

Student/Industry Project in Industrial-oriented Undergraduate Degree in Electrotechnology

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This paper is to discuss a new methodology for the student/industry project in an industry oriented undergraduate degree. As discussed at the industrial oriented teaching and learning education in an electrotechnology undergraduate degree (Qi & Cannan, 2004, 2005b), students have an approach to learning from an industry perspective. All courses in the Bachelor of Applied Technology (Electrotechnology) are directly linked to industry and the focus is on industrial products where the design for teaching and learning is through a project based philosophy. All foundation knowledge and skills can be achieved within these studies and the students are well equipped to develop advanced knowledge and expertise required for their second year technology project and industry project required in their final year through a cooperative education agreement with industry. Students are to complete their final year industry project in six months full-time or 12 months part-time. Instead of traditional final year work practices, students will focus on approved research topics and complete their project through real world learning in an industry environment. A robust assessment for the industry project to meet industry and academic requirements is discussed in this paper.

Introduction

Students studying at traditional tertiary institutions often have no exposure to experiential learning and lack any worthwhile practical work experience. Predominately traditional methods of learning, particularly when teaching electronics often use models of learning that build the underpinning knowledge through subject based teaching of mathematics and physics independently from industry practice (Qi & Cannan 2004). The lack of practical work experience can be perceived as a problem for students that have excellent academic ability but have no experience with a prospective employer when searching for a job in the industry. If the gap can be narrowed between what the student learns in an educational institution to the learning that is experienced at the workplace (Lewis & Durcharme 1990) then part of the challenge for educationalists and for industry to work closer together may well be met through such processes as work integrated learning and cooperative learning programs. Moreover, cooperative learning is an excellent form of learning and has many benefits for students, employers, and for educationalists and is well documented nationally and internationally (see NZACE, 1996).

Industry placements have been used as alternative methods of learning options with some tertiary education providers for some time linking education programs to a real work environment, and generally the two main objectives of industry placements are for students to:

- Gain hands on work experience, or
- earn academic credits within an academic program.

The first type as work experience only is usually set up at the end of or during an academic program. Students are sent to work placement and no academic assessment is required because the work experience is additional to the academic program. The second type is part of academic programs and students earn academic credits from the work placement. This type of placement is well used in certificate level courses and in particular at trade type courses where 'on-the-job' assessment is relatively straight forward to do as students work towards achieving competency standards in a particular field. However, above cooperative education program were not changed from the existing traditional academic programs. They just built a bridge between University and Industry. Students learnt their academic programs and then went to the industry for their work experience.

This paper is to discuss a new methodology for the student/industry project in an industry oriented undergraduate degree. As discussed at the industrial oriented teaching and learning education in an electrotechnology undergraduate degree (Qi& Cannan, 2004, 2005b), students have an

approach to learning from an industry perspective. All courses in the Bachelor of Applied Technology (Electrotechnology) are directly linked to industry and the focus is on industrial products where the design for teaching and learning is through a project based philosophy. All foundation knowledge and skills can be achieved within these studies and the students are well equipped to develop advanced knowledge and expertise required for their second year technology project and industry project required in their final year through a cooperative education agreement with industry. Students are to complete their final year industry project in six months full-time or 12 months part-time. Instead of traditional final year work practices, students will focus on approved research topics and complete their project through real world learning in an industry environment. However, where student project assessment is required at the workplace when students are on placement studying a degree a greater level of difficulty of assessment is experienced and students completing projects in undergraduate and post-graduate degrees need a valid industry project and learning agreement to ensure adequate protection with their academic study, health and intellectual property and a robust assessment for the industry project to meet industry and academic requirements.

Work-based Learning Experiences

Work-based Learning Experience Programs in North America

Various models of student work-based learning experience programs have been introduced and operate successfully in North America. The School District of Saginaw, Michigan, was implemented through the Manufacturing, Engineering, Construction, and Automotive (MECA) partnership (Claus, 1996). This partnership included collaboration among Career Complex staff and local business representatives in the planning of course and work experience content, the placement of students in actual work settings for training, and methods for assessing both student and program progress. An evaluation assessed the 1995-96 school year of MECA partnership's operation and detailed its progress against interim (three-year) goals and reiterated targets for long-term (five-year) goals. An estimated 9,200 students participated in career awareness activities; 117 seniors and 149 juniors entered the MECA program; and 838 students were placed in a work-based learning experience.

