

Review of Australian Higher Education

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ENGINEERS
AUSTRALIA

Table of Contents

Executive Summary and Recommendations	1
1. Introduction	5
2. Forms and functions of higher education	5
2.1 Discussion paper description	5
2.2 Society and community outcomes	6
3. Meeting labour market needs	6
4. Educating the engineering team	8
4.1 Supply, demand and nationally important disciplines	10
5. Rationalisation and specialisation of engineering schools	12
5.1 Restrictions to specialisation	13
5.2 Credit transfer arrangements	15
5.3 Enrolment mechanisms	16
6. Articulation pathways and student support mechanisms	16
7. Accreditation of university engineering courses	17
8. Accreditation of VET engineering courses	19
9. Education and innovation	21
9.1 Teaching and research	21
9.2 Education, research and industry linkages	21
9.3 Government support and assistance	23
10. Resourcing the system	26
11. Conclusion	28
Box 1: What is Engineering?	4
Box 2: The engineering team	9
Box 3: Developing Engineering Centres of Excellence	14
Box 4: Gender balance in engineering	18
Box 5: Loss of government training and the introduction of CPD	25
Table 1: Immigration of Engineers to Australia 2000-01 to 2006-07	7
Table 2: New Engineering Graduates – Universities and VET	10
Figure 1: Percentage of business-funded R&D performed in the higher education and government sectors, 2005 or latest available year	22

Executive Summary and Recommendations

Engineers Australia is the peak body for engineering practitioners in Australia and represents all disciplines and branches of engineering. Engineers Australia has over 86,000 members Australia wide and is the largest and most diverse engineering association in Australia.

Innovation is the key to future growth and prosperity in a competitive global economy. Building a culture of continuous innovation through education is an essential requirement of the knowledge based economy. A well educated and skilled workforce that embraces lifelong learning is essential for generating employment and achieving growth, thus bringing benefits to all Australians.

Education provides the flow of knowledge workers. Without high quality education in schools, TAFE and universities and high quality non-formal education in the workplace and everyday life, the knowledge economy will be unable to survive, dampening the growth of the Australian economy.

Engineers Australia is concerned with the following aspects related to the provision of engineering education by the higher education sector:

- The higher education sector does not give enough weight to stakeholders and their needs. These stakeholders include academics, students, industry, the professions, and the general public. Better interaction between these stakeholders is essential, particularly linkages between industry and the higher education so that Australia's innovation system functions at its most effective level.
- Labour market needs must be met both in terms of supply of graduates and the quality of graduates. Engineering in particular is suffering from a severe skills shortage that must be overcome if Australia is to remain economically and socially prosperous. The higher education sector has a clear role in influencing curricula and the teaching profession to raise the level of science and mathematics literacy of Australian students, and to ensure a high level of interest in these subjects to enable them to make career choices in these fields.
- The opportunity to graduate more students with a Bachelor of Technology Degree or Associate Degrees in engineering is being missed by many universities, which is also contributing to the current engineering skills shortage.
- The aging profile of engineering educators means that many will be retiring in the not too distant future. There does not appear to be any strategy in place to ensure the replacement of those retirees.
- Significant constraints impede the delivery of engineering education, including increased student/staff ratios; inadequate staff promotion criteria and staff development opportunities; research impediments; and resource difficulties in terms of up to date equipment and laboratories.
- Differences in education design philosophies frustrate articulation between VET and Universities. Further, current enrolment mechanisms and credit transfer arrangements impede the mobility of students, and need to be improved.
- Reducing duplication in university courses without at the same time any reduction in the diversity of offerings needs to be more fully embraced and the opportunities for rationalisation and specialisation in engineering offerings need to be welcomed to enhance student and research outcomes.
- Resources to the higher education sector are currently inadequate.

Engineers Australia's recommendations include:

Recommendation 1: Forms and Function of Higher Education

The forms and functions of higher education should be redeveloped to: identify stakeholders, their requirements from the higher education sector, and the commitments that are necessary to meet stakeholder requirements; and provide more emphasis on lifelong learning, human capacity building and society and community outcomes.

Recommendation 2: Increasing the supply of engineering graduates

Australia needs more students who choose to study high-level school science, technology and mathematics and to continue into tertiary education in these fields, engineering in particular. The development of a new national curriculum for primary and secondary education must be structured to support this goal. Without "schoolroom solutions", engineering university education will continue to be constrained and skill shortages will worsen.

Research is essential to identify the influences that encourage students to undertake further study in science, engineering, technology and mathematics subjects at university. The results will give guidance on how to best design and deliver programs that promote these subjects.

The federal government must be willing to influence the education system to encourage more students into engineering careers.

Recommendation 3: Specialisation and amalgamation of course offerings

Engineering schools should embark on a priority setting exercise. The process should aim to facilitate the amalgamation and specialisation of course offerings and research across universities. Government has a role to play as a facilitator.

Recommendation 4: Removing barriers to student mobility

If the specialisation and amalgamation of university courses is to be successful, obstacles preventing students from taking parts of their degrees or programs in different universities should be removed. Initiatives to encourage students to relocate to study must also be considered.

An external body is essential to facilitate the formalisation of credit transfer arrangements between institutions. The competitive nature of the Australian university environment means that universities will need assistance to undertake this task.

The universities admission system should be reformed and operated at a national level. The new system should operate as a single application process to all universities Australia-wide.

Recommendation 5: External Accreditation of Programs

Where university courses are accredited by well recognised, high quality external agencies, such as Engineers Australia, this assessment should be regarded as eliminating the need for any other external assessment of quality standards.

All students studying engineering degree programs accredited by Engineers Australia should have access to the same level of student support including admission to a Commonwealth-supported place and access to Commonwealth Scholarships, HECS and Centerlink payments.

The blurring boundary between the delivery of VET and university education should be seen as a positive development. External accreditation and quality assurance will need careful and thoughtful facilitation as the post-compulsory education sector becomes more diverse and educational offerings differentiate across the sectors.

The Commonwealth and the States will need to be willing to support, the full-scale accreditation of all post-compulsory engineering education in Australia. Without this support program standards and articulation pathways cannot be developed and maintained across the Engineering Team.

Recommendation 6: Improving Research and development

A centralised register of the R&D being undertaken in universities and public research institutions is needed as a mechanism for Australian industry to identify collaboration opportunities. This could form part of a wider program to encourage collaboration between small and medium enterprises with universities, TAFE's, and other publicly funded organisations, such as the CSIRO.

Funding for the CRC program should be continued and ways to encourage better access by SMEs. Cooperation between universities and other research agencies must be improved.

Promotion of Government assistance programs is needed to assist collaboration between companies to encourage greater and more effective private spending on R&D.

The review of government innovation and industry assistance programs to reduce duplication and improve effectiveness is welcomed and must link strongly with any recommendations made by the Higher Education Review.

The tax concession should return to at least 150%, as a useful driver of business R&D.

Recommendation 7: Upskilling and retraining existing workers

The education and training system must focus on the up skilling and retraining of existing workers. Flexible pathways must be created to meet the education and training needs of individuals at all stages of their careers.

Recommendation 8: A better resourced sector

Government funding to universities must be increased to at least the OECD average. Options to reduce the HECS burden on engineering students and other areas of skills-need must be explored and targeted to increase enrolments.

Alternative systems for allocating funding for teaching and research must be considered. All options should be considered and all aspects of the current funding system should be rigorously and fundamentally reconsidered.

The majority of post-graduate study in Australia is full-fee paying. Options to reduce the fee burden on students in engineering and other areas of skills need must be evaluated and the best introduced. Initiatives to increase enrolments in courses which are retaining pathways for entry into the engineering profession must be launched.

Recommendation 9: Collaboration and coordination

There must be formal recognition of the need for an overarching body to bring together academia, industry, and the profession in a cooperative way to improve the delivery of engineering education and research.

Box 1: What is engineering?

The engineering sector is a diverse and large profession that includes a range of practitioners, such as professional engineers, engineering technologists, engineering associates, and tradespeople.

Engineering is about applying science and technology to develop and implement new technologies, placing engineers in a central role in improving the security and living standards of the community, improving the standards of environmental care and generating wealth for Australia.

The traditional focus of engineering activities has been in infrastructure – the fundamental facilities and systems that allow a modern society to function effectively. These include transportation, communication systems, energy and water supply, and waste removal. However, engineering impacts on virtually every aspect of community life.

