

# RE-ENGINEERING THE BUSH: AN INNOVATIVE COLLABORATIVE ENGINEERING DEGREE AT THE UNIVERSITY OF NEW ENGLAND, ARMIDALE

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## Abstract

This paper reports on the introduction of a three-year Bachelor of Engineering Technology degree programme at the University of New England (UNE), Armidale, New South Wales in 2008. The degree is presently offered with majors in civil and environmental engineering.

The programme has been developed very closely with industry and professional organisations and enjoys very strong support from these areas. The format, structure and mode of delivery have been collaboratively and empathetically designed for regional students and employers.

A number of innovative aspects of the degree programme include a range of delivery modes; industry traineeships; on-the-job work experience for those enrolled off-campus; advanced standing for recognised successful prior learning; preparatory units in chemistry, mathematics and physics for mature-age students; mid-year enrolments; and mature-age intakes from those employed in industry and who require formal qualification for advancement. Engineers Australia provisional accreditation at engineering technologist level was conducted in April 2009. Articulation pathways are available to four-year Bachelor of Engineering or Master of Engineering Practice with a partner university.

The format, structure and mode of delivery, the degree is attracting interest from students and industry in that it facilitates work and study concurrently. The course is relevant and delivering what industry and professional organisations require, as well as attracting students to engineering as a profession of choice.

**Key Words: Bachelor of Engineering Technology; civil and environmental engineering; engineering education; external education; industry collaboration; regional; traineeships; variable delivery modes.**

## Introduction

Changes in engineering education in Australia, coupled with a regional professional skills shortage, initiated a new and innovative engineering degree course at the University of New England (UNE), Armidale, New South Wales. The course commenced at UNE for the 2008 academic year.

Engineering education in Australia has been undergoing somewhat of a 'quiet revolution' in terms of changes that have occurred in recent times. The Institution of Engineers Australia (IE Aust 1996) reviewed engineering education in Australia and suggested that a cultural change for future engineering education should include:

1. Engineers must receive a broader education and be drawn from a wider range of backgrounds;
2. Student intakes must be sufficient for Australian industry to remain internationally competitive;
3. Engineering courses must have clearly stated goals and outcomes and equip graduates for lifelong learning;
4. Professional accreditation systems must encourage innovation in course content and delivery;
5. Each university should consider the viability of its engineering school;
6. Internationally competitive Advanced Engineering Centres must be developed;

7. Engineering schools must be prepared to form alliances and facilitate student mobility;
8. An effective and independent National Centre of Engineering Policy must be established;
9. School and community liaison must be enhanced so that more students choose engineering;
10. The four-year full-time course equivalent must remain the minimum requirement, but diversity must be encouraged;
11. Staff profiles must balance teaching, research, professional practice and community skills;
12. Engineering schools must be prepared to collaborate to produce innovative courseware;
13. There must be greater collaboration between the engineering schools and industry; and
14. The sponsoring bodies must take immediate action to implement these recommendations.

### **Background**

Regional employers in Northern New South Wales (NSW), particularly in local government and consulting sectors, were experiencing difficulty in recruiting professional engineers from the early 2000s. This was exacerbated by numerous factors, including:

1. increased competition for high school leavers by many other professional groups such as medicine, legal, accountancy, teaching, etc.;
2. reduced propensity for high school students to study maths and science subjects;
3. 'brain drain' of higher performing students to metropolitan universities, with little likelihood of these returning to practice in rural and regional areas;
4. increased demand from the minerals industry to meet the unprecedented growth arising from the international demand for resources – the so-called 'minerals boom'; and
5. significant loss of services to rural and regional areas compared with metropolitan areas.

An industry deputation with input from the local professional groups of Engineers Australia (EA), the Institute of Public Works

Engineering Australia (IPWEA), local government and local consultants met with UNE senior management in October 2005. This meeting resulted in a request for a business plan to justify the need for an engineering programme at UNE. A joint engineering education sub-committee was formed with representatives from Engineers Australia, IPWEA and UNE to prepare the business plan.

Important matters that the Committee identified included (EA & IPWEA 2006):

- The imminent retirement of a relatively large number of experienced engineers from local government (from the so called 'baby boomer' generation) in the next few years
- The competition with metropolitan areas for recruitment of engineers into the local government sector
- The competition with other industry sectors such as consultancies, contracting organisations, the mining industry, etc. for a relatively scarce group of graduate engineers
- Continuing growth in the resources sector and the seemingly insatiable appetite for graduate engineers (e.g. 250 identified vacancies in NSW alone for mining engineers) (ABC Radio 2006)
- Growth of large infrastructure projects such as motorways, rail networks, etc. in rural and regional areas and competition with local government, regional consultancies, contractors and government agencies for graduate engineers
- The lack of promotion of engineering and particularly lack of promotion of 'career of choice' amongst local school leavers.