At California's City College of San Francisco (CCSF) a strategic plan called 'CityWorks' for improving workforce education and training was introduced (CCSF, 1996). In January 1996, a project group was formed to determine a timeline and tasks to be accomplished by the project through June 1996, establishing goals related to project dissemination, forming external linkages, implementing pilot course clusters, and developing work experience and placement services plans. Other project accomplishments include the completion of a 'work experience plan' in May 1996, setting requirements for earning credit for off-campus activities; the establishment of Career Connection to coordinate linkages between employers and CCSF.

Industry Projects in Vocational Education in North America

During 1992, the Missouri Department of Elementary and Secondary Education (MDESE) conducted a state-wide assessment of the vocational educational delivery system to determine the extent to which instruction in 'all aspects of the industry' was provided for within the vocational educational curricula (MDESE, 1993). It was determined that many of the component areas of 'all aspects of the industry' were included, with both competency profiles and related instructional educational materials, within the existing curricula of most vocational education programs in the state. A program was then developed to satisfy the need to determine the appropriate specific competencies for each unit so that students gain experience of 'all aspects of the industry'. During the program, the appropriate competencies that would provide strong experience in and understanding of 'all aspects of the industry' in 15 industry areas were identified (MDESE, 1993)

A project was designed to customize training for employees of manufacturing industries in six western Pennsylvania counties (Northwestern Pennsylvania Cooperative Demonstration Project [NPCDP], 1990). Project goals were to facilitate collaborative vocational and technical training programs between educational institutions and private sector companies and to establish

demonstration sites, manufacturing cells, an electronic communications network, and various training programs in high technology areas.

Project staff designed and mailed a needs assessment survey to manufacturers to determine training needs. After receiving survey data, staff built an organizational structure responsive to the training needs that could deliver services through training facilities available in industry and educational institutions (NPCDP, 1990).

UK Case Study: Academic Quality in Industry Project in Degree Level Education

UK higher education institutions are expected to be able to demonstrate that they are adhering to the Code of Practice for the Assurance of Academic Quality and Standards in Higher Education in Placement Learning. The responsibility for ensuring that a placement provides an adequate opportunity for its intended learning outcomes rests with the educational institution. In recognition of the increasingly global nature of the business, a placement program had been developed to meet the particular challenges of students operating in multidisciplinary and multicultural environments. Participation in the European Commission's Leonardo da Vinci Vocational Training Programs and pilot projects has enabled the identification of further criteria for evaluating and disseminating experience gained in work based learning across the frontiers of language and culture. However, the report of the project identifies problems peculiar to the UK market for construction professions and higher education programs in construction-related disciplines. A study by Northumbria University highlighted challenges for both industry and higher education arising from economic pressures on students and the positioning of construction-related courses in the higher education market (Murdoch, 2004).

Degree Level Industry Projects in New Zealand

Most engineering degrees in New Zealand require their students to complete a minimum proportion of hours of industrial experience relevant to their specified programs, for example, Waikato University's bachelor of engineering students need to complete a minimum of 800 hours of industrial experience relevant to their specified programs (University of Waikato, 2005). In Auckland University of Technology, a bachelor of engineering student undertaking a full-time year's work is required to enroll in papers to the value of 120 points. There is also an 800-hour work experience requirement (Auckland University of Technology, 2006).

In New Zealand higher level degree industry projects generally tend to be structured as part of the work placement where usually some form of memorandum of understanding (MoU) is based around a 'work-integrated learning' category where there is a required academic component of the course that is required to be assessed at the workplace. In the Unitec programs there are clear guidelines in the form of a learning agreement that all three parties the student, employer and learning provider agree to, ensuring that the academic requirements are met maximizing the students learning opportunities at the workplace (Unitec, 2006). Unitec offer programs that include work placements that require project work to be completed as 'work-integrated learning' such as in the Bachelor of Business and the Bachelor of Computing. Academic supervision is provided and the assessment consists of a project report and employers' evaluation report. Students will need to demonstrate effective personal, interpersonal and intellectual competency in the completion of a project and to critically reflect upon the process undertaken in completing a work-based project (Unitec, 2006).

