

A pathway to regional engineering

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Abstract: *This paper discusses engineering in a regional context and the pathways to engineering inclusivity. The Bradley “Review of Higher Education” stated that Australia’s higher education was falling behind the OECD countries and recommended “to set a national target of at least 40% of 25- to 34-year olds having attained a qualification at bachelor level or above by 2020.” The report identifies specific difficulties in achieving these goals in regional areas and recommends remedies at regional universities to increase the number of professional people living and working in regional Australia. This paper outlines the approach taken at La Trobe University’s Bendigo campus to interest and attract potential mathematics/science students in the region to the Civil Engineering course. The paper then discusses how inclusive processes in the engineering curriculum and engineering socialisation have been developed. The paper concludes with comments about the future directions of the course.*

Introduction

Tony Blair during his 10 years as Prime Minister of the United Kingdom nearly succeeded in raising the university participation rate to 50%, as he believed a university degree was the cornerstone of social mobility (Birdwell et. al., 2011). Professor Bradley in the “Review of Higher Education”, recommended “to set a national target of at least 40% of 25- to 34-year olds having obtained a qualification at bachelor level or above by 2020.” (Bradley, 2010). The review found that those from lower socio-economic groups, regional and remote locations were under-represented in higher education participation compared to the rest of the general Australian population and that, “Improving access and equity in higher education for these groups is a difficult task and the solutions that will help to resolve this challenge are not immediately obvious.”

Engineers Australia has a focussed interest in engineering education and ensuring the supply of suitably prepared engineering professionals is sufficient to meet the Australian demand. Policy analyst Andre Kadpura (2011) stated “In engineering the change was more pronounced with the overseas-born share increasing to 52.5% in 2010.” He further stated that, “This brief review shows that Australia has made little progress in dealing with the structural shortage of skilled engineers from within its own resources.” He applauded Engineers Australia’s advocacy and success in increasing student commencements in engineering, but noted that “At this stage, increased commencements have not translated into increased degree completions.” In fact, the completions in 2010 are noticeably down on 2003 figures, but in contrast the number of female students choosing an engineering education has marginally improved (Kadpura, 2011). The question that needs to be asked (and answered) is why the number of engineering degree completions remains static at best and falling at worst?

The remainder of this paper will review the search for answers to this issue, and describes how the Bendigo campus of La Trobe University has managed the dual issues of inclusivity and being a regional civil engineering campus.

Background

The engineering education dilemma in Australia is best described by Goodhew (2010) in his recent book, where he writes

“The background attitudes and expectations of students are changing increasingly rapidly. Each generation grows up in a different technological environment, in a different economic climate and according to different social mores. Engineering education cannot stand aside from these factors, even if we believe that many of the fundamental concepts and practices of our chosen profession are relatively timeless. It has to be the business of engineering educators to motivate students to engage with modern engineering and to relate their offered programmes to the contemporary environment, both in content and style.”

Why should 21st century students select a difficult four-year engineering program they know very little about when there is an abundance of courses that offer an enriching educational experience? Matusovich et. al. (2010) concluded that students persist in their chosen course for a variety of reasons, with the most important being attainment value. Attainment value is “the perceived importance of doing well on a task, particularly to how engaging in the task is consistent with self-concept.” (Matusovich et. al., 2010, p.294). They suggest that authenticity in engineering career opportunities and engineering activities increase student attainment values and so increase the students’ persistence in their chosen engineering course. This was found to be even more important for female students, who generally started with lower attainment values. “Moreover, it is important to understand how specific classroom and program practices contribute to changing and developing value beliefs. We must help students understand what it means to be an engineer not only by teaching a variety of engineering skills, but also by exemplifying the breath of activities engineers perform in their daily work.” (Matusovich et. al., 2010, p.300).

Lichtenstein et. al. (2010) found that engineering students achieved the strongest scores in *Gains in Practical Competency* and achieved significantly higher means in *Higher Order Thinking* but scored lowest for *Gains in General Education*. These authors “believe that the engineering demands and the packed curriculum require students to choose between earning the engineering degree and participating in enriching educational experiences.” They also asked “Are engineering faculties asking students to make too stark of a choice in choosing a major in engineering, thereby not attracting students who want both practical skills and personal development to be part of their college experience?” They claim that their “findings should challenge those responsible for engineering education to consider ... degree programs in which engineering students report high gains not only in practical competence, but also in general education and educationally enriching experiences.” (Lichtenstein et. al., 2010, p.315).

Molyneaux et. al. (2010) evaluated the effectiveness of a new Civil and Infrastructure Engineering program at RMIT that had been introduced in 2004. The new program “was commenced in 2004 following an intensive period of curriculum/development. The graduate attributes were based on graduate capabilities as defined by Engineers Australia in their accreditation process augmented by consultation with industry.” (Molyneaux et. al., 2010, p.263). Apart from stating that the Civil Engineering program was closed in 2003, “following a sequence of years in which the quality indicators showed the Civil Engineering program was not attractive to industry or students”, and that an opportunity was provided “to develop a more modern and attractive program with broader focus and emphasis on sustainability”, they did not offer an explanation of the shortcomings of the superseded program.