The Business Plan identified clear and distinct skills shortages for professional engineers in rural and regional areas. It identified at the time a 20-25% vacancy rate in local government in New England and Northwest NSW (Figures 1 and 2). Coupled with a further anticipated loss due to 'Baby boomer' retirements (Figure 3), it was projected that this could balloon out to an intolerable 50% vacancy rate. There was a clear need for local recruitment and training in the hope that students would be retained in rural and regional areas.

As a consequence of these alarming figures, the Business Plan proposed and supported the introduction of a three-year Bachelor of Engineering Technology degree programme by The University of New England (UNE) in 2008. This approach was adopted on a 'first point of defence' basis. It was acknowledged that a four-year degree was the desired outcome, but the immediate situation was to restore as much as possible current vacancies; provide technological support to the reduced number of professional engineers; enable UNE to ramp into the degree by progressively building up its resources; and make provision for articulation to the four-year degree for those students who have the capacity to progress. This staged approach has worked well to date given the relatively short period of operation. However, the overall objective is eventually for a four-year degree that will fully satisfy industry's needs.

Whilst the Plan identified that the proposal would not entirely obviate the demand for trained/qualified engineers, it would nevertheless go a long way towards:

- addressing local needs for skilled engineering personnel
- provide community strengthening through retention of young professionals in rural and regional areas
- provide professional development and training for young school leavers and other eligible candidates, which in turn will lead to greater staff stability and ongoing opportunities in rural and regional areas.

(EA & IPWEA 2006)

### **Course aspirations**

To assist with the structure of the course clear goals, aims and objectives were developed to facilitate comprehensive course design and structure that satisfied industry needs, academic rigour and professional accreditation requirements. In short, the course had to be relevant.

### **Goals**

The goals that have been developed for the BEngTech degree course are to:

- achieve a total number of students studying for the BEngTech at UNE to at least 100 by 2012

- encourage students to pursue studies in the elective units offered by UNE's Environmental Engineering
- ensure a high standing and reputation of the BEngTech degree
- foster relations with other tertiary education institutions to develop joint offerings and broaden the scope of elective units for students
- develop clear and defined articulation pathways into the BEngTech
- develop clear and defined articulation pathways from the BEngTech degree on to four-year Bachelor of Engineering and post-graduate degree programs appropriate for professional engineers.

### **Course aims**

The course aims have been developed to produce graduates who will have a sound understanding of the environment, impacts of development and engineering projects.

Graduates will:

- understand the principles of sustainable development and have the necessary knowledge and skills to implement such principles
- have the necessary skills to embrace a holistic analysis of design, where environmental factors are considered as an integral part of the design process, together with technical factors
- have a combination of skills relevant to civil and environmental engineering and the development and management of natural resources in regional Australia and overseas, where appropriate.

### **Course objectives**

The underlying ethos of the course is to provide students with a suite of basic skills necessary to achieve the course aims and to acquit themselves for work-ready placement on graduation. The suite of skills involves three principal areas:

1. Essential professional practice skills,
2. Basic technical knowledge and application skills, and
3. Advanced specialist skills.

Essential professional practice skills will be progressively developed in students in the following key areas:

- information literacy
- be effective problem solvers

- have good written and verbal communication skills
- work well in group situations
- awareness of limitations of their expertise
- are adaptable and willing to learn
- take a professional attitude
- take a broad perspective of the world.

Wherever possible, these professional skills will be embedded in the core units and sequentially developed and integrated as students progress.

Fundamental scientific/technical knowledge and application skills will be provided to graduates in core units of their respective majors. These skills will be invaluable in application units, in the professional workplace and for post-graduate study.

Advanced specialist skills will be encouraged as a means of providing market distinction for graduates to enhance their employment prospects. Such skills will be provided in the following typical areas: agricultural management; ecotourism; environmental monitoring; local government; mining and rehabilitation; solid waste management; sustainable land management; water resources management; water and wastewater treatment.

These, and others specialist skills, can be acquired by taking one of the specialist streams. Alternatively students may compile their own separate specialist streams that will enable them to achieve their desired career objective/s.