For instance, the following lists only some of the areas in which professional engineers commonly practice: Acoustics, Aeronautics, Agriculture, Automation and control, Biomedical, Bridges, Building services, Civil, Chemical, Coastal and oceans, Communications, Computing, Construction management, Dams, Electric power, Electronics, Education, Environment, Fire safety, Food technology, Fuels and energy, Geotechnics, Government, Maintenance, Manufacturing, Materials, Metallurgy, Military, Mining and tunnelling, Naval architecture, Nuclear, Petroleum and gas, Pipelines, Process control, Railways, Risk, Roads, Space, Structural, Telecommunications, Transportation and Water Resources.

There is a strong social and humanitarian dimension to engineering and virtually all engineering solutions are a response to a human need. Engineers solve problems. For example the most significant advances in medicine were not based on improved surgical or medical techniques, but almost entirely on engineering breakthroughs: from replacement joints to whole-body scanners; heart pacemakers; dialysis machines to artificial limbs - they are all designed, developed and built by engineers working closely with medical professionals and their patients.

Engineers work independently, in teams with other engineers, or as part of larger multi-disciplinary groups alongside other professionals, like scientists, researchers, architects, lawyers, human resource managers, accountants, technologists and trades people.

Engineers take practical steps towards realising positive environmental outcomes. Imagine a world where cities have become peaceful and serene because cars and buses are whisper quiet, vehicles exhaust only water vapour, and parks and greenways have replaced unneeded urban freeways. Living standards for all people have dramatically improved, particularly for the poor and those in developing countries. Home owners can pay part of their mortgage costs by the energy they produce; there are few if any active landfills; worldwide forest cover is increasing; worldwide CO₂ levels are decreasing for the first time in 200 years and the effluent water leaving factories is cleaner than the water going in.

This vision of utopia is already reality on a small scale and as long as engineering skills are valued and supported within our society, larger changes of this nature are possible. Without question, engineering has been a constant companion in our development as a civilisation and engineering continues to play a powerful role in bringing us closer to an environmentally sustainable and economically viable future.

1. Introduction

Engineers Australia is the peak body for engineering practitioners in Australia and represents all disciplines and branches of engineering with 86 000 members Australia wide. All members of Engineers Australia are bound by a common commitment to promote engineering and facilitate its practice for the common good. Engineers Australia welcomes the opportunity provided to comment on the Higher Education Discussion Paper as the paper addresses many important questions relevant to the discipline of engineering.

The quality, relevance and accessibility of university education have always been core interests of Engineers Australia. In 1995 and 1996, in association with the Academy of Technological Sciences and Engineering and the Australian Council of Engineering Deans (ACED), Engineers Australia undertook a major review of engineering education in Australia.¹ Many of the findings of that review are reflected in the discussion paper. For instance, our review showed concern about engineering schools in Australia covering much the same range of activities. Approaches such as amalgamation, specialisation, collaboration and attraction of critical masses through overseas students were canvassed.

Recently the ACED in partnership with Engineers Australia and other engineering professional bodies² with funding from the Australian Learning and Teaching Council (ALTC), reviewed the position of engineering education since the 1996 review and scoped emerging issues. In spite of the fiscal stringency faced by universities, engineering schools have addressed many of the issues identified in the 1996 review. Courses have been re-designed and there is more cooperation between universities. However, some issues still need to be addressed.

The discussion paper understandably does not consider individual disciplines within higher education, but to Engineers Australia, the issues surrounding engineering education are of significance. Particular difficulties faced by engineering in the present policy environment along with general issues surrounding skill shortages and engineering education in Australia are discussed below.

2. Forms and functions of higher education

2.1 Discussion paper description

The forms and functions of higher education outlined in the discussion paper are all relevant, wide ranging and fair. However, they pay insufficient attention to a number of key issues including:

- Identifying stakeholders, their requirements from the higher education sector, and the commitments that are necessary to meet stakeholder requirements;
- Considerations of the other essential aspects of building human capability including for example, attitudes and values as well as broader personal attributes including self-fulfilment, personal development and the pursuit of knowledge as an end in itself throughout an individual's life;
- Emphasising "skills and knowledge" to meet the labour market needs without recognition of the need to provide ongoing professional development opportunities to older adults throughout their careers;
- Transparency within discussions about resourcing along with the concept that the sector should be "appropriately, effectively and efficiently resourced".

2.2 Society and community outcomes

The role of university education and outcomes for society and the community in general is also not sufficiently developed within the forms and functions listed in the discussion paper. While community engagement between universities and their local environment is considered later in the discussion paper, the benefits of higher education to society and the community are not sufficiently canvassed. Universities UK, the British equivalent of Universities Australia has identified the following broader positive outcomes for society and the community of tertiary education:

- Higher levels of education have a positive impact on the readiness of successive generations to learn;
- A clear negative correlation between educational level and criminal conviction;
- Overall education level is positively correlated with cultural tolerance and understanding;
- Better educated people make a more active contribution to the development of the voluntary sector; and
- Better educated people tend to be more flexible and innovative in response to the unexpected, better able to cope with problems in family and community, and less dependent upon services supplied by the state;

Higher education contributes to Australia's economic, social and cultural capital. Engineers Australia believes that the forms and functions of higher education identified by the discussion paper should be redeveloped to better highlight these additional issues and outcomes.

Recommendation: The forms and functions of higher education should be redeveloped to: identify stakeholders, their requirements from the higher education sector, and the commitments that are necessary to meet stakeholder requirements; and provide more emphasis on lifelong learning, human capacity building and society and community outcomes.

3. Meeting labour market needs

Recent analysis of the Australian Census by Engineers Australia³ has shown that in the five years between 2001 and 2006, the number of Australia's engineers in the profession has decreased by around 6500 individuals, with more engineers having left the engineering workforce than having joined it.

By the 2011 Census, a conservative estimate of up to 70,000 retirements may have occurred from the engineering profession. Over the same time period, only 45,000 Australian graduates will have completed study in engineering.

Engineers Australia believes that the future Australian skills base will not cover retirements, let alone increased demand for engineering expertise driven by growth in the Australian economy and our transition to a climate friendly knowledge based economy.

Government focus on infrastructure renewal, the engineering inputs needed to support the resources boom and to tackle climate change all mean that demand for engineering expertise will only continue to increase.

Engineers Australia undertakes a regular survey of engineering companies and has included questions on engineering skill shortages in the last two surveys. Anecdotal information that engineering skills shortages were harming the Australian economy was confirmed by both surveys with 82% of businesses reporting that there were moderate to severe consequences.

Moderate problems with some monetary consequences were experienced by about half of this group (39% in 2006 and 40% in 2008) and major problems including project delays and major cost consequences by the other half (43% in 2006 and 42% in 2008). The share of businesses which reported that projects did not proceed because of engineering skills shortages was 6% in 2006 and 7% in 2008.⁴

What is particularly concerning in terms of the long term skills need of Australian industry is that graduation and migration rates are not meeting the current skills shortage, let alone compensating for retirements from the profession.

Currently migrants account for more than half of growth of new entrants to the Australian engineering profession each year. The immigration of professional engineers into Australia through both the off-shore and on-shore permanent visas since 2000-01 and via the temporary 457 visa since 2003-04 are show in Table 1.

Table 1: Immigration of Engineers to Australia 2000-01 to 2006-07

YEAR	PERMANENT OFF-SHORE	PERMANENT ON-SHORE	TOTAL PERMANENT	TEMPORARY 457 VISA	OVERALL TOTAL
2000-01	1240	31	1271	0	na
2001-02	1140	271	1411	0	na
2002-03	1447	451	1898	0	na
2003-04	1420	952	2372	810	3182
2004-05	1732	1800	3532	540	4072
2005-06	2312	1629	3941	1380	5321
2006-07	1980	2140	4120	1970	6090

Source: To 2003-04 Birrell, Sheridan and Rapson; since 2004-05 and 457 data Department of Immigration and Citizenship

Since 2003-04, the number of engineers working in Australia on 457 temporary visas has more than doubled, increasing from 810 to 1,970. The increase between 2005-06 and 2006-07 was particularly large and may be related to the fall in permanent off-shore migration between those years.

The significance of these changes can be put into perspective by comparing migration to the output of Australian universities. In 2006, there were 5044 new four year Bachelor of Engineering graduates. The supply of new engineers to the Australian workforce is the sum of university output and immigration. Thus in 2006, the supply of new professional engineers was 11,134 (5044 new domestic graduates and 6090 new migrant engineers) with migration accounting for more than half of new supply.