These examples show that many universities are struggling with the issues of attracting quality students and upgrading their engineering curricula to make their courses relevant to industry needs and attractive to prospective students.

Changing Demands on the ‘Tool-Kit’ Engineering Curriculum

Russell et. al. (2010) discussed the recent changing demands on the ‘tool-kit’ engineering curriculum that prevailed until the late 1970s. Prior to this time, most engineers were employed by large government organisations. These organisations wanted graduates with a solid grounding in engineering basics as a starting point for their induction into the culture of the organisation. Conformity, continuity and succession were vital requirements for the organisation to deliver its legislative responsibilities. The 1980s and 1990s saw these large organisations transform their organisational structures, and the majority of engineering work was outsourced to consultants and contractors. Since these companies operated in a competitive environment, they did not want to incur the additional overheads of mentoring and developing graduate engineers. Contractors wanted their graduates to ‘hit the ground running’, and consultants did their mentoring in ad hoc ways. Consequently, the majority of contemporary engineering employers need and expected a different set of graduate attributes than was provided by the ‘tool-kit’ curriculum.

Engineering Education and Inclusivity

A contemporary perspective for engineering education is offered by Goodhew (2010) where he identifies the purpose and context of engineering education as

- a. “To prepare students for research
- b. To prepare graduates for employment in engineering industry
- c. To prepare engineering/science/numerically literate citizens for society and
- d. To provide an intellectually stimulating education.”

Goodhew implies that there is a place for “inclusivity” but does not state it explicitly. The authors suggest that inclusivity must underpin contemporary engineering education programs, where inclusivity is defined as “So as to include; by including a part or parts of a whole.” (Oxford Dictionary, 2002). Inclusivity is used in this paper as a term akin to initiation into engineering in its fullest sense. Therefore, an inclusive education program should have an inclusive curriculum where “the subject content covered, the way in which it is taught and the learning methods promoted take into account the diversity of perspectives, attitudes and learning styles brought to the subject from different gender, cultural and social groups. Existing undergraduate engineering curricula tend to reflect male cognitive styles and interests.” (Mills et. al., 2010).

The ‘tool-kit’ type of engineering education never fully accomplished any of the above, and the creeping unattractiveness of engineering persisted until old courses were closed, transformed or renewed under the direction of Engineers Australia, demands from employers and from 21st century students seeking an enriching educational experience.

Transforming the Engineering Curriculum at La Trobe Bendigo

In 2000, the Civil Engineering course required more students for it to remain viable within the Bendigo region. This required a gradual transformation of the curriculum from a ‘tool-kit’ one to one that would attract current students and meet regional employers’ needs. The aim was to commence the transformation of the course and to be proactive in attracting students from regional Victoria and New South Wales into the course.

As a first step, a project-based stream was introduced, following the model described by Legge et. al. (1999). This stream consists of four subjects, namely *Engineering Practice*, *Engineering Group Research*, *Environmental Case Studies* and *Investigation* (Kilpatrick et. al., 2006). Next, as a response to the Engineer Australia Accreditation Review in 2003, an environmental stream of subjects, *Climate, Sustainability and Society*, *Environmental Law*, *Environmental Case Studies* and *Sustainable Infrastructure*, was vertically integrated throughout the four years. This gave the course viable environmental and project streams, and positioned the course to prepare students in their final years for leadership roles in industry (Russell et. al., 2010). In total, seven new subjects spread throughout the four years superseded the old ‘tool-box’ subjects, and the new subject embodied, where possible, more student and gender inclusivity in their subject matter.

Regional Universities and Regional Students

Regional universities are characterised by student catchments being spread over large distances, creating a unique set of circumstances compared to urban-based universities where student catchments are not as large and students are within daily commuting distances to universities. Hence, regional students often have to travel large distances to their university of choice. In addition, they often live in residences and only return to their home during semester breaks. Usually, regional students demonstrate a high level of self-reliance and resilience, with a strong attachment to community, family, friends and sport, and in many cases they are among the first generation of the family to attend university.

The restricted range of courses at a regional university limits the choices available to students who wish to remain in a regional setting. Students are forced to move to metropolitan campuses to complete some specialised courses, such as medicine, and the costs involved with this can limit their access to higher education. These additional costs can also be a factor for students who study at a regional university that is a significant distance from their home.

Integration of the Civil Engineering Course into the Region

As noted above, around ten years ago the viability of the Civil Engineering course at Bendigo was under scrutiny, and a concerted effort was initiated to increase student numbers. Discussions with regional career advisors revealed that many students did not understand what engineering is. Moreover, some careers advisors were also uncertain about engineering, and also struggled to promote engineering amongst all the other options available to students. Hence, the University attempted to improve the student numbers through promotional activities such as presentations to high-school students, careers expos, open days, the Science and Engineering Challenge run by Newcastle University and on-campus visits. These activities covered much of regional Victoria, Southern NSW and the ACT. They helped to slowly increase the student numbers and also the quality of the students as measured by their ATAR scores.

