# Innovation and Design, a Technical Subject for All University Students

**F.G. De Boer[1], N. Prichard[2], M. Jonkman[1], R. Wheway[3], R. Wolff[1], L.A. Martin[1]**

1) School of Engineering and Logistics, Charles Darwin University, Darwin, Australia
2) Centre of Access and ESL, Charles Darwin University, Darwin, Australia
3) Faculty of Engineering, University of Wollongong and School of Engineering and Logistics,Charles Darwin University

## Abstract

Undergraduate courses at Charles Darwin University include two so called "Common Units". The purpose of one of these units is to provide all beginning undergraduate students with the fundamental academic skills and background knowledge necessary for academic success. When the School of Engineering at Charles Darwin University commenced offering Civil and Mechanical Engineering in 2004, a design unit was introduced for all first year Engineering students (Civil, Electrical and Electronics and Mechanical). Since the objectives of this unit overlap to a large extent with the objectives of the Common Units it was decided to offer the design unit, called CUC106, Innovation and Design: Communicating Technology, as a common unit.

During the course of the unit, students, working in teams, undertake to design an item, working through each stage of the design process from conception to implementation. The design project is supported by a lecture series, given by experts from the community and University, which introduces students to different aspects of innovation and design, a literacies tutorial which focuses on communication skills necessary for students to report on their project in an academic and professional context and a project work tutorial.

Experiences during the first year indicate that the aims of the unit were largely met. Most students enjoyed the subject, in particular the design project. Students reported that they had improved their communication skills and had learnt to work in groups. They enjoyed working with students from other disciplines and reported that the subject had given them an understanding and appreciation of the design process. In general the engineering students thought they had learnt more than students from non-technical backgrounds; while all students thought their communication, team work and design skills had improved. Only engineering students thought that their research, critical evaluation and organisational skills had improved.
The majority of students said that their perceptions of Technology had changed very little. Engineering students felt confirmed in their study choice but students from non-technical backgrounds felt no more inclined to follow a technical career path than they had at the start of the subject.

## Introduction

Charles Darwin University has a program where students from any discipline complete as part of their undergraduate course two so called "Common Units". The main purpose of the common units is to provide all beginning undergraduate students with the fundamental

*"Proceedings of the 2005 ASEE/AaeE 4th Global Colloquium on Engineering Education*

academic skills and background knowledge necessary for academic success and to help them understand the social, political and cultural context of the Northern Territory region. Additional aims are to broaden the range of students' knowledge and to give students from all faculties a sense of learning together. All undergraduate courses include two Common Units, which are normally taken during the first year of study. One unit deals with regional and indigenous issues and the other unit includes academic skills like critical thinking, communicating, researching and computing. The units have no prerequisites and can be taken independently from each other.

Many universities in Australia and abroad include in their Engineering curriculum a design unit (Dahm & Newell, 2001, Giolma & Nickels, 2002, Keilson, 2003, Little & Cardenas, 2001, Newman & Amir, 2001 Clavet et al., Peterson, Rogers et al., 1998) , where students, usually working in teams, undertake to design an item, from conception to implementation. An example is the University of Wollongong, which has been successfully running such a unit for the past 35 years (Davey & Wheway 1986, Wheway 1993). This is known to be an effective way of teaching (Pajares, 2003). When the School of Engineering at Charles Darwin University started offering Civil and Mechanical Engineering in 2004, a design unit was introduced for all first year Engineering students (Civil, Electrical and Electronics and Mechanical). The objectives of this unit overlap to a large extent with the objectives of the Common Units: students must be able to gather and process information, to think critically and to communicate their ideas. In addition the unit gives students experience with working in teams and broadens their horizon. As the unit has no prerequisites, there was no reason not to make the unit available to students from disciplines other than Engineering and it was therefore proposed to offer the unit as a common unit. After some minor modifications were made to the unit this proposal was accepted and the unit, called CUC106, Innovation and Design: Communicating Technology, was offered as common unit for the first time in 2005.