Engineers Australia recognises the significant contribution made by migrant engineers to Australia's competitiveness and economic growth. Migrant engineers are a vital element in generating new ideas and approaches to engineering, and for providing skills where there are shortages.

However, there is an acute need for the Australian education system to produce more engineering graduates. Until relatively recently, only traditional immigrant countries (Australia, New Zealand, Canada and the United States) competed for immigrants.

Now European nations and nations elsewhere (especially in the Middle East and Asia) are entering the competition for migrants with desired characteristics, especially skills in short supply. Countries experiencing labour shortages and population pressures are directing the focus toward skilled migration. Australia's reliance on migrant engineers to meet skills shortages leaves industry and our innovation system vulnerable.

The engineering profession is already experiencing a significant skills shortage which is not being met by current university graduations or significantly increased migration rates. The flow on effects of low participation in science, engineering, technology and mathematics at primary and secondary school into the tertiary level has been inevitable and the domestic engineering skills base has been allowed to languish.

Engineering university graduates are the main domestic supply from which new demand for engineers and the replacement of older engineers, retiring from the workforce, must be met. Although there have been some increases in the number of undergraduate places in engineering, many more are needed. However, currently there is not a large enough pool of school students capable and interested in studying engineering and other science and maths subjects.

In 2004 less than 12% of Australian students were studying advanced mathematics⁵. In 2001, only 10 percent of Year 12 students had completed the prerequisites required to study engineering at university.⁶ We need students capable and willing to fill university places. With an ageing population and booming economy it is no surprise that both graduating and experienced engineers are in high demand. For the long-term success of the Australian economy and to meet the challenges of the future including climate change, the domestic supply of "home grown" engineers must be increased.

Recommendation: Australia needs more students who choose to study high-level school science, technology and mathematics subjects and to continue into tertiary education in these fields, engineering in particular. The development of a new national curriculum for primary and secondary education must be structured to support this goal. Without "schoolroom solutions", engineering university education will continue to be constrained and skill shortages will worsen.

Recommendation: Research is essential to identify the influences that encourage students to undertake further study in science, engineering, technology and mathematics subjects at university. The results will give guidance on how to best design and deliver programs that promote these subjects.

4. Educating the engineering team

There is a broad range of skills and services that fall within the ambit of engineering and not all of these are provided by "professional" (four year university trained) engineers. Most professions, including engineering, acknowledge the broad scope of possible practice within them, and allow for differences in qualifications and for specialisation in areas of work.

For instance, engineers can be divided into three main occupational categories. These are professional engineer, engineering technologist and engineering officer/associate. The occupational categories can be differentiated by the length of education and training undertaken by the engineer. These categories and the engineering work typically undertaken by them are outlined in Box 2. In recognising the contribution that each occupational category makes to the engineering profession, Engineers Australia has designated 2008 as the "Year of the Engineering Team".⁷

Box 2: The engineering team

Engineering work is undertaken by individuals trained at both university and through the vocational educational system. As a group these engineers form the “Engineering Team”. Engineers, technologists and associates come together in different combinations to undertake projects and programs. Their activities and competencies are often closely inter-related with some features of engineering being common to all three categories. All members of the “engineering team” work together and provide services to each other in order to complete engineering tasks.

Professional Engineers: The benchmark qualification for professional engineers is the four-year Bachelor of Engineering university degree. Professional engineers are required to take responsibility for engineering projects and programs in the most far reaching sense. This includes the reliable functioning of all materials and technologies used; their integration to form a complete and self-consistent system; and all interactions between the technical system and the environment in which it functions. Professional engineers have a particular responsibility for ensuring that all aspects of a project are soundly based in theory and fundamental principle, and for understanding clearly how new developments relate to established practice and experience and to other disciplines with which they may interact.

Engineering Technologists: The benchmark qualification for engineering technologists is the three-year Bachelor of Engineering Technology university degree. Engineering technologists normally operate within a relatively well-defined technical environment, and undertake a wide range of functions and responsibilities. They are typically specialists in a particular field of engineering technology and their expertise lies in familiarity with its current state of development and its most recent applications.

Within their specialist field, their expertise may be at a high level, and fully equivalent to that of a professional engineer; but they are not expected to carry the same wide-ranging responsibilities for stakeholder interactions, for system integration, and for synthesising overall approaches to complex situations and complex engineering problems.

The competencies of engineering technologists equip them to approve and certify many technical operations such as calibration and testing regimes, compliance with performance-based criteria for fire safety, and design of components and sub-systems and of installations such as building services in circumstances that do not call for significant new development.

Engineering Associates: The benchmark qualification for engineering associates is the two-year Advanced Diploma of Engineering under the Australian Qualifications Framework or the Associate Degree in Engineering. These courses are delivered by the university and vocational education system.

Engineering associates focus mainly on practical applications. They may be expert in installing, testing and monitoring equipment and systems, in the operation and maintenance of advanced plant, and in managing or supervising tradespeople in these activities. They may be expert in selecting equipment and components to meet given specifications, and in assembling these to form systems customised to particular projects.

Engineering associates are often required to be closely familiar with Standards and Codes of Practice, and to become expert in their interpretation and application to a wide variety of situations.

Engineers, technologists and associates come together in different combinations to undertake projects and programs. Their activities and competencies are often closely inter-related and it is difficult and sometimes artificial to say where the responsibilities of one category ends and those of the next category begin.

There are activities that could be undertaken, in different circumstances, by members of any of the three categories. Other activities are clearly the province of one category but not of another – for example, the province of a professional engineer but not an engineering associate, or vice versa.

Just like the university system, the vocational education system (VET/TAFE) needs to increase graduation numbers in order to meet industry needs. Skill shortages exist across the engineering team and the problems of attracting students to study engineering are equally valid for both the university and vocational education system.

4.1 Supply, demand and nationally important disciplines

The higher education sector currently has the sole responsibility for educating Professional Engineers (four year awards leading to a Bachelor of Engineering) and Engineering Technologists (three year awards leading to a Bachelor of Technology).

The higher education sector shares responsibility with the VET sector in providing award programs for Engineering Officers/Associates through two year Associate Degrees and Advanced Diplomas. Because engineering skills shortages are not confined to professional engineers, there is a need to rethink, reposition and improve the education pathways for the engineering team as a whole.

In particular, while industry needs more Engineering Technologists, the provision of these courses at universities has declined dramatically and many universities have ceased enrolling new students in three-year courses despite the shortage of graduates. Only 809 Engineering Technologists graduated from Australian universities in 2006.

Table 2: New Engineering Graduates – Universities and VET

Men

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Engineering Officer Uni	315	313	186	65	62	129	106	162	176	141	115	134	106
Engineering Officer TAFE	na	na	na	na	na	na	na	na	2810	2850	2905	2898	2525
Engineering Technologist	305	510	616	684	694	656	501	488	473	449	441	583	679
Professional Engineer	3672	5830	3737	3803	3849	3684	3753	4361	4098	4224	4398	4016	4252
Total	4292	4673	4539	4552	4605	4469	4360	5011	7557	7664	7859	7631	7562

Women

Engineering Officer Uni	23	17	8	10	4	16	6	5	10	15	9	7	8
Engineering Officer TAFE	na	na	na	na	na	na	na	na	405	390	420	550	530
Engineering Technologist	46	71	72	94	92	85	53	88	77	74	76	133	130
Professional Engineer	613	629	653	697	711	646	687	907	847	879	857	785	792
Total	682	717	733	801	807	747	746	1000	1339	1358	1362	1475	1460

All Domestic Graduates

Engineering Officer Uni	338	330	194	75	66	145	112	167	186	156	124	141	114
Engineering Officer TAFE	na	na	na	na	na	na	na	na	3205	3300	3165	3530	3055
Engineering Technologist	351	581	688	778	786	741	554	576	550	523	517	716	809
Professional Engineer	4285	4479	4390	4500	4560	4330	4440	5268	4945	5103	6255	4801	5044
Total	4974	5390	5272	5353	5412	5216	5106	6011	8886	9082	9061	9188	9022

Note: The protocols followed by the provider of TAFE data means that TAFE totals will not sum
Source: Data supplied by DEEWR and the National VET Provider Collection NCVER

The number of enrolments in engineering education is dependent on two factors: the number of qualified applicants and the proportion of these who are motivated towards engineering. University engineering schools have seen very low demand for three-year courses from potential students and have responded by reducing course offerings.

The majority of engineering schools are primarily focused on providing four-year Professional Engineering courses. However, a small number of universities have responded to local industry demand and have reintroduced or substantially increased offerings at the three-year level, for example the University of Ballarat, University of Southern Queensland and the Central Queensland University.

