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DESIGNING THE FUTURE – ARE OUR UNIVERSITY STAFF UP TO IT?

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ABSTRACT
The reality of design in most organisations is a multi-skilled team-approach with fluid management structures focused around outcomes and the maximisation of company opportunities and profit. Universities on the other hand are often focused around small groups, and commonly individuals, whose objectives are not necessarily commercial or university centred. Academics teach students to work in multi-discipline teams, but do not always practice this approach themselves. The problem of the disparity of the commercial and university environments is seen all the way up to the upper echelons of University administration, where the opportunities to work in multi-university networks with the flow of ideas, staff and resources is often hampered by outmoded administrative practices, fear of liability and loss of status, and lack of clarity of joint venturing, and the global commercial environment.
This paper presents some experiences of the author as a Head of School who tried to bring his Industrial Design and Engineering staff together to facilitate collaborative teaching, educational training relevant to a globally networked industrial environment, and enhanced student education focused on the theme of design.

Keywords: Engineering education, curriculum, design education, internationalisation, administration

1 INTRODUCTION

During the period 2002 to 2005 there were significant changes in the undergraduate programs of the University of Western Sydney [1,2]. There were two drivers for change for the School of Engineering and Industrial Design (predecessor of the present School of Engineering during the period). The first driver was related to trends and views on the nature of Engineering and Industrial Design Education (EIDE). The second was the mode of delivery of the programs and their content. The two drivers are inter-related, and always have been. The first driver, which influences course content, is within the context of the demands of the industry in which our students will be employed. EIDE is professionally oriented and hence has a focus on employability – our students and the community, and particularly the industries which we serve, dictate this focus. The second driver was influenced and determined by the policies of the University, the resources available to deliver the programs, and the requirements of accreditation, amongst other factors.
The change process for engineering and industrial design was not met with universal acceptance amongst staff at UWS. In fact the underlying causes and drivers for change were either not believed or not understood by many academic staff.

2 ENGINEERING AND INDUSTRIAL DESIGN EDUCATION

There is always a fine balance in the professional technology area between the training required to have the technical expertise for practising the profession and the actual practice of the profession in an era of rapidly changing technology. The 1996 review of engineering education [3,4] concluded that "there is a widespread view that discipline-based categories in the engineering profession are already becoming obsolete, and that the most useful distinction in the future may be between communicators and implementers" (p.10). A critical statement about current practice in the review was the comment that "the view was expressed that the educational system was tailored to the last century, the engineering curricula had become overcrowded, students were overloaded, and faculties were living with past definitions of engineering. This combination of factors had encouraged a concentration on lower order skills, with insufficient attention being given to the development of learning, reasoning and communication skills" (p.11). Cameron [5] recently stated that "Engineering is now "contested terrain", and many academic educators are still working to an old paradigm divorced from reality and reluctant to admit it." (p.1). It is worth noting that only 3 of the 10 generic attributes required for accreditation by Engineers Australia are related to specific technology training. There are more attributes related to community engagement and skills for lifelong learning than related to technological knowledge.

Criticism of over-concentration on specialization in undergraduate engineering and industrial design programs is within the context of the rapid changes in technology. The argument is that it is better to produce graduates who can accommodate change through a variety of strategies than graduates who are specialist in particular discipline areas. Technology change makes specialist engineering graduates less employable in the long term than those who are trained to manage change. Very few engineers or industrial designers who completed undergraduate degrees more than 10 years ago would argue that the specialist areas that they trained in are entirely relevant to the technology of today.

Beder [6] states that "a new educational approach is needed to meet these changing requirements. It is no longer sufficient, nor even practical, to attempt to cram students full of technical knowledge in the hope that it will enable them to do whatever engineering task is required of them throughout their careers" (p.309). Petroski [7] states that "the ideas of engineering are in fact in our bones and part of our human nature and experience." (p.vii)

It has to be accepted that the quality of technological training of engineers has to be of the highest standard. A recent review of the training of civil engineers [8] concluded that there was a need to include significant increases in technical depth and professional practice and it identified 15 outcomes that have to be achieved in the graduating engineer. Realising the difficulties in achieving the necessary outcomes and training in the undergraduate degree they recommended the development of a Masters program for the professional accreditation.

