

Greenhouse Gas Reduction in Industry: A Multidisciplinary Approach to Project-Based Learning

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***Abstract:** Since 2004, ten to fifteen final year undergraduate mechanical engineering students at RMIT University have worked on projects with local firms aimed at reducing greenhouse gas emissions by enhancing energy efficiency, reducing waste and/or using renewable energy. This Greenhouse Challenge Plus Support Program is a collaborative project with NORTH Link under the auspices of the Australian Greenhouse Office. In 2007, this project was extended to include students from other disciplines with the help of additional funding from RMIT's Design the Future initiative. In addition to the engineering projects, five multidisciplinary teams of undergraduate students – from the disciplines of mechanical engineering, social science and environment, industrial design, and management – were formed to work on more extensive projects with local firms. On completion of the project, the students and industry representatives were interviewed and the findings evaluated. In this paper, we report on our preliminary findings.*

Introduction

Every year since 2004, final year Mechanical Engineering students from the School of Aerospace, Mechanical and Manufacturing Engineering (SAMME) at RMIT University have been given the opportunity to work with local firms on projects aimed at reducing greenhouse gas emissions. This *Greenhouse Challenge Plus Support Program* is a collaboration between RMIT and NORTH Link (a regional partnership of industry, education and government in Melbourne's north) under the auspices of the Australian Greenhouse Office. The firms hosting the projects have signed on to the Federal

Government's *Greenhouse Challenge Plus* program. Some city councils that are members of the *Cities for Climate Protection* program have also hosted projects. Each year around ten to fifteen students participate. Students investigate, evaluate and made recommendations on opportunities involving increased energy efficiency, reduction of waste and/or use of renewable energy. Students work with the company, under the joint supervision of RMIT academics and a company supervisor, to investigate the opportunity, design process changes, evaluate their proposed changes, and where possible, assist with actual implementation (NORTH Link/NIETL and RMIT, 2006).

In 2007, with additional funding from RMIT's *Design the Future* initiative, this program was extended. In addition to the usual projects where engineering students are engaged singly with a firm, five multidisciplinary student teams, each comprising three students, were formed. The students were drawn from the final year of the following programs:

- Bachelor of Engineering (Mechanical) and related engineering programs.
- Bachelor of Social Science (Environment)
- Bachelor of Industrial Design (Architecture and Design)
- Bachelor of Business (Management)

In taking this multidisciplinary approach, we had a number of aims. One was to give a wider range of students an opportunity to gain valuable experience on one of the most critical issues currently facing industry, and society in general – that of reducing greenhouse gas emissions (Stern, 2006). A second aim was to bring students together from diverse disciplines to work on an actual project, thus providing students with real-life experience working in a multidisciplinary team and helping students to gain an appreciation of other disciplines (Parker, 2003). A related benefit was that academics from diverse disciplines were also brought together to work on a project. A third aim was to broaden the type of investigation undertaken by the students. So while engineering students have strong skills in investigating and evaluating technical options for greenhouse gas reductions and have clearly provided real value to hosting companies, the impediments to greenhouse gas reductions are invariably broad. Often a complex mix of economic, social and environmental factors needs to be addressed for a successful outcome. Thus it was believed that the engagement of students from a range of disciplines would lead to a greater focus on energy users and energy management practices, and would help strengthen the case for greenhouse gas reductions.

Project process

As in past years, the task of identifying companies willing to host these multidisciplinary projects was undertaken with the assistance of NORTH Link. This task proved more difficult than finding projects for single engineering students: projects needed to be identified that offered sufficient scope for a multidisciplinary team, and the firms needed to be willing to host three students. Moreover, projects were expected to have significant design element, in keeping with the funding offered by RMIT's *Design the Future* initiative.

Significant effort was required in the early stages to build partnerships with companies interested in hosting a project. Initial discussions built a common view of project outcomes and helped to temper and narrow expectations around project delivery. In hindsight, this aspect proved to be a key determinant of project success, as it governed how the project results were received by companies and how companies participated in project development.