Generally, enrolments in engineering are low across all education levels. More graduates are needed and mechanisms to encourage school leavers to choose engineering education options must focus on promoting all the available education and career pathways within the Engineering Team.

In an environment where unit offerings within engineering schools have been driven by student demand there has also been ongoing concern, particularly from industry, that along with the three-year Bachelor of Technology Degree, some disciplines of engineering are in danger of disappearing because of small student numbers.

Many of these disciplines, for example, telecommunication and high voltage power engineering, are vital for the economic, health and defence requirements of Australia. The issue of maintaining specialist areas of study, critical to Australia's economy, regardless of student numbers will also need to be addressed.

Having education institutions supplying education and training on the basis of student demand, with student choice being the key determinate in what is offered, may result in the system not meeting industry needs, with skill shortages developing. Additionally, new and emerging areas of expertise needed in the Australian economy, for example related to climate change, nuclear science or infrastructure renewal, will have to be imported.

There is also a lag problem when pricing and labour market signals act as the key influencer of student choices. Fluctuations in the economy, combined with the length of a standard degree mean that it may take three to four years before graduate supply will begin to react to labour market signals.

This situation is at an even more critical stage for engineering skills as the number of high school students studying prerequisite subjects including maths and science continues to decline. The lag problem might in fact be more like 10-15 years.

As outlined above, the success of the higher education system in "meeting Australia's needs for highly skilled and capable people" will be determined primarily by "schoolroom solutions" that work to ensure enough students are interested and capable of studying engineering at a level that meets industries current and long-term skills needs.

Recommendation: The Federal Government must be willing to influence the education system to encourage more students into engineering careers.

Additional issues of concern include:

- The age profile of teachers and lecturers in schools, TAFEs and higher education institutions and the large number of educators who will shortly reach retirement age;
- Significantly increased staff/student ratios and administrative obligations that reduce the capacity for academic staff to devote time to develop and implement innovative educational resources while the increased workload makes it increasingly difficult to attract academic staff with the capability to lead innovative educational design and delivery. Academic staff promotion criteria, staff development incentives and institutional research impediments reduce the investment of effort and resources into education research, innovation and development within disciplines. These problems are common to the university environment generally and are not just found in engineering schools;
- Resource difficulties prevent proper provision and maintenance of laboratory and practical learning facilities that can provide 'hands on' learning experiences reflecting current industry practice. The study of engineering is equipment-intensive and the facilities at Australian engineering schools need access to government support to quickly update and purchase laboratory equipment to meet present and future requirements;
- There is scope for a more rational distribution of program offerings across the sector and a better sharing of resources and effort aided by modern ICT tools and flexibility in educational delivery. Technology offers significant opportunities for the enrichment and increased sophistication of the learning environment and in the development of flexible learning opportunities. The current competitive operating environment of the university sector reduces the likelihood of collaboration and rationalisation developing across institutions despite these opportunities; and
- Philosophical differences in educational design between the vocational education and higher education systems can act as an impediment to the development of articulation pathways. These differing approaches can be characterised as a competency based training framework at the VET level and established curriculum models at the university level.
- It is essential that engineering students develop an understanding of the workforce and the profession, and therefore require exposure to industry experience as part of their degree. Engineers Australia supports the extension of this to internships – that is, a student undertaking a period of around six or twelve months work experience in industry that includes academic supervision.

Some of these issues will be considered in further detail below.

5. Rationalisation and specialisation of engineering schools

Engineers Australia supports the concept of reducing duplication in university courses. However, any reduction in duplication cannot reduce the diversity of academic offerings as specialisation is needed to meet the widening needs of Australian industry.

Most Australian universities have engineering schools. In contrast, European countries tend to have much smaller numbers of larger engineering schools. For example the Netherlands, with a comparable population to Australia, although geographically dissimilar, has three.

Questions arise as to whether the Australian university system should be supporting so many small engineering schools, while in contrast not every university has a medical or dental school. The problem may lie, not in having too many engineering schools but in having too many trying to cover the same broad range of activities.

The emergence of new technologies and fields of engineering places pressure on Australian engineering schools that are too small and tightly funded to be able to devote significant resources to a new field. Major engineering schools in Europe do not have to contend with this problem and are able to establish new research teams, recruit professors and reach a reasonable volume of activity fairly quickly.

The diffused nature of engineering schools in Australia works to limit their ability to keep laboratory equipment up to date and properly functional. Given the financial pressures universities are under additional equipment funds are not going to be provided. The sharing of facilities and infrastructure is the obvious answer to this pressing problem.

Similarly, providing a large range of course options to engineering students in each school can only be supported successfully if staff can maintain real expertise in a wide range of areas. The spreading of small numbers of students across a large number of schools limits the ability of engineering schools to support multiple course offerings.

Research concentrations in advanced technical areas would be better served if there were groupings that were large enough to develop a “critical mass” of activities, facilities and resources. These groupings would also be well placed for interactions with other centres and industry. While it cannot be supported that large research groups are more productive than small ones, in equipment intensive areas such as engineering, expensive facilities cannot be replicated easily. Facilities will be more comprehensive and effective if they are concentrated rather than dispersed.

Each capital city now has three or more independent engineering schools. The viability of these arrangements needs to be questioned. There is a case to move toward fewer and larger metropolitan engineering schools, and some of the smallest regional engineering schools may not remain viable unless they access niche markets. In this environment it makes sense to move toward institutional groupings where universities cease to see themselves as self-sufficient, and self-contained.

Institutional groups should be considered in order to achieve critical mass, particularly in research. These alliances should be formed on perceived mutual advantage and may involve engineering schools with similar or complementary strengths. In the United States, the National Science Foundation has funded engineering schools to form “coalitions” since the mid 1990’s. In the Australian context, for example, there would be benefit in concentrating expertise and facilities in manufacturing in one or two national centres. Engineering schools should begin to look at their strengths and set priorities to amalgamate and transfer some courses to other institutions.

Recommendation: Engineering schools should embark on a priority setting exercise. The process should aim to facilitate the amalgamation and specialisation of course offerings and research across universities. Government has a role to play as a facilitator.

5.1 Restrictions to specialisation

Many problems exist that currently restrict specialisation within Australian universities, the key issues is primarily related to the current funding and regulatory framework that encourages competition rather than collaboration between universities.

Secondly, the lack of specialisation between universities can also be linked to the issue of student expenses. Australia, unlike many other countries, has a tradition of students studying in their home cities. This makes sense in terms of private living costs; indeed, within large cities, it makes good sense for students to choose a university within their urban region, for instance, western Sydney or south-east Melbourne.

Amalgamation and specialisation would be easier if students found it less costly to shift away from home to study. More generous student living allowances, de-linked from parents' means, may make it easier for universities to specialise and amalgamate courses.

Box 3: Developing Engineering Centres of Excellence

During the 2007 election the Australian Labor Party made a commitment to reinvest in Australian research infrastructure, establishing a "hubs and spokes" model of research cooperation between universities and other research agencies to promote excellence, reduce the fragmentation of our national research effort, build on our research strengths and encourage greater collaboration between researchers and research institutions. The Government has promised to promote a strong culture of collaboration, networking and clustering, including at the international level, across our universities, research institutes and private research programs in order to maximise our capabilities.

Engineers Australia believes that within this government commitment there is a strong case for the development of Engineering Centres of Excellence to act as a system wide approach to engineering innovation in Australia. The Centres would act as innovation hubs giving business confidence in the quality and continuity of teaching and research undertaken with the hope that industry would be more willing to partner and invest in university research programs. The Centres could also act as a facilitator towards university specialisation and restructuring particularly in metropolitan areas where there is greater scope for facilities sharing and teaching and research collaboration.

The engineering profession has envisioned that the Centres would be established as internationally competitive institutions with world class expertise and facilities with the objective of promoting Australian industrial strength, research and development capability and advancing the education of engineers.

As well as research and commercialisation AECs would cover the full spectrum of interaction with industry, including technology transfer, consultancy and specialist education and training courses while offering undergraduate and postgraduate programs. Developing industry adjunct appointments, academic staff interchange, and secondments to industry as well as joint industry and academic appointments would be a key aim, particularly as these arrangements strengthen both teaching and research and act as a tool for maintaining educational direction and relevance.

There would also be scope for the AECs to focus resources on teaching and learning developments providing staff with incentives and opportunities to devote time and expertise to developing and implementing innovative educational resources supported by advanced and flexible delivery mechanisms including on-line solutions.