2.1 Trends in the delivery of engineering programs

The level of prior learning of students entering first year is not common across the engineering student cohort, which means that the approach to first year teaching has to be flexible and responsive to student needs. It is also evident that students are entering with levels of training in mathematics and science lower than a decade ago.

The focus of engineering education is on developing the intellectual skills and cognitive intellect of students and essentially moving the students towards thinking in abstract terms, so that they can "go beyond the information given" (to use the language of constructivist theory [9]).

Within the School of Engineering and Industrial Design it was realised by several senior staff that the redesign of the programs should not lead to programs to teach students "how to do mechanical things", like using computers, or applying a code. Teaching such skills may be necessary, but primarily because these skills assist in moving towards the true goal of enabling the students to work in complex situations for which there are no defined mechanical approaches to achieving an answer. In short, we needed to teach students to "design" in engineering and industrial design

2.2 Design as the Unifying Theme

There are various definitions of engineering and industrial design. It is not the purpose of this paper to review these, but it is worth noting that the concept of design is seen to be fundamental to engineering. "Design is at the heart of engineering and it is where professional engineers demonstrate their creativity and innovation" [10]. Petroski [11] states that "the idea of design and development is what most distinguishes engineering from science" (p.2).

Petroski [7] defines design as "making something that has not existed before" and states that "design is central to engineering" (p.vii). Innovation has to be a component of the learning environment, for both the student and the staff [12].

3 ACADEMIC OBJECTIVES

The general objectives of the engineering and industrial design program at UWS were:

- to educate engineering students at UWS to an international accepted standard, premised on the fact that internationalisation was fundamental to the curriculum [13].
- to promote engineering and industrial design, educating the next generation of professionals to manage and develop the necessary infrastructure and industry and its maintenance for the support of safe and sustainable communities, taking into consideration the efficient use of natural resources in an ecologically sustainable environment.
- to provide the best quality design and engineering programs that pro-actively relate to both industry requirements and undergraduate aspirations.
- to develop generic "enabling" skills, which allow graduates to apply their knowledge and skills to unfamiliar challenges and to continue to learn and develop throughout their working life.
- to develop teaching programs that are uniquely "hands on" to prepare industry-ready graduates.
- to facilitate an ethic of continued professional development and life-long learning
- to enable students to meet the challenges of life and of creating a more advanced ecological balance between humans and the artificial environment which they inhabit
- to engage in teaching and research that encompasses the domains of knowledge represented by the broadly defined discipline areas of engineering including industrial design and manufacturing.

In order to realise some of these objectives it was necessary to ensure financial viability by increasing revenue from non-government sources, with a particularly emphasis on links to industry. Focusing on industry links would automatically establish our links with the community and demonstrate our worth. It was also accepted by some of the senior staff in the School that we had to aim to be international in engineering and design in all teaching, research, industry and community activity, and develop strong integrated links with overseas universities and globally focused industries. Finally, we needed to deliver through teaching, research and industrial relationships, opportunities for a seamless transition from product research and development to product placement.

3.1 The Context of Change

The trends in the number of students doing Physics and Mathematics at High School are declining. Mathematics is no longer a compulsory subject in the Higher School Certificate. It can no longer be assumed that students entering the EIDE programs have significant backgrounds in Mathematics and Physics. It would be unwise and unresponsive to continue to assume that the EIDE programs of a decade ago, which were based on the premise that students had the necessary background in Physics and Mathematics, are relevant to the present cohort of students, where the majority do not have this background. Also, the completion rates for Engineering are low and few students complete their undergraduate program in the minimum time. This is often associated with failure in first year mathematics and physics programs.