### **Academic rigour**

The common aspect of both majors is that they are founded in the basic sciences. A core of first year units provides the scientific rigour needed to underpin the remainder of the units in the course. First year in both majors includes two units of maths and physics, at least one chemistry unit (two in environmental major), engineering statics (in civil major) and introductory units in sustainability and environmental management. There is a high level of commonality with fundamental and environmental sciences in 1st year. This provides an opportunity for students to enter/exit the course without significant

disadvantage. Such a strategy has helped to address attrition levels to the extent that a significant number of students are still retained in the scientific disciplines. It has proved an advantage in that the BEngTech has attracted additional students.

Second year units in one or both majors include: geology; hydraulics; hydrology; introduction to environmental engineering; soils engineering; remote sensing and spatial data; environmental chemistry; vegetation management; two electives (for specialisation).

Third year core units in both majors include: environmental impact assessment; pollution management; project management; freshwater management; a project; two electives (for specialisation) and a non-science UNE-wide general studies unit. Typical specialisations in either major by way of electives are available in: agriculture; building/development; construction; environmental chemistry; ecology; mining rehabilitation; Geomechanics; GIS/Remote Sensing/Geomatics; local government; public policy/environmental advocacy; remediation; road/transport; soils; structures; water/irrigation engineering; water quality; vegetation.

### **Unique characteristics**

#### ***Innovative delivery***

The degree has been developed with a number of modes of offering to suit the needs of industry. It is offered in the conventional full-time (on-campus) mode; in external (off-campus) mode and uniquely: first-year full-time (on-campus) and later years in external (off-campus) mode, whilst students concurrently work as trainees in the workplace. Each of the modes will take a minimum of: three years full-time; five and six years respectively for the external modes.

#### ***Mature age entry***

UNE has been long been appealing for external students and particularly for mature age students. To this end a number of initiatives have been undertaken by UNE, which include:

- provision of advanced standing for relevant prior studies (e.g. TAFE advanced diplomas)
- provision of Foundation units in Maths, Physics and Chemistry (for

- students not current in these core areas)
- a unique Pathways (tertiary preparation) programme for students who did not matriculate
- mid-year intake (particularly for those who have undertaken Foundation units and want to fast track their study).

### **Collaboration with other universities**

A collaborative arrangement has been developed with the University of Southern Queensland (USQ), Toowoomba for:

1. more specialised units in the core and elective offerings,
2. articulation to USQ's four-year Bachelor of Engineering (BE), or
3. articulation to USQ's Master of Engineering Practice (after applicable post-grad experience).

Satisfactory completion of the latter options is anticipated to provide for corporate status of Engineers Australia (see Figure 4).

### **Articulation to/from the course**

Articulation models are being presently developed with TAFE, particularly for the civil major in accordance with Engineers Australia (and as espoused in IEAust 1998 and EA 2008).

### **Industry sponsorship**

Industry has been very responsive to the course by providing traineeships, cadetships and other forms of support for students at various stages. Numerous local government councils have provided traineeships in either the internal-external or full external modes of study. Industrial awards in local government provide for traineeship grading, with progression for satisfactory completion on a year-by-year basis.

UNE is in the final stages of discussion and negotiation with the NSW State Road Authority (RTA) for cadetships in 2010. These will be the most lucrative and attractive packages available to students to date. It is expected that these will be very competitive and will attract greater attention to and recognition of the course.

### **Life-long learning**

There is increasing need for life-long learning for practising professionals because of:

- changing work environment

- changing work portfolio
- method of work
- changing/new positions
- maintain own portability/employability.

The BEngTech at UNE provides for and assists in addressing these contemporary problems.

### **Accreditation**

Engineers Australia Accreditation Board conducted an external accreditation of the both the majors on UNE's BEngTech in late April 2009. The environmental major was provisionally accredited. The civil major will be eligible for provisional accreditation later in 2009.

### **Awards/accolades**

The course was nominated by the local industry advisory panel for an Engineering Excellence Award with Engineers Australia (Newcastle Division). The course was awarded a Highly Commended, a Finalist and a special Regional Award. The course competed amongst major regional infrastructure projects in a rigorous peer-reviewed process.