The five projects selected, and the hosting companies were:

- RMIT University Property Services: reducing energy usage in student computer labs through redesign of lighting and use of computer power saving;
- Moreland Energy Foundation Ltd: investigating barriers to reducing emissions from water heating in medium-density housing;
- VicUrban: investigating feasibility of small-scale wind generation in a new urban development;
- Sofitel Hotel: designing technical and behavioural initiatives to reduce emissions that were in keeping with customer expectations of a five star hotel;
- South Pacific Tyres: energy auditing and identifying technical and behavioural measures to enhance energy efficiency.

One of the main difficulties in setting up these projects was the constraint that they needed to fit into existing courses. In the past, engineering students engaged in the Greenhouse Challenge Plus Support Program were enrolled in two 12 credit point courses – one per semester. This year, the engineering students in the multidisciplinary projects were still enrolled as in the past; however, the other participants were enrolled in single 12 credit point courses, and needed to complete the work in one semester. Thus each company project had to be split into two components – one for the multidisciplinary team and the other for the engineering student who would complete the work in the second semester. This was not ideal, and added to the complexity of the process.

Having only one semester to complete a multidisciplinary project with industry proved difficult. Forming the teams took time because student participation was voluntary and within each subject there were other competing projects. Working out how the team would function and how each member of the team could contribute also took time. Moreover, being inexperienced, students took time to work out their approach to the project – which had typically been defined only in general terms by the industry representative. While these were all very valuable learning experiences for the students, it meant that in some cases, the expectations of the industry partner were not fully met.

Once the project teams and content were established, significant effort was placed on guiding student design teams on a ‘team by team’ basis. Each team had an industry supervisor – the representative of the hosting firm. RMIT also provided a project supervisor, who met with each team at least fortnightly in order to help manage team outcomes and provide technical guidance. Students also had an individual discipline supervisor, who could provide discipline-specific guidance where necessary. Each team was expected to meet weekly and work together at the hosting firm when appropriate.

Students were also provided with pre-project training on topics including teamwork, research methods, project planning, greenhouse gas accounting, project financial analysis, and lifecycle assessment. The benefits of these sessions were mixed, mainly due to the different discipline backgrounds of the students. We suggest that care needs to be taken in future to ensure that the content is not overly technically biased so as to provide all students with universally engaging subject matter. The most successful training sessions centred around teamwork and the integrated nature of the design process.

Were the aims of the project achieved?

From the perspective of the teaching staff involved, the project was, in the main, successful.

One of the main benefits of the project was giving a wider range of students the opportunity to work on sustainable energy initiatives – an area that is becoming increasingly important for industry and the community. While some of the students were attracted to this project because of their concern about environmental issues and their interest in working in this area, other students had no prior interest in the subject matter. The project not only gave these students an opportunity to master a new subject area, that of energy analysis, but also allowed them to explore how within their own discipline they could make a contribution towards environmental improvement. A number of the participating students have now indicated that they wish to direct their career accordingly.

The experience of working within multidisciplinary teams on an industry project also provided clear benefits. Students were able to contribute their discipline-specific academic knowledge and technical skills, while embedding, sharing and further extending on their discipline-specific knowledge in a ‘real’ applied context. Thus the project enabled authentic work integrated learning, a goal which RMIT strongly promotes. Students were able to enhance the graduate capabilities that they have developed over the course of their studies. Each School at RMIT has a range of graduate attributes that it aims to instil in students in preparation for work. These capabilities are similar in essence to those adopted by the Australian Government’s Department of Education Science and Training as ‘employability skills’ They include: problem-solving, teamwork, planning and organising, learning, technology, initiative and enterprise, communication, and self-management. (DETYA, 2000, See also Hager *et al*, 2002, ACCI/BCA, 2002). RMIT prides itself on preparing ‘work-ready’ students and the development of discipline-related skills and graduate capabilities are what employers are looking for. The students’ experience of working in multidisciplinary teams is dealt with below.

