The coaches, together with the technical advisers, propose and describe the generic project assignment and determine the technical specifications. For the first-year-students' project the specific knowledge and skills of these students are taken into consideration. A survey held during the first term inquires about their previous training, the subject of their final project in secondary education and their individual interests or suggestions.

At the kick-off meeting of the first interdisciplinary project students attend a sensitizing presentation about:

- the meaning of project-based learning,
- the purpose of project-based learning,
- the requirements and expectations regarding students and coaches,
- the methods of evaluation.

This presentation also incorporates some directions because coaches experienced that this way students get into action faster and feel more confident in their new role. On the other hand, prolonging a strict guidance is not recommended as creativity is a key competence in the project.

At the kick-off meeting students receive a manual which comprises the following aspects: the general principles of project-based learning, the project phases, professional planning techniques and information concerning evaluation.

The following table summarizes the past generic projects of the first and the second year of the entire study programme.

Table 1
Past generic projects

	First year	Second year
2004-2005	Weather station	/
2005-2006	Compost master	Elektromobile Self-supporting fishbowl Sun boiler
2006-2007	Euro Counter	Sumobot or Anty-project* Terrarium
2007-2008	PMD - Waste is food for me	Experimental music instrument - Waste is food for music ADB-engineering** Passive house
2008-2009	Air Rocket	Be weatherwise Fire at Mokum Ice palace

* In the academic year 2006-2007 students worked on the ANTY project proposed by the *Vrije Universiteit Brussels*. They designed and manufactured movable robot arms as part of an automated soft toy called 'Probo'. Probo is an intelligent soft toy that helps long-term sick children to communicate with their parents and friends by means of a webcam and screen integrated in the belly of the toy.

** In the academic year 2007-2008 students of the main subject Automation carried out a project commissioned by the company ADB Engineering. This company intended to bring onto the market safety vests with light-emitting strips guaranteeing the wearer absolute safety. These strips needed a charge of 150 Vpp to lighten. Students had to study the power supply for the vests and adjust it in order to comply with the following demands: transfer from 4 x AA to the necessary 150 Vpp, rechargeable via a car cigarette lighter, blinking adjustable.

The Electromechanics programme committee decided to use the same project manual both in the first and in the second year of the entire study programme.

The manual was extended with several appendices: an overview of professions and functions, assessment criteria, useful documents (a number of templates e.g. for agenda and minutes of group meetings, for action plan, for individual log book) product specifications and the evaluation forms.

The way the generic project is conceived and implemented matches the basic principles and philosophy of CDIO. However, the complete CDIO lifecycle could even be more prominent should the project assignment not be determined beforehand, so the students would have the freedom to choose, design, develop and market their own technical concept.

In their second year students can take up this challenge by opting for a Small Business Project as an alternative to the generic project. In this way we wish to stimulate the development of specific CDIO skills even more.

SMALL BUSINESS PROJECTS (SBP)

In the second year of the entire study programme students can opt for a Small Business Project instead of the generic project. The SBPs are organized in cooperation with the Flemish Young Enterprises (Vlaamse Jonge Ondernemingen = VLAJO) [1].

About VLAJO

In cooperation with the Flemish Government Flemish Young Enterprises offers an important contribution in the renewal of the offer in Flemish Education willing to stimulate students for entrepreneurship. Here for Flemish Young Enterprises brings schools and enterprises together in a win-win relation willing to contribute to Flanders' prosperity [1].

Figure 1. Flemish Young Enterprises is an independent, not for profit education association. Flemish Young Enterprises has the purpose of enabling young people to learn about the world of work and to develop attitudes and skills for personal success, lifelong learning and employability through the real experience of running their own company.

The common aims of Flemish Young Enterprises are:

- To foster an understanding of the world of work and a spirit of entrepreneurship through the principle of 'learning by doing'.
- To encourage young people to think internationally in their business affairs.
- To develop international contacts between Achievers in member countries.
- To organize activities which promote and develop the cross cultural European dimension.

The first initiatives to set up an organization were taken in 1977. Since then, up to 50.000 students in Belgium have participated in the program alone, supported by volunteers from a cross-section of several hundred businesses of varying size.

The unique features contributing to the appeal and success of the program are the principle of "learning by doing" and business leadership. Volunteers from the business world join forces with teachers to guide and support the Young Enterprise Companies. These student companies sell shares, conduct market research, produce and market products just as real enterprise do [1].

SBP concept

Students brainstorm to find a product they wish to make and sell. Based upon a detailed business plan and a market study they investigate the feasibility and the saleability of their idea. The financing is secured through selling shares or by looking for sponsorship. Within the SBP an organizational structure is set up with a commercial, technical, financial and administrative manager supervised by a general manager. Thanks to the SBPs students get a clear view on several aspects of entrepreneurship and on starting one's own business whilst still training. The focal point is developing an attitude of entrepreneurship. 'Godfathers' from the business world assist them in this learning process [1].

SBP phases

VLAJO composed a start-up kit that helps students find their way when developing a project. For VLAJO emphasis is put on writing out a business plan, in principle physical production is not imperative. Our Electromechanics study programme uses the start-up kit, but we expect our students to develop a specific technical product, this in the spirit of the CDIO lifecycle model.