**Aims of the unit**

The aims of the unit are:

- to introduce students to effective ways of learning at university
- to develop skills in academic reading and writing and to enable students to prepare a report and give a presentation for a general audience
- to strengthen students research skills in regard to their ability to identify, access, evaluate, organize and communicate information
- to introduce technological aspects of life to as many students as possible in an exciting, practical and interesting
- to provide students with an understanding and appreciation of the design process and to enable them to design a simple item
- to give students experience with working in teams
- to encourage students to think critically

- to improve the communication between the providers of technology, students and graduates

- to broaden the educational background of graduates and to improve communication with people working in other disciplines

**Description of the unit**

The main part of this unit is a collaborative design project. Students are grouped into teams of approximately four, each of which will design a simple item. Each team will produce basic sketches of the item, build the item, carry out a basic economic analysis of the item and develop a marketing strategy. Teams are required to write a report covering the development of their design process and to present their findings in class. This is done in the form of a competition with the five best teams progressing to the finals. During the finals, the teams will present their design to the community and the group with the best design will win a prize.
The design project allows students to relate the importance of technical learning within society to everyday problems, showing them how to use technology in a hands-on way directly relevant to the lives of all people.

To support the design project, a series of lectures by various experts from the community and University introduces students to a range of views not normally available in a more traditional series of lectures. These lectures cover a wide range of subjects, from interaction within groups to the effect of technology on history. The specialist lectures are related to each stage of the project and include the following topics: creative thinking in design; working in groups; oral presentation skills; tropical considerations in design; cultural aspects of design; technical evaluation; keeping in touch, telecommunication; economic evaluation and financial planning; environmental evaluation of design; design evaluation for human factors; aesthetics of design; report writing; decision making; legal factors and intellectual property.

The weekly lectures are augmented by two tutorials per week. The first tutorial students attend each week focuses on communication skills necessary for students to report on their project in an academic and professional context. Thus, literacy is learned in the context of "real" tasks and helps students achieve "real" goals, the successful achievement of their assessments for this unit.
Students work on their design project during the second weekly tutorial. Tutors monitor the design progress, offer suggestions and technical help when this is needed and provide encouragement, ensuring each project remains on schedule. Tutorial groups are limited in size to ensure each student receives satisfactory support. Additional help for students is available on the university's Blackboard system. All lecture presentations and other support material are made available through this medium.

**Students from non-technical backgrounds**

CUC106 was offered as a common unit for the first time in 2005. In total 80 students enrolled, 43 of them were Engineering students. Since CUC106 is available to all students, a significant proportion of the students enrolled in the unit are from non-technical backgrounds

such as Arts, Business, Education, Health and Law. Thus the unit provides students of non-technical backgrounds with the opportunity to experience a technological education they may not otherwise have had exposure to. While the subject is not expected to be as relevant to their field of study as it is for engineering students, it was anticipated that completing this subject could have a number of benefits to these students.

- University graduates in all fields are the future leaders of society. Basic knowledge of technology will allow lawyers, accountants, language experts, etc to communicate more effectively with more people.
- Ideas for advances in technology usually come from the users of the technology, rather than the people who implement the ideas. Some technical knowledge will enhance development of these ideas.
- It might encourage the development of more appropriate technology for today's world.
- Students may develop an interest in history and culture by examining changes in lifestyle brought about by advances in technology.
- The subject may demonstrate the benefits that can come from working in groups, and prepare students for collaborative work that will come later in both their study and in their work.
- The concept of life long learning is introduced in the form of research based activities. This will help students both while still studying and later in their professional careers.

Offering a subject to such a diverse group raises a number of interesting questions. What is the experience of students from non-technical backgrounds compared to students in technical oriented courses? What is the influence of the exposure to technology on the perception of technology, specifically on the students who chose a non-technical field? Is this broad, project based, learning environment equally suitable for both groups of students? Do students of both groups find the subject equally beneficial in terms of improving their creative thinking, communication skills and a general broadening of their problem solving approach?

**Student experiences**

The following section will discuss the outcomes of the above questions based on questionnaires and individual interviews with the first combined group of students.

The first group of questions concerned the overall experience of the subject, whether students felt they learnt much, whether students considered the subject useful and whether the workload and level of difficulty were acceptable. While there was no difference in how much both groups felt they had learnt, on average the Engineering students considered the subject more useful and more enjoyable. Neither group considered the subject too difficult or the workload excessive. Although many students said during their interview that they thought the subject would be more difficult for students from non-technical backgrounds this is not supported by their own perceptions of the level of difficulty as the students from non-technical backgrounds generally found the subject easier than the Engineering students.