However, it was not until the acute professional labour shortages and the need for urgent responses to the drought conditions that regional employers and local government organisations decided to be more proactive in helping the University in its promotional activities. As a general rule, regional organisations struggle to attract metropolitan graduates to their organisations. Students who live in large metropolitan centres often have very little knowledge of regional areas, and don’t wish to work there. Moreover, regional employers report that few metropolitan graduates who initially choose to work regionally stay in the region in the longer term. Hence, attracting and retaining suitably qualified professionals to regional areas, in particular small regional centres, remains an on-going challenge. Regional organisations are also aware that regional-trained students are more likely to remain in the region after graduation.

The shortage of suitably qualified engineers in the region led employers to work with the University to introduce a scholarship program for civil engineering students. The first formal scholarship agreement

between the University and industry was negotiated in 2002. Since then, the program has expanded considerably both in the number of organisations who are part of the program and in the locations covered by the program. The scheme is currently supported by 19 regional organisations, and 31 students are receiving a scholarship in 2011 (La Trobe, 2011). The success of the program was recognised in 2010 by a Business-Higher Education Round Table award to the University and its scholarship partners for the Best Higher Education & Training Collaboration (B-HERT, 2010).

Although the specific details of each scholarship vary depending on an organisation's needs, each scholarship has the following common components.

- Annual scholarship payment,
- Paid vacation work, and
- Career mentoring.

The vacation work is normally done during the summer break. However, some students also work for their sponsor during the mid-semester break and during the semester if they have spare time. Some organisations also offer students a guaranteed job at the completion of their course.

The total scholarship payment to students is around \$125,000 in 2011. Payments for the work experience component are around \$200,000 per year. In total, regional organisations are making a substantial contribution to the Civil Engineering students at Bendigo. The benefits to the course have been a higher profile in the community, improved student numbers, improvement in the quality of students as measured by ATAR scores, and increased teaching and research links.

The Regional Engineering Curriculum and its Socialisation

It is a basic tenet for a regional university to be involved with and socialised by its community, and this is what has occurred with the Bendigo campus of La Trobe University. Bendigo is one of the fastest growing regional centres in Australia and it has recently endured a crippling drought, city growth, regional stress and a shortage of professional staff. This has necessitated that the University and engineering community closely collaborate to produce professionally-trained graduates suited to meet the regional needs and challenges. Apart from the scholarship program, other examples of the collaboration are as follows.

- The Bendigo Chapter of Engineers Australia provides engineering guest speakers as required, selected site visits, arranges annual keynote lectures and conducts the valedictory dinners for graduate engineers.
- The Course Advisory Committee, composed of senior regional engineers, regional managers and recent graduates, has overseen the transformation of the engineering curriculum.
- Most of the regional engineering organisations and consultancies provide scheduled field excursions to targeted engineering activities, attend student awards, assist with fund-raising, offer vacation employment to engineering students, provide mentoring, and suggest topics and provide assistance for final-year engineering projects.

These collaborative activities have socialised the engineering curriculum through the direct engagement of a network of past graduates, and improved the quality and relevance of the engineering experience enjoyed by the engineering students. As an example, the third and fourth year civil engineering students spent around 7% of their scheduled contact hours per year on field excursions with practising engineers demonstrating problem solving in the workplace. The practical instruction appeals greatly to most of the engineering students, as noted in student feedback surveys.

The Pathway to Regional Engineering

In hindsight, the pathway to a successful regional engineering education has been made possible through the following.

- The desire and commitment to maintain a viable Civil Engineering course in regional Victoria by La Trobe University and regional employers.
- The transformation of the Civil Engineering curriculum into a more inclusive one to provide an enriching engineering education experience to the students.
- The Australian economy being in dire need for more qualified civil engineers so that organisations were prepared to compete in the market place for students by offering generous scholarships.

In summary, the success of the transformed course is evident in the ongoing graduate engagement and support from regional employers for the Civil Engineering course at Bendigo.

Conclusions

The pathway to Regional Engineering as demonstrated at the Bendigo campus of La Trobe University has been essentially about sustaining a regional community during stressful times by establishing a significant regional engineering capability. To achieve this outcome, prospective engineering students were attracted to the civil engineering course and kept in the course by providing them with an enriching engineering education experience. This meant that the traditional ‘tool-box’ civil engineering course had to be transformed through the introduction of new subjects and the inclusion of project-based and environmental streams as suggested by the Engineering Australia Accreditation Review.

The introduction of the scholarship program and recruitment activities has resulted in a vibrant civil engineering course attracting more students. The engagement with the regional engineering community is ongoing, and the transformation of the engineering curriculum continues to improve the inclusivity for all students. The success of La Trobe’s evolving Civil Engineering course has been demonstrated through the success rates of graduates in gaining employment in a competitive market, and the positive feedback received from their employers, especially the regional employers.

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