The third aim of the project was to broaden the type of investigation undertaken by the students. In the main, this was successful. For example, in the VicUrban project on the feasibility of small-scale wind power, students considered the planning framework, the electricity regulations and supply chain as well as the technical and economic performance of wind generators. In other projects, students investigated user behaviour and made recommendations on energy management practices. In one case, this led to problems, which were not well anticipated by the teaching staff. One student team investigating energy management practices became quite critical of company management, which was not well received by the company. This suggests that future projects which look at energy management practices need to be handled more cautiously.

Project evaluation

Methodology

An evaluation is currently being conducted, with the aim of investigating how the multidisciplinary groups operated in practice, and what we can learn from this project for future similar initiatives.

Individual semi-structured interviews have been conducted with student participants and industry partners. Separate sets of questions were designed for each group. At the most basic level, the questions asked of the students were designed to ascertain what they felt that they had learned from participating in the project, both in terms of practical knowledge as well as interpersonal and project management skills. The questions were also designed to dig for more nuanced information relating to how the students understood their own sense of 'disciplinarity' in relation to others, and whether or not the project had helped them to become more aware of the parameters of their own discipline and its approach to structuring knowledge. The questions asked of the industry partners were particularly targeted towards finding out their experience of working with a multidisciplinary student team and whether they felt that the multidisciplinary nature of the project had been beneficial.

The transcribed data from these interviews are being analysed using the constant comparative method of qualitative data analysis (Silverman, 2005). This method was chosen, because we hope to elicit from all the participants their views on the value of working in multidisciplinary groups and the qualities of the interpersonal interaction within the groups themselves. Unlike quantitative analysis, this study does not seek to replicate results for the purpose of generating statistical facts, but rather to extract as much detail as possible from the situation under investigation. Therefore richness of data is favoured over large sample sets, which in this process tend to generate redundant data.

Preliminary findings

Preliminary findings from the interviews are that the students learnt a great deal about working in a team, including organisational and project management skills, how to manage conflict and to communicate with students from other disciplines. Furthermore, they learnt how to design and structure the parameters of their own project, including how to scale the project according to the time they had available and how to ask themselves the right questions. Skills in negotiating management structures in industry were also developed. Frustrations were expressed by some students at not having continued input from support staff from their own discipline throughout the process and a feeling that there was an uneven level of commitment from students in their group. The industry partners generally reported positive experiences working with the student teams. Some were very pleased with the potential economic savings that would result from the implementation of student designs. The most widely expressed difficulty was that they felt they did not have enough time to give to the students when required, due to other time pressures in their jobs. One key suggestion with regards to this issue is that more industry partnerships with educational projects are undertaken within the structure of the university itself so that the potential exists for time to be properly allocated to staff supervising the students.

Conclusions

What advice, then, would we give academics contemplating such projects in the future? Running such multidisciplinary projects takes much more time than do single discipline projects. In particular, teams require extra planning, monitoring, coaching and support. We suggest that a project supervisor be

engaged, in addition to the academics from each discipline. Also, considerable time is required before the project starts for planning and organising industry and other resources.

Also important is pre-project training of students to work in teams, particularly in team building project management, negotiation, handling unexpected contingencies and conflict.

Investing in effort to develop the right industry partnerships needs to be a key focus. In particular, companies need to be recruited that are prepared to actively support student involvement and accept project findings. The strategic nature of most greenhouse gas reduction initiatives means companies are most likely willing to enter into planning discussions for projects many months before project commencement. Early establishment of company partnerships should be a priority.

The complexity of greenhouse gas projects and the relationships between partners certainly emulates the real world, and working through related issues has been an invaluable experience for the students. Their academic learning has been applied and tested in the workplace. Overwhelmingly it has enriched the students as well as the companies.

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