Industrial-oriented Teaching and Learning

A new teaching methodology (Qi & Cannan, 2004) industrial oriented teaching and learning is an approach to learning from an industry perspective. This is particularly the case when viewing the program developed for the Unitec Bachelor in Applied Technology (Electrotechnology). This program is different from traditional technical bachelor degrees as the approach to learning is from an industry perspective. The program in the Applied Technology (Electrotechnology) Bachelor degree is specifically focused on practice and is a creative, purposeful activity in which ideas and techniques

are used for developing or modifying products, systems or environments. Knowledge and skills are combined with available resources to help solve defined, practical problems. The problem-management that lies at the heart of applied technology is specialized, disciplined and systematic.

Undergraduate Degree- Bachelor in Applied Technology

In the first two years of the program students specialize in one technical area and acquire a set of technical knowledge, skill and capability using the strategies described above to solve practical problems in an applied mode. The final year is wholly focused on integration and application where students will work on their industry project in cooperation with industry working at the workplace through a co-operative work placement plan. The premise that technological practice takes place within, and is influenced by, social and cultural contexts underpins the authenticity of the industry project. This project requires students to manage the innovative and informed use of specialized technical and social knowledge to achieve commercial and/or social objectives. The courses in the Bachelor of Applied Technology vary from traditional technical training as they combine fundamental and theoretical learning toward a technical Bachelor degree. It is not only a career-oriented program but also an industrial-oriented one where the courses are not only designed to suit the market but determine the course’s content, learning and teaching processes. Students will learn in a different way and they will acquire the knowledge and skills to be competent professional engineers in the future.

Degrees in technology often include separate, introductory courses on underlying first principles - such as mathematics (Qi & Cannan, 2005) and physics; these are often taught as content unrelated to practice. In the Bachelor of Applied Technology, underlying principles are associated with design, construction, and service, as well as health and safety, professional ethics and sustainability. Subjects such as mathematics and physics are totally integrated into the technical courses to authenticate the practical application.

As shown in Figure 1, students are involved in:

- Investigating, using, and understanding the technological products, systems, and environments that have been developed in their society
- developing knowledge of the principles and processes of technology
- identifying and exploring needs and opportunities which may be met through technological activity
- creating and evaluating ideas to improve or modify technology in relation to these identified needs and opportunities
- choosing and using materials, tools, and equipment skillfully and safely
- designing their own technological solutions and ideas
- working with agreed specifications and quality standards and performance-based outcomes
- recognizing the inter-relationship of technology and society – now, in the past and in the future, and
- feeling empowered to contribute to an ever-changing technological society.

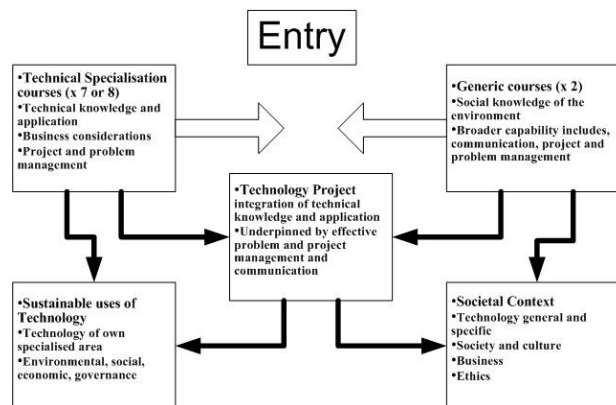


FIGURE 1
Program structure of applied technology bachelor degree at Unitech

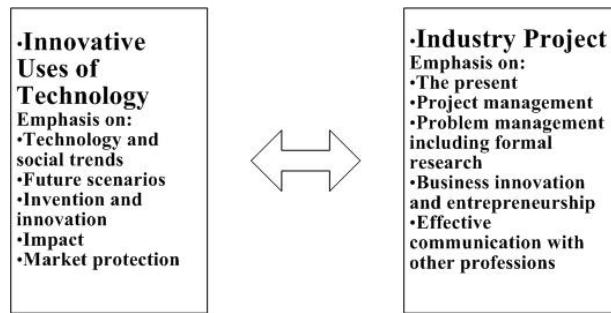


FIGURE 2
Final year papers for applied technology bachelor degree at Unitech

The final year is wholly focused on integration and application where students will work on their industry project in co-operation with industry working at the workplace through a co-operative work placement plan. As Figure 2 shows, the industry project requires students to manage the innovative and informed use of specialized technical and social knowledge to achieve commercial and/or social objectives:

1. The Bachelor of Applied Technology is about integration and application and the courses taken in the early stages require the students to identify and solve problems, and to be innovative
2. The body of knowledge acquired is through an integration of fundamental, theoretical and practical learning
3. Not only is the focus on a career-oriented pathway but also an industrial-oriented focus where the courses are designed in collaboration with industry to suit the current market
4. Degrees in technology often include separate, introductory courses on underlying first principles - such as mathematics and physics; and these are often taught as content unrelated to practice, and
5. In the Bachelor of Applied Technology, underlying principles are associated with design, construction, and service, as well as health and safety, professional ethics and sustainability. Subjects such as mathematics and physics are totally integrated into the technical courses to authenticate the practical application.

Discussion and Implications

Project-based Learning

Technical Teaching Courses

As an example, the course in Applied Electronics Technology is taught at Year 1. Students are required to spend at least five hours a week, and 34 weeks in total to complete this course. The course structure is as below:

- Project one: Electronic Amplifiers
- Project two: Power supplies, and
- Project three: Light dimmers.

Switch-mode power supplies are taught in Project Two: Students design and build a switch-mode power supply under the normal schedule as is current practice in New Zealand industries. During this schedule, students not only learn the processing of design and build a prototype but also can verify the EMI issue in switch-mode power supplies with mathematic tools and electronic tools (Qi & Cannan, 2005b).

The content of this course is as below:

1. Fundamental concept of power supplies:
 - a. Methods of operation of switch-mode power supplies
 - b. Analysis of circuit diagram for PC power supplies, and
 - c. Consolidation of fundamental knowledge.

2. Faultfinding:
 - a. Electronic circuit faultfinding
 - b. Diagnosis and repair a faulty PC power supply, and
 - c. Specialized knowledge of electronic fault finding.
3. Electronic circuit design:
 - a. Methods of circuit design
 - b. PCB CAD software Protel 2004
 - c. Design a switch-mode power supply
 - d. Create PCB and produce bill of materials
 - e. Prototypes assemble and test, and
 - f. Written assignment.

Technology Project

The purpose of this course is to enable the student to negotiate and fulfill a contract that promotes a solution to a technological problem within their area of trade specialization, while demonstrating the interrelationship of technical and social knowledge and skill (Unitec, 2005a). For example, the 2005 Technology Project is an external funded project and students are paid for the jobs. Students design, build and test a PC-based security camera system. This involves students working in a group situation, however each student has an individual task and signs an individual contract with his/her technical advisor before he/she starts on the project.

The content of this project is to:

1. Construct a PC system installing software to capture the image from eight digital cameras and save the image to PC hard-drive while motion is detected
2. Design, build and test a sensor control system to ensure cameras capture a clear image
3. Build a cabling system to deliver image communication and provide power to cameras and sensors
4. Design, build and test an alert system via mobile phone and email, and
5. Design, build and test a power supply unit.

All the above content is taught on the technical courses to enable students through the Technology Project to utilize current industry methodologies and practice in an industry environment. At the conclusion of the project students are required to write a technical report including the solutions to technical issues, for example, EMI cabling, and have to verbally defend a documented solution before peers at end of this course.

Industry Project

The purpose of this course is to introduce students to problem-solving and communication in the context of occupational health and safety and sustainable practices, and to introduce them to collaborative, student-centered learning. Students will integrate the technical and social knowledge through proposing, creating and evaluating a new industry environment (Unitec, 2005b)

Industry Project Agreement

To ensure that the student gains a valuable experience at carrying out the project work at the workplace it is essential that all parties have a clear understanding of the learning requirements, responsibilities and assessment criteria by forming a suitable industry project learning agreement agreed to by all the parties. The learning agreement will determine the parameters of what the project focus is and expectations of both the students and employers

For the success of the partnership agreement, it's important to ensure that all parties are involved in the process of decision making and ownership of the degree program, and that the project work meets the academic and industry requirements. For students the project is about using the knowledge and skills gained through the technical and technology projects in the course work and integrating these specialized technical and social knowledge skills into a relevant industry project.