3.2 Staff Teaching loads.

A key resource issue in delivering programs was the available academic staff resources. Prior to 2001 a majority of engineering staff taught 4 or more units a year. A need to free staff from teaching and managing Union enforced workload agreements meant we had to reduce teaching loads to less than an average of 2.5 units per staff member, which could only be brought about by a restructure of the courses. Large teaching loads had impacted on the research performance of staff. The School had to change from a teaching focus to a combined teaching and research focus. Some saw this as being partly achieved by attempting to engage undergraduate students in research, placing their learning at the cutting edge of developments in their chosen area of specialisation in engineering.

3.3 Budget constraints

All Australian and overseas universities face increasing financial pressures. It was amazing to see how many staff thought that the University had unlimited financial resources, often expressed in terms such as “they will always find the money”, and “what about the hollow logs”. Many staff still fail to realise the seriousness of financial limitations placed on most Universities (Australian and overseas).

4 THE REACTION OF STAFF AND THE UNIVERSITY

4.1 Curriculum change

There was resistance from engineering staff to curriculum change, but a readiness to accept change amongst the Industrial Design staff. All staff had “favourite” units, which often reflected their specific academic interests. More than 60% of the units had to be abandoned or modified through amalgamations as part of the change process of the curriculum in 200-2004. Resistance was encountered, even when the units had small numbers of students enrolled in them. Fear of potential loss of one’s job or de-focus on an area staff were trained in were obvious reasons for some of this resistance, but in often robust debates it was clear that there was a fear of weakening what some called “the tradition” or “the standard” of engineering. We found considerable resistance to modification of units. For some units that overlapped and were amalgamated we found on review that the new units were treated as two separate halves, with contributing staff not integrating their separate content from the two units that were amalgamated. Power-plays on curriculum control in units were obviously underway.

The common first year engineering program engendered a lot of resistance from some staff who argued that specialists did not need the broad training. It was argued that there was not enough space in the four year degree to teach the specialist technical material of a discipline. This view was an obvious direct contradiction of the objective of the common first year and what the literature says of the future of undergraduate engineering training.

4.2 Linking Engineering and Industrial Design

There were staff in School meetings who argued that there was no reason why Industrial Design and Engineering should be in the same school, let alone collaborate in their curricula. The argument was put in several venues that Engineering would be "diluted" by Industrial Design, and had nothing to gain from them. After five years there are still a number of Engineering staff who do not accept that Engineering and Industrial Design should be united.

Linking the curricula in engineering and design also met considerable resistance. Attempts to bring a project-based design thread into the undergraduate engineering program that extended from first to fourth year were not successful, and this was after presenting examples of successful programs at Universities like MIT. The Industrial Design staff had more success developing collaborative project work with overseas universities than they had in the school.

4.3 The University Administration

On the whole the University administration was supportive of the changes, especially those that brought about savings in resource allocations and improved the efficiency of delivery of programs. However, the policies and procedures for change were cumbersome, taking more than 2 years in some cases to bring about change, and complicated in some cases by Industrial matters that involved negotiations with the Unions.

The University was not quick at realising the value of the international and innovation-focused component of the program. Policies and resources for these took 6 years to implement across the University. When we tried to form alliances with overseas universities and organisations we found ourselves bogged down on legal issues. The topic of quality was also frequently raised, even when dealing with overseas universities that had good reputations.

The School is still trying to work through the issue of how to realise the commercial value of the innovation-focused designs of our students and staff. External agents, not the university, seem to reap most of the financial benefits of new designs developed by staff and students.

As in all situations of change the School had its champions and supporters both within the school and outside. Were it not for this support we would not have brought about the changes we did.

5 CONCLUSIONS

We are living in a changing academic environment, where the pressures of finance and the need to keep abreast of technological developments are important in the delivery of

Engineering and Industrial Design. Hence, any program developed for the next decade has to enable the school and the college to respond to change. It is unlikely that the drivers of engineering training will differ significantly from those identified above. Engineering students benefit from mixing with students from the allied field of Industrial Design, particularly as it is highly likely that they will be working with Industrial Designers in the workforce. Units that are directed towards a more general rather than specialized training program are likely to be more readily modified to accommodate changing industry demands. However, the attitudes of staff and the general policies of the University may not always be capable of adapting to these changes.

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