The second group of questions looked at the different components of the subject. The design project was clearly the most successful part of the subject as all students had positive things to say about this component. Comments ranged from: "good way to learn design and project

management" to "great fun" and "cool!!". This was despite the fact that some students indicated that working in a team had been quite a challenge. A number of students mentioned that learning how to work with others had been a very valuable learning experience for them. The overwhelming majority of Engineering students listed the design project as the most useful component of the subject. The non-engineering students were evenly divided: 50% thought the design project was the most useful component, 50% thought the lectures were the most useful component. The majority of students in both groups said the lecture series was good, with a number of students commenting that they found them "inspiring". Since the lecture series covers a wide range of topic and is delivered by many different lecturers, it was not surprising that many students said that some lectures were better than others. One student from a non-technical background thought that the lectures were too much directed at Engineering students, whereas a few Engineering students thought the range of topics was to broad and insufficiently related to Engineering.

The literacy tutorial compone nt was the least popular part of the subject. Although this component should give students general academic skills, which are applicable in any subject, only one student thought the literacy tutorials were the most useful component of the subject. A large proportion of students considered the literacy component the least useful component of the subject. Many mentioned that they did not learn anything new in these tutorials. This may be caused by the fact that this component is insufficiently aimed at the level of the students doing this unit. It should be noted that the entry requirements in Engineering have been raised in recent years and that many of the students from non-technical backgrounds doing this subject are also good students. One student explicitly mentioned that he obtained 18/20 in year 12 English and that for him the literacies tutorials were simply a waste of time. There were however also a number of students who indicated that they thought all components were useful and that they had learnt important skills during the tutorials.

**Perceptions of technology**

This subject exposes students who have not chosen a technical study to a technology-oriented subject. A number of questions were asked to see if the perception of technology was different for the two groups. Not surprisingly, engineering students considered technology more interesting than non-engineering students. They also felt more strongly that Technology is practical. In other regards there was no significant difference between the two groups. Unfortunately, we did not ask the same questions at the start of the semester, so we could not observe the change in perceptions over time but the students were asked whether their perception of Technology had changed during the course of the subject. The majority of students said that their perceptions of Technology had changed very little. Remarkably, a larger proportion of the Engineering students felt that CUC106 had influenced their perception of Technology. They mentioned the fact that the subject had broadened their horizon and had presented them with a different point of view. An example of a comment of one of these students: "There are many more factors that affect design than I once thought". They considered this a positive experience and mentioned that they felt confirmed in their study choice. The students from non-technical backgrounds, however, indicated that their perception of Technology had changed very little or not at all and that they felt no more inclined to follow a technical career path than they had felt at the start of the subject. As one business student put it: "I am more interested in wealth creation".

**Skills**

One of the main aims of the common units is to provide all beginning undergraduate students with the fundamental academic skills and background knowledge necessary for academic success. Students were therefore given a list of skills and asked whether they thought these skill had been enhanced by CUC106. Most of the students felt their communication skills had been improved, both their report writing and their oral presentation skills. Creative thinking, design and team work were also skills that were enhanced by the subject, according to most students, although the Engineering students in general considered their skills more improved than the students from non-technical backgrounds. Research skills, decision making and critical evaluation were improved according to the Engineering students but were not or only a little improved according to the students from non-technical backgrounds. The same was true for organisational skills, Engineering students felt they had improved their organisational skills but the students from non-technical backgrounds thought their organisational skills had improved very little. Neither group felt their mathematical skills had improved as a result of this subject.

In addition to the general skills, an aim of the subject was that the students would gain an understanding and appreciation of the design process. This aim seems to have been achieved as most students in both groups say that the subject has given them a larger understanding and appreciation of the design process.

Finally students were asked what they thought about working with students from different disciplines. Nearly all students answered that this was a positive aspect and that they enjoyed the cooperation with students from different backgrounds. A number of students mentioned the fact that the different skills of the group members had been valuable during the design process and that they had learnt from each other's point of view.

**Conclusions**

A new design subject was introduced at Charles Darwin University in which all students can enrol. The subject consisted of three components: a design project, a lecture series and a series of tutorials designed to teach students research and communication skills (the literacy tutorials). Experiences during the first year indicate that most students enjoyed the subject, in particular the design project. Students reported that they had improved their communication skills and had learnt to work in groups. They enjoyed working with students from other disciplines and reported that the subject had given them an understanding and appreciation of the design process.

In general the engineering students thought they had learnt more than students from non-technical backgrounds; while all students thought their communication, team work and design skills had improved, only engineering students thought that their research, critical evaluation and organisational skills had improved.