In essence, AECs would act as specialist discipline hubs for engineering excellence across Australia with direct links to industry. There is much scope but currently few incentives for this level of collaboration between existing engineering schools.

Thirdly, barriers between educational providers will have to be reduced. A new system of allocating government funding per student would have to be canvassed, dealing with issues such as how should funding be divided between the first university that provides a student with the bulk of their undergraduate training, and the second institution that allows the student to take limited specialist courses.

While suggestions of a voucher system have been contentious in the past, Engineers Australia believes all funding options should be considered and that a voucher system could be a potential mechanism for addressing these issues.

Support for amalgamation and specialisation when possible in metropolitan areas, where course offerings are often duplicated, should not result in support for the closure of regional universities where they are unable to provide specialisation. Regional universities do have a community service obligation and a public service role.

The provision of generalist university courses should be encouraged in regional centres with amalgamation and specialisation when possible. Initiatives to encourage student mobility could also allow regional universities to provide the basic teaching of any university degree that is, in turn, supported by study in other institutions when appropriate.

Recommendation: If the specialisation and amalgamation of university courses is to be successful, obstacles preventing students from taking parts of their degrees or programs in different universities should be removed. Initiatives to encourage students to relocate to study must also be considered.

5.2 Credit transfer arrangements

If collaboration between universities is to be successful, obstacles preventing students from taking parts of their degrees or programs in different universities should be removed.

Policy changes should be made to formalise student transfers between institutions. Currently such transfers take place on an ad hoc basis and are unnecessarily complex for the student.

Policy changes in this area should also work to formalise relationships between regional universities and those in capital cities. Increased collaboration where teaching costs may be high and student numbers may be low is highly important and not only contributes to improved learning environments but can reduce the costs of that learning.

There is a need for a statutory body to facilitate the formalisation of credit transfer arrangements between institutions.

Recommendation: An external body is essential to facilitate the formalisation of credit transfer arrangements between institutions. The competitive nature of the Australian university environment means that universities will need assistance to undertake this task.

5.3 Enrolment mechanisms

Currently, the process for Year 12 and other potential students to apply for admission to university is operated on a State and Territory basis. For example the Universities Admission Centre (NSW and ACT) and Queensland Tertiary Admissions Centre.

Under the present arrangements NSW school students are provided with information on NSW higher education institutions only and Queensland students are provided with information on Queensland institutions only.

It is obvious that this lack of complete information and flexibility in admission processes is hampering the movement of potential students interstate to study. In the first instance, a common guide listing all the courses offered Australia wide should be prepared for Year 12 students including information on how to apply in each State and Territory.

This publication should be prepared as soon as possible and the State and Territory based guides should cease publication. Eventually, the admissions centres of each State and Territory should be amalgamated into a national body, providing potential university students with a single application process to all universities, Australia wide.

Recommendation: The universities admission system should be reformed and operated at a national level. The new system should operate as a single application process to all universities Australia-wide.

6. Articulation pathways and student support mechanisms

Engineers Australia accredits the undergraduate engineering courses offered by all university engineering schools in Australia. Recent changes to the university landscape, particularly in relation to the restructuring of the University of Melbourne has resulted in Engineers Australia broadening its accreditation function to include those Masters Degree programs where graduates would be eligible for entry into the engineering profession.

Only those courses successfully accredited by Engineers Australia provide the required level of tuition to students resulting in graduates who have the required level of education necessary to become Chartered members of Engineers Australia or to be registered on the National Professional Engineers Register (NPER) or National Engineering Technologists Register (NETR).⁸

Another type of Masters program being actively encouraged and accredited by Engineers Australia are those acting as articulation pathways into the profession for individuals who have completed a three year university qualification in engineering, or a diploma from a vocational education provider. Engineers with these qualifications are not eligible for entry into the engineering profession as “Professional Engineers”.

For example, the Master of Engineering Practice offered at the University of Southern Queensland provides an education pathway that upgrades student’s vocational education qualifications to a level equivalent to a four year undergraduate engineering degree making graduates from the Masters eligible for entry into the profession as a “Professional Engineers”. That is, eligible for registration on NPER and membership of Engineers Australia at the Chartered level.

Engineers Australia compiles a listing of every university course in Australia which has been given accreditation. The 2008 version can be downloaded from:

www.engineersaustralia.org.au/education/program-accreditation/accredited-programs

Engineers Australia believes that all student support mechanisms including admission to a Commonwealth supported university place, Commonwealth Scholarships, HECS and Centrelink payments should be extended to all courses accredited by Engineers Australia. These courses result in graduates that increase the pool of engineering expertise in Australia and should be supported equally.

This measure will capture not only those Masters courses established by the restructure at the University of Melbourne, but also those Masters courses developed to create articulation pathways into the engineering profession. Support for articulation courses is particularly important as the engineering skills shortage continues to worsen.

Additionally, it is inequitable that some students studying Masters programs which lead to an accredited engineering degree (eg Melbourne University) are able to access government support, while other students studying articulation programs at the Masters level (eg University of Southern Queensland) are forced to pay higher fees and are unable to access equal levels of student support, despite the fact that their qualification on graduation is the equivalent to a four year undergraduate degree in engineering.

Recommendation: All students studying engineering degree programs accredited by Engineers Australia should have access to the same level of student support including admission to a Commonwealth-supported place and access to Commonwealth Scholarships, HECS and Centerlink payments.

7. Accreditation of university engineering courses

One of the activities undertaken by Engineers Australia is the accreditation of undergraduate engineering programs at Australian universities. Engineers Australia undertakes accreditation of engineering degrees offered by Australian higher education institutions to ensure engineering programs consistently meet national and international benchmarks, and that engineering graduates are operating at worlds best standards and meeting the needs of engineering employers.

Employers of engineers recognise that the accreditation system helps to ensure that all engineering graduates across Australia are operating at a comparable level, and that they can feel confident of an engineering graduate's skill when choosing to employ them. Over 90% of graduates from university engineering programs are employed one year out from completing their course and at one of the highest graduate salary rates of any professionals.

Engineers Australia's accreditation function is overseen by an Accreditation Board that considers reports from accreditation panels. Industry input is vital to the accreditation process, and is well represented on the Board and in the accreditation process.

Box 4: Gender balance in engineering

Only small numbers of females currently enrol in programs leading to employment in the engineering profession and there is an immediate need to encourage more women to make engineering their career choice.

Improving on the ratio of women to men is a critical issue for the future of both the engineering profession and the communities it serves. Because engineering has such an important influence on Australia's public health, safety, security, prosperity and the environment it is essential that the profession reflect the needs and aspirations of the entire Australian community. For the engineering profession to attract and retain female engineers, it must address negative perceptions of the engineering working environment.

Currently starting salaries for female engineers are equal (or slightly higher) than those offered to males. This is not the case in medicine, optometry or architecture.⁹ While additional workplace equity issues may need attention in some fields or engineering workplaces, overall engineering employers are looking to balance the engineering workforce and women graduates are highly sought after within the profession.

At university, females studying engineering are significantly under-represented. The proportion of female engineers has not increased to a level as high as in other traditionally male dominated professions. In 2006, 6026 domestic students graduated from university courses in engineering at the bachelor level, while only 964 of these were female¹⁰.

The proportion of females completing engineering courses does seem to vary by discipline however, with much larger proportion of women graduating from environmental engineering rather than chemical or mechanical engineering. Worldwide the proportion of women selecting an engineering career is low. In Australia, engineering has the lowest female share of any broad field of study in Australian universities, and the rate of increase of female enrolments in engineering courses remains low.

While there are larger proportions of women engineers involved in environmental engineering; there no reason why women should not comprise a greater proportion in all engineering disciplines. A refocus on gender issues in the engineering profession is needed and must be a key facet of any programs focused on addressing growing skill shortages across the Engineering Team.

Accreditation involves evaluating undergraduate engineering education programs offered by universities. Assessment of the academic program is outcome based, and includes an assessment of the teaching and learning environment, the structure and content of the program and the quality assurance framework. The accreditation process doesn't prescribe detailed program objectives or content, but it does judge the appropriateness of educational objectives and targeted graduate capabilities.

Engineers Australia looks upon accreditation as a community of interest between the profession and its educators and does not impose accreditation. Universities need only submit their programs if they wish, and will only do so if they think it worthwhile. Deans of engineering schools confirm that they see value in a credential validated by an external body as an objective measure of quality that is internationally benchmarked.