This will increase their learning and satisfaction and empower the students to take responsibility for their own learning outcomes to meet the assessment and gain some real world experience. The project outcomes will also have a great deal of value to an employer where the work achieved may have an impact on present or future technology (Unitec 2006). Responsibilities of all parties to the industry project learning agreement are shown as an appendix.

Academic Assessment

An essential element in industrial project learning situations is that of appropriate assessment methodology. Employers that host the project, the academic institution and of course the student must have clear guidelines as to what the assessment criteria will be. With the integrated industry project in the Bachelor of Applied Technology program, students will produce a portfolio of evidence of the achievement of all prescribed learning outcomes. At the end of the second semester each student will present a portfolio for assessment. The assessment process will commence with a presentation before a panel of assessors and fellow students. At the end of the presentation, the student will be asked questions about his/her work. At a later date, after the panel has examined the material in the portfolio, the assessment process will conclude with a formal discussion with the individual student at which the assessors will seek clarification of any matters arising (Unitec, 2005b). At the start of the second semester there will be formative assessment of progress made to that point. The results of that assessment may be used as supporting evidence when summative judgments are later made (Unitec, 2005b).

An academic assessment for the student industry project is the most important part of an academic program. A trade level on-site competency assessment is relatively straightforward, but a degree level on-site assessment is very difficult. An academic supervisor and an industry supervisor have to work closely to ensure student industry project assessment is completed successfully. Therefore, an industry project agreement is developed to ensure adequate protection of students with their academic study, health and intellectual property as well as ensure academic supervisors are to be involved in the on-site assessment and industry supervisors are to understand academic requirements.

Conclusion

Through the industrial-oriented methodology with an approach to learning from an industry perspective in the very early stages of the Applied Technology Degree with the technology courses and the technology project and then finally through cooperative education placement in their final year, graduates are going to be more employable having gained integrated foundation skills and specialized technical skills relative to industry practice. An important component of the learning pedagogy throughout the project based learning methodology is the rigorous assessment standards that meet industry and the academic requirements.

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Appendix

Responsibilities of All Parties to the Industry Project Learning Agreement

The Student will:

- Use [*his or her*] best endeavours to complete the Placement within the time frame and according to the requirements of the Placement Specification
- during the Term, undertake the Placement at the Sponsor's premises on days and times agreed between the Student and the Sponsor
- abide by any policies, practices, rules and codes of conduct of the Sponsor provided to the Student while carrying out the Placement
- organise and attend any progress meetings as provided in the Placement Specification;
- raise any concerns about the Placement with [*his or her*] Academic Supervisor as soon as those concerns arise
- at all times during the Term abide by the policies, rules and codes of conduct set out in (provider) Academic Statute
- complete course assessment requirements as provided in the Placement Specification, and
- at the end of the Term, return to the Sponsor all resources provided by the Sponsor for the duration of the Placement.

The Sponsor will:

- During the Term, provide the Student with the supervision, resources and industry experience described in the Placement Specification
- contact the Academic Supervisor as soon as possible in the event that it has any concerns about the Placement, the Placement Specification
- contribute to the course assessment of the student in accordance with the assessment procedures set out in the Placement Specification
- permit the Academic Supervisor to have reasonable access to the Sponsor's premises to supervise the Placement, assist in the resolution of disputes and generally deal with Student queries
- not require the Student to undertake activities as part of the Placement which are beyond the Student's experience or ability or beyond the scope of the Placement
- provide the Student with resources appropriate to the nature of the Placement, and
- after the agreement is signed, provide the Student with an induction into the Sponsor's business, including information on:
 1. reporting procedures on the Sponsor's premises; safety procedures; dress code;
 2. the Student's rights and conditions of access to the Sponsor's premises during the Placement; and business structure.

The provider will:

- Provide the supervision and resources described in the Placement Specification during the Term
- contact the Sponsor as soon as possible at any time where it has any concerns about the Student, the Sponsor or the Placement
- assess the Student's Placement in accordance with the Student Brief
- ensure that the Student has a general awareness of the key requirements of and obligations imposed by statutes applicable to the Sponsor's business
- attend meetings as provided in the Placement Specification, and if, in its absolute discretion, it considers the Placement is not being conducted satisfactorily or the Sponsor's premises are not a suitable environment for the Student, withdraw the Student from the Placement.