### **Growth and promotion**

UNE has initiated and become actively involved in a number of innovative programmes to promote science and particularly engineering education in rural, regional and metropolitan areas. Typical examples of such outreach initiatives include (Glencross-Grant 2008):

- *Science and Engineering Challenge* (through Rotary International, Newcastle University and Engineers Australia)
- *Science in the Bush*: a regional initiative where local high schools are invited to UNE campus to participate actively in hands-on activities
- *HSC Booster days*: on-campus supplementation to HSC content
- *UNE Open Day*: an open campus day for prospective students and parents to attend
- *Careers Markets*: attended by UNE staff and professional association representatives
- *Schools Liaison Officers (SLOs)* visit schools in UNE's catchment area on a

regular basis. More recently an engineering staff member has accompanied some visits to address students on engineering careers, courses and in-classroom activity very successfully

- Field days: CIVENEX in NSW, agricultural events in rural areas, etc.
- Industry and professional association (EA and IPWEA) sponsored activities during semester such as student BBQs, site visits, visiting guest speakers, meeting invitations, etc.

The roll-out of other majors is presently under consideration for 2011 and beyond.

### Conclusion

UNE has developed a unique and effective para-professional engineering technologist course in close collaboration with industry. The course addresses the immediate needs of industry and 12 of the 14 cultural changes suggested for engineering education in Australia by the Institution of Engineers (1996); it provides academic rigour and articulation; and allows for sustained growth and development.

The engineering profession has to:

- accept responsibility for training
- demonstrate clearer futures for students
- provide role models
- provide mentoring
- be self-promoting.

It is clear that engineering education has to:

- adapt to meet changing market needs
- be more attractive to school students
- offer articulation for a variety of students – clear entry and exit points
- actively and enthusiastically promote the profession through contemporary role-models and the media.

UNE's BEngTech has addressed these aspects and is achieving success as a result.

### References

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### Acknowledgements

In initiating this course wide appreciation should be expressed to professional colleagues (fellow members of Engineers Australia and Institute of Public Works Engineers Australia), industry colleagues (in local government, consultancies and state government agencies), academic and administrative colleagues at UNE and USQ. All of these have contributed to ensuring the success to date.

Further information available at:

[www.une.edu.au/bet](http://www.une.edu.au/bet)

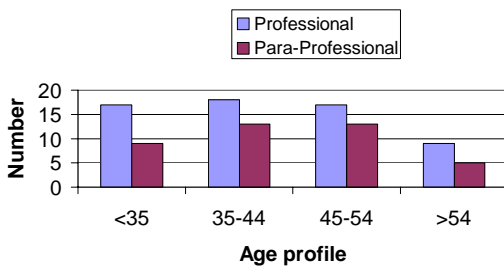


**Figure 1: Local government areas in NSW showing IPWEA regional groupings of council areas**

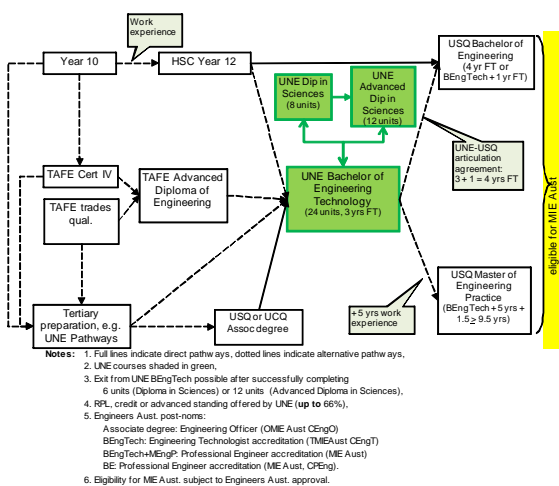
(Source: EA & IPWEA 2006:4)



**Figure 2: Local government areas in New England/Northwest NSW**  
(Source: EA & IPWEA 2006:3)



**Figure 3: Age profile of local government engineers in New England/Northwest area of NSW for 10 local government councils**  
(Source: EA & IPWEA 2006:8)



**Figure 4: BEngTech articulation pathways, with UNE-USQ collaboration**

## Biography

Rex has been employed as Senior Lecturer in Environmental Engineering at the University of New England since 1995. His main



teaching areas are environmental engineering, pollution management, project management and waste management. He has also taught into a number of TAFE programmes and written several nationally accredited units for TAFE.

Other areas of academic interest include engineering heritage and timber engineering. He has presented a number of papers at international timber engineering conferences. Rex has been involved from the outset with the establishment of the Bachelor of Engineering Technology degree at UNE and has worked very closely with an industry advisory panel on its development. Prior to academia Rex worked for a state government road authority, several local government authorities, including Norfolk Island and at various stages has run his own consultancy.

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