In maintaining and developing its system of credentials, Engineers Australia is acutely conscious of the importance of international benchmarking and undertakes its accreditation program to international standards. As well, almost all engineering work now has international implications of some kind. Many engineers will practice internationally at some time, and require portable qualifications.

Engineers Australia was a founding member of the Washington and Sydney Accord's (www.washingtonaccord.org). These agreements between national engineering accreditation bodies in an already large and growing number of countries results in the international benchmarking of Australian engineering qualifications and the international recognition of Australian engineering degrees. Graduates from a program accredited by Engineers Australia enjoy international recognition within the jurisdictions of Accord signatories, aiding the mobility of practising engineers.

Currently some international trends in the delivery of higher education including the Bologna model of undergraduate education are potentially incompatible with the Washington Accord and the Australian engineering degree framework which is based on a four-year professional degree structure. The Washington Accord is working to consider how these escalating international standards for undergraduate degrees will impact on the international benchmarking provided by the Accord as well as opportunities to engage with the Bologna model for mutual benefit and recognition of engineering graduates.

Finally, Engineers Australia believes that where university courses are accredited by well recognised, high quality external agencies, such as Engineers Australia's accreditation program for engineering courses, this assessment should be regarded as eliminating the need for any other external assessment of quality standards.

Recommendation: Where university courses are accredited by well recognised, high quality external agencies, such as Engineers Australia, this assessment should be regarded as eliminating the need for any other external assessment of quality standards.

8. Accreditation of VET engineering courses

The blurring boundary between the delivery of vocational (VET) and university education should be seen as a positive outcome. There are significant benefits to creating clear pathways between vocational and higher education where students can maintain lifelong learning by jumping in and out of education between vocational and university provided training.

Setting up pathways between VET and university education with clearly defined options and credit transfer arrangements would support the different roles of VET and university education and encourage life-long learning.

Given that skill shortages are being experienced in engineering at both the trade, associate, technologist and professional level, training options need to be maintained at both the vocational and university level. A shift toward any one level could have a negative outcome on the Engineering Team as a whole.

Engineers Australia is however concerned with ensuring that a high standard of engineering training is being offered within Australia for the entire Engineering Team. Currently only those courses offered by the university sector are accredited by Engineers Australia.

In recognising the high standard of graduate attributes created through the accreditation system and the link to training outcomes which are responsive to employer needs, Engineers Australia has been working on a pilot program of VET/TAFE accreditation. This includes the accreditation of AQF advanced diplomas and associate degrees in engineering. Accreditation is on the basis of a program implemented by a registered training authority (RTO) against a competency based training package, and dove-tails with the Australian Quality Training Framework (AQTF) audit process. Engineers Australia has recently accredited Advanced Diploma programs in Engineering Technology, at Chisholm Institute of TAFE.

Engineers Australia has developed the accreditation management system for the pilot program while maintaining links with the Australian Skills Council and various State based authorities such as TAFE NSW and the Victorian Curriculum Maintenance Managers. In 2008, significant projects are underway with the TAFE NSW Curriculum Centre for Manufacturing Engineering (MECAT) and also with Manufacturing Skills Australia to develop umbrella guideline templates that will assist program developers implement engineering programs against the National Training Packages.

The accreditation program of Engineers Australia is a proven method of ensuring that engineering programs best meet the needs of employers and as much as possible, training outcomes for individuals and enterprises translate into appropriate employment outcomes. Engineers Australia is committed to working toward an expansion of the TAFE accreditation program to all States and Territories over the coming years.

Engineers Australia's commitment to the development of an accreditation system for education delivered across the Engineering Team means that Engineers Australia is unconcerned about who offers what within the post-compulsory education landscape. For example, there is no reason why some engineering education, for example at the Associate Degree level, cannot be offered by both the higher education and VET sector. What should be more important is whether the course has been accredited by an external body like Engineers Australia.

What will need consideration is how external accreditation and quality assurance is going to be facilitated. Engineers Australia as a not-for-profit organisation, currently accredits university engineering courses as a community service to the engineering profession. Despite the need to ensure that the education provided across the Engineering Team is internationally benchmarked and accredited, how such a program might be resourced is still uncertain.

The State and Commonwealth Governments will need to be willing to support the full-scale accreditation of Australian engineering education and be prepared to influence the post-compulsory education sector to meet this goal.

Additionally, dual sector universities, for example Swinburne, RMIT, Victoria, Ballarat and Charles Darwin, have considerable positive student experiences with excellent learning outcomes and industry linkages and must be supported within the post-compulsory education system.

Recommendation: The blurring boundary between the delivery of VET and university education should be seen as a positive development. External accreditation and quality assurance will need careful and thoughtful facilitation as the post-compulsory education sector becomes more diverse and educational offerings differentiate across the sectors.

Recommendation: The Commonwealth and the States will need to be willing to support the full-scale accreditation of all post-compulsory engineering education in Australia. Without this support, program standards and articulation pathways cannot be developed and maintained across the Engineering Team.

9. Education and innovation

9.1 Teaching and research

Endorsed during the two previous reviews of engineering education was the idea that “unless most of our teaching staff are engaged in research and current scholarship, engineering education will fail to maintain contact with rapidly changing technologies...if this happens we will fail to inculcate the graduating engineers with the enthusiasm required to keep challenging the established ways.”¹¹

Recognising the link between teaching, scholarship and research, the reviews concluded that all engineering schools should have post-graduate and/or research involvement that gives relevance to postgraduate coursework and informs undergraduate programs.

However, Engineers Australia believes that this vision does not require all engineering schools to undertake post-graduate teaching or research on-campus. Agreements between two or three universities in close proximity to each other could result in collaboration on research activities, and in the sharing of facilities. Teaching staff and students can be moved between universities, on-line material can be developed for delivery at all institutions and technology such as video-conferencing can be utilised to bring campus' together.

Engineering schools focused on post-graduate teaching and research can feed into schools that have focused their strengths on undergraduate teaching. Lecturers can be seconded and transferred between institutions and from industry to maintain a balance of involvement in teaching, scholarship and research. Establishing Centres of Excellence could be one mechanism used to move towards a system wide approach to engineering innovation in Australia

Engineers Australia is also not immediately opposed to the notion of specialist institutions focused on delivering bachelor, master and doctoral level qualifications in a small number of disciplines. There would be concern however, that the emergence of university offerings grouped along rigid fields of study for example, a university dedicated only to Business, Humanities or Science would limit the opportunities of students to take “out of field” courses and be exposed to different disciplines.

This could prove particularly problematic with students undertaking a Bachelor of Education. A student enrolled at a university focused on delivering subjects only in the humanities would be ill equipped to provide students undertaking a Bachelor of Education with an acceptable level of maths, science and technology training.

Given that there is a rapidly growing shortage of teachers with maths, science and technology qualifications, the effect of the specialisation of university offerings on the quality of the delivery of some courses must be considered carefully.

9.2 Education, research and industry linkages

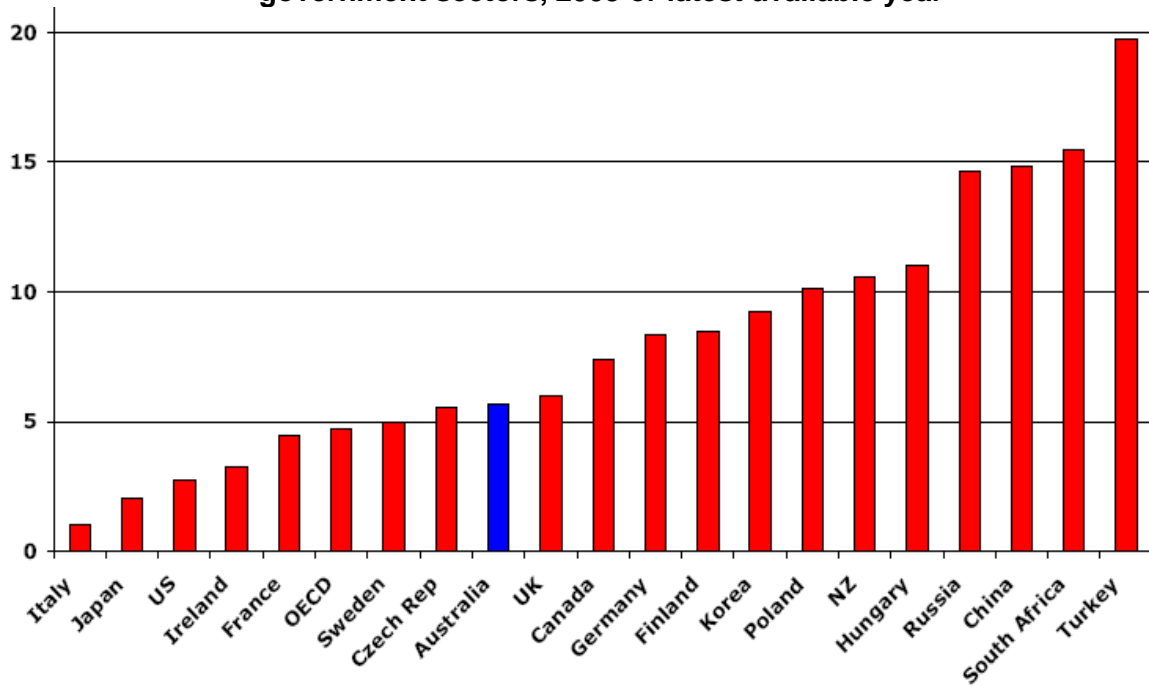
University and industry linkages are an important component in the Australian innovation system and in the national and international success of the Australian economy. While industry has long argued that to support this relationship, university research should be more clearly aligned with industry needs, many small to medium engineering enterprises (SMEs) do not appreciate the benefits that university collaboration could bring to their operations.