Phase 1 : Brainstorm, getting the idea about the product or service to be delivered > Conceiving

Students who do not opt for the generic project but for the SBP are entirely led by their spontaneous creativity. So the first phase is of the utmost importance for the future success of an SBP. A thorough preliminary study of the possibilities is necessary and this facilitates the translation of the concept into a business plan. After a brainstorming workshop students with a specific idea (a group of four to five students) present this idea to a 'godfather' company. Eventually they present their proposal to the project coaches and technical advisers, they decide whether the SBP is accepted or not.

This first brainstorm phase matches the Conceive phase in the CDIO lifecycle.

Phase 2 : Starting up/ setting up business plan > Design

In this phase the project group or team draws up a business plan. A professional business plan contains all the information necessary for potential investors. It has a clear structure

comprising a corporate identity, an HRM-organization chart, a market exploration and a financial study.

Students in Electromechanics always have to develop a technical product in their SBP (In a different study programme students can develop e.g. a service or a trade). Already in phase two they are working on the specification and development of their product.

We see here a clear link with the Design phase of the CDIO lifecycle model.

Phase 3 : Operational phase, from prototype to manufacturing > Implementing

During the operational phase students manufacture and test their product. At the same time prospecting is carried out. They also have to verify whether the product complies with specific safety regulations or whether a specific certifying is needed before it is delivered.

We see here a clear link with the Implementing phase of the CDIO lifecycle model.

Phase 4 : Closing phase/ commercializing > Operating

The closing phase, as VLAJO puts it, is rather business oriented. This phase describes the so-called liquidation of the company (settling accounts, paying invoices, paying out shareholders, stock liquidation, ending the SBP). Finally, students receive a certificate presented by VLAJO.

Furthermore, within our study programme we want our students to reflect upon maintenance service, repairs, upgrades and continuous product improvement. The possibility of a spin-off is also examined.

The following table gives an overview of the past SBPs and the percentage of participating second year students within the Electromechanics study programme.

Table 2
Overview Small Business Projects

	Title SBP	Percentage participating students
2005-2006	E lab LightDEC TouchMaster Pro Rower	12,2%
2006-2007	Can Crusher HandAid M.I.D. Promo Inno TLC Technics Coctail Cooker	18,5%
2007-2008	Modulight Smart Plants Eco Modif Dream Corp	17,7%
2008-2009	Cutting Edge FAC inventors TTS Technical Training System	13,7%

Except for the SBP-business plan, which is assessed by VLAJO, the same evaluation procedure is used for the generic project as well as for the SBPs. A distinction is made between process evaluation and product evaluation.

Evaluation

Process evaluation

Team work and working process are assessed by means of an individual logbook, a reflection report (the student reflects upon his own functioning within the team) and an analysis of the strengths and weaknesses of the team. This team evaluation is effected as a co-assessment (student and coach assessing together).

Besides this, every team member is expected to fill in the Belbin questionnaire. Belbin investigated the psychological laws and patterns influencing good team working and introduced the term “team role”. An individual team role profile is linked to a digital evaluation form used for self and peer assessment. By means of this evaluation form each team member assesses the work, the attitude and commitment of himself and his fellow team members. The results are discussed with the coach by the end of the project at the last team meeting. By comparing his team members’ assessment to his own assessment the student is able to reflect upon himself and his learning process. This process evaluation accounts for 35 % of the total evaluation score.

Product evaluation

Each team draws up a tender or quote and a professional planning, this accounts for 15 % of the total, the evaluation of the end product accounts for 35 % and the written report for 5 %. Finally each team gives a short presentation concerning the project work, followed by a defence, this accounts for 10 %. The ‘godfather’ company attends the presentation of the SBP.

ADVANTAGES AND POINTS OF INTEREST CONCERNING SBPs

Advantages

- Participation on a voluntary basis, so the motivation of the students is strong
- Concept of learning by doing
- Stimulation of problem-solving thinking
- Stimulation of creativity
- Teamwork – team spirit
- True-to-life learning
- Business aspects are highlighted
- Entrepreneurial skills are accentuated

Points of interest

- Limiting the number of team members to five students per group to avoid ‘parasites’
- Improving the time management to avoid neglect of other course units
- Making engagements clear about who does what [1]

JUNIOR ACHIEVEMENT EUROPE AND WORLDWIDE

Flemish Young Enterprises is a leading member-organization in a dynamic international network: member of Junior Achievement -Young Enterprise Europe [5] and member of Junior Achievement Worldwide [6].

Figure 2. JA-YE Europe

Figure 3. JA Worldwide

CONCLUSIONS

The four steps in the lifecycle of a Small Business Project show a striking similarity with those in the CDIO product lifecycle. We consider the business aspects and the accent on entrepreneurial skills within SBPs an important added value. Business administration and management skills are a common thread throughout the SBPs. Because our students actually develop and manufacture a technical product, SBPs are an ideal learning experience which enables them to develop the specific CDIO skills.

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