The majority of students said that their perceptions of Technology had changed very little. Many Engineering students said they enjoyed the design process and mentioned that they felt confirmed in their study choice. Some of them felt the subject had broadened their horizon and had presented them with a different point of view, which was a positive experience for them. The students from non-technical backgrounds, however, indicated that their perception of Technology had changed very little or not at all and that they felt no more inclined to

follow a technical career path than they had felt at the start of the subject. This was in spite of the fact that they also enjoyed the design project.

Summarizing we may conclude that a number of the aims of the unit were clearly met. The design project and the associated lecture series were an effective way to introduce technological aspects of life in an exciting, practical and interesting way, to give students experience with working in teams, to provide students with an understanding and appreciation of the design process and to broaden the educational background of graduates and to improve communication between students working in different disciplines. Regarding the general academic skills the results are mixed. While most student say their communication skills have improved, many students, in particular students from non-technical background do not believe their research skills or their ability to think critically have improved and many students consider the literacies tutorial the least useful component of the subject. There are however also a number of students who think that they learnt valuable skills in this component of the subject. As a final remark, lecturers in other first year Engineering subjects have noticed that report writing skills of the current first year students are much better than the report writing skills of previous first year students.

**Key words:** Multidisciplinary, First Year, Technology, Engineering, Design, Innovation, Project Based Learning, Teamwork

FRISO DE BOER is Head of the School of Engineering and Logistics at Charles Darwin University. Friso has initiated the establishment of the new Civil and Mechanical Engineering degrees at Charles Darwin University.

NICOLA PRICHARD is coordinator of Charles Darwin University's Common Units program.

MIRJAM JONKMAN is lecturer at the School of Engineering and Logistics of Charles Darwin University.

BOB WHEWAY has been an academic since 1968. He currently is an Honorary Principal Fellow at the University of Wollongong and an Adjunct Associate Professor at Charles Darwin University. He introduced the Creative Design Competition in Wollongong in 1970 and it has run for the past 35 years. Bob did much of the developmental work for CDU's subject CUC106.

ROB WOLFF is the coordinator of CUC106. Rob is also Discipline leader of Engineering at Charles Darwin University.

LORIEN MARTIN is research fellow at Charles Darwin University. Lorien has interviewed the students enrolled in CUC 106 for this paper.

## References

Dahm, K., and Newell, J. (2001). *Baseball Stadium Design: Teaching Engineering Economics and Technical Communication in a Multi-Disciplinary Setting*, Proceedings of the 2001 American Society for Engineering Education Annual Conference & Exposition, Session 1339

Giolma, J.P., and Nickels, K.M. (2002). *Herding cats: a case study of a capstone design course*, Proceedings of the 2002 American Society for Engineering Education Annual Conference & Exposition, Session 2425

Davey,R.J.and Wheway.R.T.(1986). *Creative Design Competitions as a Means of Teaching Design in First Year*, Proceedings of the 1986 Conference on Teaching Designers for the 21st Century, organised jointly by the School of Mechanical & Industrial Engineering, University of New South Wales and the Department of Mechanical Engineering, University of Wollongong, pp.46-53.

Keilson, S. (2003). *A First Year Course in Design and Creativity for All Students*, Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition, Session 1153

Little, P., and Cardenas, M. (2001). *Use of "Studio" methods in the Introductory Engineering Design Curriculum*, Journal of Engineering Education, July 2001, 309-318.

Newman, D, and Amir, R. (2001). *Innovative first year aerospace design course at MIT*, Journal of Engineering Education 375-381.

Michaud, F., Clavet, A., Lachiver, G. and Lucas, M. (2000). *Designing Toy Robots to Help Autistic Children - An Open Design Project for Electrical and Computer Engineering Education*, 2000 ASEE Annual Conference and Exposition, Session 2220

Pajares, F. (2003). *Overview of Cognitive Theory of self-Efficacy*, Accessed March 22nd , 2005 at http://www.emory.edu/EDUCATION/mfp/eff.html

James, N., and Peterson, H. L., Hess (1999). *Feasibility, Design and Construction of a Small Hydroelectric Power Generation Station as a Student Design Project*, Proceedings of the 1999 American Society for Engineering Education Annual Conference & Exposition, Session 2633.

Rogers, C. Cyr, M., MacDonald, J., Nocera, T. (1998). *The Design and Performance of Musical Instruments*, 1998 ASEE Annual Conference and Exposition, Session 3553

Wheway,R.T.(1993). *Introducing Engineering Students to the Design Process through a Creative Design Competition*, HERDSA Research and Development in Higher Education, Volume 14,1993,pp.229-238.