The percentage of business funded R&D in Australia performed in both the higher education and government sectors is low in terms of OECD comparisons. There is certainly room to improve on this low level of collaboration both from an industry and academic perspective.

A key issue in improving R&D rates in Australia is that many small and medium businesses fail to undertake R&D, or are unsuccessful in the commercialisation of R&D because of a lack of access to information and/or skills to make informed decisions about investments in R&D.

Companies may also be unaware of how to access the mechanisms to transfer technology from institutions such as universities and public science agencies to the company. In some instances, this information is available, but companies do not know where to access it. In other instances, institutions do not hold centralised registers of research projects nor do they promote the expertise and knowledge they have available.

Figure1: Percentage of business-funded R&D performed in the higher education and government sectors, 2005 or latest available year



OECD Science, Technology and Industry Scoreboard 2007

There are already some significant government programs developed at a Commonwealth and State government level to assist with collaboration and linkage issues. One of these is the CRC program.

Engineers Australia believes that funding for this program should continue into the future, however, programs such as the CRC program are generally accessed by larger firms, rather than SMEs.

A successful CRC program is reliant on a number of factors. There needs to be a direct focus on industry needs. Some representative groups (such as academics) may have preferred topics to pursue, which may not be a priority to industry or more importantly, the end user.

CRC's also need to establish a set of performance indicators with real measures and targets, determined in consultation with industry and other relevant stakeholder groups. This will ensure that real outcomes are achieved. There must also be a balanced representation of Government, industry and academia on any CRC Board as greater representation of one stakeholder group over another can skew activities.

Engineers Australia believes that there needs to be an increased focus on encouraging collaboration between SMEs and universities, TAFE's, and other publicly funded organisations, such as the CSIRO. Most SMEs know little about assistance packages for collaboration or what facilities are available within research organisations.

If this collaboration was better understood and utilised by SMEs, and taken further by the universities, TAFE's, and government R&D organisations, it would be another source of income for all concerned.

Strategic linkages between organisations with complementary skills and competencies have been identified as a critical factor in successful innovation systems. It is also recognised that a major driver for innovation is postgraduate research at universities.

Thus, it is essential to make postgraduate education attractive by offering scholarships that are competitive compared to industry standards. There is also a need to remove any barriers that make it difficult to recruit outstanding international postgraduate candidates.

However a key bottleneck to individuals accessing existing retraining pathways is that the majority of postgraduate coursework study in Australia is full-fee. Options to reduce the fee burden on students in engineering and other areas of skills need must therefore be considered to increase enrolments.

9.3 Government support and assistance

Direct government assistance is an incentive to innovation and R&D. Incentives can take many forms. Market based incentives can be in the form of grants, repayable grants, loans, interest rate subsidies, and tax preferences.

However, business has been deterred from investing in R&D by frequent changes to incentives, and by the reduction in their value. As well, the number and complexity of government programs designed to support innovation creates confusion and the difficulties in accessing programs deter many companies and individuals.

Tax measures have many advantages. For instance, they are market driven, allowing companies to decide for themselves what R&D to undertake and when, they can have relatively low administrative and compliance costs, and they are generally available to all eligible companies, regardless of the sector in which they operate.

While larger organisations see R&D as essential for future growth and prospects, there are many companies who feel that the ability to undertake value adding R&D in their industry results from the impetus given by tax concessions. Many of our best export earning companies say they would not have been able to get their R&D base off the ground without some assistance. Unfortunately, a reduction in R&D spending developed in Australia after the decision to reduce the R&D Tax Concession from 150 percent to 125 percent.

Those organisations that have claimed the tax concession in the past believe their increased efforts in R&D have been substantially enhanced by the support provided by the concession. They have subsequently demonstrated success in providing the government with payments through taxes, which have more than adequately covered the initial outlay.

In the recent survey, Engineers Australia asked members what support was needed to assist industry to undertake and increase their levels of business R&D. The initiative ranked 'most important' by the majority of members was the need to revitalise the R&D Taxation Concession while the recent decision to discontinue the Commercial Ready Grant Program was seen as a blow by members to the Australian innovation system. Additionally, there was general agreement from that Government support was not 'business welfare', but rather a strategic investment decision with huge paybacks for the Australian economy.

The Federal Government commitment to review all government innovation and industry assistance programs to reduce duplication and improve effectiveness is welcomed by Engineers Australia. In the twentieth century, economic leadership became a matter of strategic investment in R&D to deliberately invent new technologies. Germany, the US, Taiwan, Singapore and Ireland have all invested heavily in supporting their R&D base.

To be competitive, Australia must be internationally competitive in terms of R&D funding and R&D tax treatment. As a useful driver of business R&D, the tax concessions should return to at least 150 percent.

Recommendation: a centralised register of the R&D being undertaken in universities and public research institutions is needed as a mechanism for Australian industry to identify collaboration opportunities. This could form part of a wider program to encourage collaboration between small and medium enterprises with universities, TAFE's, and other publicly funded organisations, such as the CSIRO.

Recommendation: funding for the CRC program should be continued and ways to encourage better access by SMEs. Cooperation between universities and other research agencies must be improved.

Recommendation: promotion of Government assistance programs is needed to assist collaboration between companies to encourage greater and more effective private spending on R&D.

Recommendation: the review of government innovation and industry assistance programs to reduce duplication and improve effectiveness is welcomed and must link strongly with any recommendations made by the Higher Education Review.

Recommendation: the tax concession should return to at least 150 percent, as a useful driver of business R&D.

Box 5: Loss of government training and the introduction of CPD

In the past, a significant percentage of engineers were trained in the public sector. As government agencies and utilities have been privatised or have been outsourced, there has been a fundamental shift in the employment of engineers. Cadetships are virtually non-existent and engineers are now, on the whole, private sector employees and the major responsibility for training engineering graduates has been transferred with them.

Continuing education and post-graduation training are particularly important for engineering graduates. Engineers are not fully “formed” and are not competent to practice independently until they have gained several years of “mentored” engineering experience.

Additionally, it is recognised that in view of today’s rapid pace of change in technology, and the increasingly accountable and litigious environment in which engineers operate, it is essential that engineers adopt a program of lifelong learning through Professional Development.

In this new environment, graduate and experienced engineers, industry, private training companies and universities have recognised the need to work together to support these changes in the employment, education and training environment of engineers.

Engineers Australia has responded to this challenge through its Professional Development (PDP) and Continuing Professional Development (CPD) programs. These programs help to maintain the currency of an engineer’s qualifications and support an engineering training and “up skilling” in new areas of engineering expertise. Currently over 280 companies and over 5500 engineers participate in the two programs.

The Professional Development Program (PDP), which focuses on the professional development needs of recent engineering graduates, is a formally recognised agreement between Engineers Australia, the enterprise/employer and the individual/graduate engineer. The PDP is a structured program delivered in the workplace with external assessment and support from Engineers Australia. Participation in a PDP is open to engineering practitioners employed in all fields, types and sizes of enterprise.

These organisations include defence, mining, utilities, consulting, aerospace, information technology, telecommunications, processing, manufacturing, construction and public authorities. They include all three employment categories; Professional Engineer, Engineering Technologist and Engineering Associate.

Under the Continuing Professional Development (CPD) program, professional engineers, on an individual level, undertake activities in order to maintain and extend their knowledge, skills and judgment. For an activity to qualify as CPD it must be related to the engineer’s professional career.

For many engineers CPD activities will include both technical and non-technical topics. Non-technical topics include management, accounting, law, economics, and foreign languages. Engineers must undertake CPD to maintain Chartered Status with Engineers Australia and are subject to random audit.

Further information can be found at: www.engineersaustralia.org.au/education/professional-development-program

10. Resourcing the system

Engineers Australia believes that current funding levels to public universities are insufficient to service any future increase in demand for engineering education. Since the mid 1980's (with the exception of a few years) governments have let the per capita investment by the Commonwealth in public universities slide, and have allowed it to be wholly or partially replaced with fees, grants and outside earnings. Funding per student has been decreased.

University capabilities are severely stretched, and the reduction in public funding has meant that universities must gain income from other sources. The chase for this funding depletes academic strength. This particularly affects the engineering schools' ability to engage in research. The reduction in funding is also detrimentally affecting the quality and diversity of teaching and research.

There is a shrinking limit to which industry will undertake research within Australia. The dramatic fall in business expenditure on research and development in recent years has impacted on universities ability to establish new research partners in industry and to access outside sources of funding. This has been compounded by the number of high value added Australian companies purchased by multinational organisations who then relocate their R&D to more cost effective R&D taxation countries.

The current competitive positioning of institutions mitigates against any lateral sharing of educational development and delivery at the discipline level. This leads to duplication of effort and inefficiencies in the use of resources. As a result of the competitive attitude of universities, we have seen a proliferation of boutique program titles and offerings that are motivated more by marketing imperatives than by academic professional necessity.

Lack of resources and incentives have impeded quality assurance systems from penetrating more effectively to the delivery level, to ensure that academic teaching teams engage with systematic and holistic educational design, outcomes-based attainment tracking processes and their planned review.

These factors place limits on the ability of universities to provide the high standard of undergraduate teaching and the required research infrastructure necessary to create the skilled workforce vital for Australia to remain a significant player in the world economy.

Total expenditure on educational institutions in Australia is low compared to international indicators. Universities are a fundamental component of Australia's success in a knowledge-based global economy and, as such, government must continue to take its fair share of responsibility in funding them, rather than relying on industry to provide increasing levels of funds, or relying on increases in full fee paying student numbers. Reduced funding can only lead to reduced achievement by graduates.

The Government's commitment to halve HECS fees for maths and science students, and halving their repayments if they take up jobs in key fields, such as teaching, must be extended to engineering graduates. Support and encouragement for more students to study engineering is particularly important as the skills shortage continues to worsen. It would be counter-productive to price engineering programs higher than science or other disciplines, for example economics and accounting, when they all draw on essentially the same school leaver pool.

Engineers Australia supports the encouragement of students into courses and universities in areas of skills need by lowering HECS fees, as long as this funding is compensated by increased levels of government funding. Government funding of higher education in Australia is currently inadequate, which has led to an over-reliance on increased HECS and full-fee paying students. Australia is the only developed country to reduce its public investment in post compulsory education over the last decade. This is certainly not something to be proud of, nor will it benefit Australia's long term economic future in knowledge based or high value added manufacturing.

The current funding model and the level of funding are inadequate and the current funding framework is not a sustainable mechanism by which to support Australia's higher education system in the longer term.

Engineers Australia would also like new and innovative funding options to be considered as part of the Higher Education Review. In particular, the potential exists for the growing level of superannuation funds in Australia to be invested in the innovation system, perhaps through the issuing of Higher Education Infrastructure Bonds, supported by taxation incentives to attract funds from the private sector. In the United States the bond market has been used to fund both secondary schools and university institutions.

Alternative systems for allocating funding for teaching and research must be considered. All options and all aspects of the current funding system should be rigorously and fundamentally reconsidered. This should include the potential issuing of education vouchers, the potential to restructure the HECS system to reduce the financial burden on students, opportunities to increase philanthropy, reduce reliance on full-fee paying students, reduce the cost of post-graduate education. Funding mechanisms should be chosen to encourage lifelong learning, articulation and retraining of Australian citizens throughout their careers.

The delivery of engineering education by the higher education sector could be greatly enhanced by formal recognition of the need for better coordination and interaction between academia, industry and professional bodies.

Engineers Australia believes that it is in a unique position to bring together and influence government, industry, the providers of engineering higher education and the engineering profession to develop a strategic overview of where these sectors can provide the outcomes needed for Australia in the future. We believe that there is a need to:

- bring industry and academia closer together to produce students that meet the standard required by industry
- provide a linkage to allow industry input into teaching and engineering practice
- assist engineering academics to maintain up to date skills and knowledge by providing a mechanism to facilitate industry experience
- encourage benchmarking between engineering schools
- encourage collaboration between engineering schools to share laboratory resources and realise economies of scale in teaching and research without reducing diversity
- promote alliances to enhance innovation
- promote mobility of staff, research students and undergraduate students
- define standards to recognise prior learning in other institutions

Engineers Australia currently has a close relationship with the Australian Council of Engineering Deans, and has an international focus on accreditation of courses, benchmarked through the Washington, Sydney and Dublin Accords. We have a strong interaction with engineering students, and provide assistance with vocational experience to provide exposure to industry practice through our divisional offices in each State and Territory.

Engineers Australia also offers chartered status to engineering academics, which is a professional credential that is recognised by government, business and the general public worldwide. It certifies that a person practices in a competent, independent and ethical manner and indicates that a person is a leader in their field. We also offer many continuing professional development opportunities through our technical seminars and conference programs.

Recommendation: The education and training system must focus on the up skilling and retraining of existing workers. Flexible pathways must be created to meet the education and training needs of individuals at all stages of their careers.

Recommendation: Government funding to universities must be increased to at least the OECD average. Options to reduce the HECS burden on engineering students and other areas of skills-need must be explored and targeted to increase enrolments.

Recommendation: Alternative systems for allocating funding for teaching and research must also be considered. No options should be off the table and all aspects of the current funding system should be rigorously and fundamentally reconsidered.

Recommendation: The majority of post-graduate study in Australia is full-fee paying. Options to reduce the fee burden on students in engineering and other areas of skills need must be evaluated and the best introduced. Initiatives to increase enrolments in courses that are retaining pathways for entry into the engineering profession must be launched.

Recommendation: Formally recognise the need for an overarching body to bring together academia, industry, and the profession in a cooperative way to improve the delivery of engineering education and research.

11. Conclusion

Engineers Australia strongly recommends that the Government recognise that public investment into higher education is a benefit and not a cost.

Engineers Australia challenges the Government to invest in higher education at a level that will support Australia's transition to a knowledge economy. As rapidly-changing technology and globalisation transforms the pattern of demand for skilled labour throughout the world, raising the proportion of young people who participate in higher education will only become more important to Australia's global success.

Unless the recommendations provided in this submission are actioned, the engineering skills shortage will continue to worsen and the competitiveness of our economy will be undermined leaving us vulnerable and unable to meet the challenges of the future, particularly infrastructure renewal and climate change mitigation. In this environment, Engineers Australia welcomes the Federal Government review of higher education in Australia and appreciates the opportunity to provide comment on the discussion paper.

¹ Institution of Engineers, Australia, *Review of Engineering Education, Changing the Culture: Engineering Education into the Future*, 1996.

² The Australasian Association for Engineering Educators (AaeE) and the Academy of Technological Sciences and Engineering (ATSE).

³ The Engineering Profession: statistical overview, fifth edition 2008, Andre Kaspura, Engineers Australia

⁴ <http://www.engineersmedia.com.au/bookshop/salarysurvey.html>

⁵ The Engineering Profession: statistical overview, fifth edition 2008, Andre Kaspura, Engineers Australia

⁶ *Australia's Teachers: Australia's Future*, Volume 3. 'Background Data Analysis', Review of Teacher Education, DEST Canberra, 2001.

⁷ <http://www.engineersaustralia.org.au/about-us/2008--year-of-the-engineering-team>

⁸ Chartered membership www.engineersaustralia.org.au/education/chartered-status and National Registers

www.engineersaustralia.org.au/nerb/

⁹ Universities Australia University Statistics, Table B.11 Female graduate starting salaries: as a percentage of male graduate starting salaries, 1996 - 2003

¹⁰ The Engineering Profession: statistical overview, fifth edition 2008, Andre Kaspura, Engineers Australia

¹¹ Institution of Engineers, Australia, *Review of Engineering Education, Changing the Culture: Engineering Education into the Future*, 1996., p35