

Engineers Australia - Issues in Relation to Innovation

Engineers Australia¹

General

Engineering has always been central to the economic growth that has characterised the rise of industrial capitalism and, as we move into a knowledge-based economy, it remains a fundamental element. In the innovation literature a strong science and engineering base has been identified as a distinct component within the framework of innovation systems.

Investing in science, technology and innovation, and having a pool of trained innovators will not happen unless:

- there are increased levels of business expenditure on Research and Development (R&D);
- corporate culture significantly changes its appreciation of innovation;
- technology resources and strategic alliances are more readily available;
- there is better access to finance for projects, particularly R&D projects;
- clients become better informed;
- government offers sufficient and appropriate incentives; and
- there is access to quality education and training opportunities.

Business R&D

A key matter that must be addressed to attract and retain researchers is the level of business R&D in Australia. There is often a misunderstanding by governments on what research and development involves. Research can involve many types of activity. In the minds

of many people there is a view that it involves scientific investigation of one kind or another. There is a temptation to include development in this definition. However, scientific research does not by itself easily translate into technical practice. For instance, in many cases, it is engineering that provides a bridge between science and technology, and between technology and commerce.

Engineering plays an essential part in meeting the material requirements of society and in the generation of wealth. It is the engineers who translate technology into the resources and products of the future. Research leads to development, which often involves prototypes, tests with less than full-scale plant and demonstration projects. The next stage is usually commercialisation. This sequence must be borne in mind when considering R&D policy and related matters affecting the people involved and their training.

Engineers Australia (EA) takes the view that technological innovation is a prime driver of economic growth and accounts for an estimated 50 percent of long-term economic growth in advanced industrial countries. Essential to this is a strong R&D base. There is a high correlation between the wealth of nations and R&D intensity, and EA believes that business expenditure levels on R&D must increase if there is to be significant growth for Australia in the future.

Corporate Culture

Leadership is a vital influence in a company's decision to be innovative and to have highly skilled staff. The key issues identified as drivers of innovation in this context are:

- a corporate culture that seeks continuous improvement and excellence;
- a working environment that is conducive to, and encourages innovation;
- drive and vision of the managing director;
- an environment offering freedom and support (including finance) to explore new ideas;
- internal drive for innovation and excellence from the top down; and
- continuing determination by the Board to support development of new products and services.

Predominant negative attitudes are:

- tendency to 'when in doubt-don't';
- resistance to change; and
- conservative 'risk' management.

Availability of Technology Resources and Strategic Alliances

Many small and medium businesses do not attract large numbers of highly skilled because they don't innovate. They 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 many instances, this information is available, but companies do not know where to access it. Government programs designed to assist collaboration between companies and provision of advisory support are beneficial,

and should be better promoted to encourage greater private spending on R&D.

The following are incentives to innovation:

- alliances, partners and technology;
- access to resources, including finance;
- availability of technology;
- investment in and utilisation of internal and external R&D; and
- university resources including infrastructure and equipment.

Finance Issues

Highly-skilled people will not stay in Australia unless there is sufficient business activity through major projects or research activities. It is unlikely that projects will be undertaken unless companies have an expectation that there will be a reasonable rate of return, in terms of sales of new or improved products or services, or in terms of improved productivity or efficiency. There is reluctance by companies to fund medium or long-term R&D due to technological shifts in the international environment, and there is a focus on more short-term innovative efforts.

For any existing business to decide to invest in R&D, the initial expenditure produces no income until the R&D is commercialised. This has obvious cash flow implications for small and even medium-sized organisations and is a major reason for companies not undertaking R&D. The 125% taxation arrangement does not compensate for this negative cash flow period. While the new tax rebate of 37.5 cents in the dollar for companies that might need assistance with cash flow to pursue their ideas is welcomed, this is only available to companies in a tax-loss situation.

A range of government policies will impact on the availability of finance. For instance, macro-economic policy will impact on interest rates and hence, the availability of funds. In recent times, interest rates have remained at relatively low levels, and this should continue. Australia should be an attractive place to invest. Capital gains tax is a very important factor in business R&D, and should be internationally comparable

to retain investment within Australia, and to attract international investors.

The financing of technological development and venture capital funding are two of the significant weaknesses facing wealth generation in Australia. In 1998, total venture capital available in the US per head of population was around \$33 while in Australia it equalled \$1.50 (ARC 2000:17). Australia’s current international standing is well below the OECD (and EU) average, with little venture capital available for early stage development. The relatively low level of investment in venture capital is due in part to the biggest investors, superannuation funds for instance, taking a risk-averse approach. Governments need to implement policies to encourage superannuation funds to play a greater role in the provision of venture capital.

While government has attempted to address the problem of encouraging venture capital through the Innovation Investment Fund (IIF) Program, the Pharmaceutical Industry Investment Program (PIIP) and the Pooled Development Fund (PDF) Program, these programs have not, as yet, been enough to keep pace with our international competitors. Another measure that could be considered is allowing R&D tax deductibility for interest and dividends earned by investors in trusts and/or funds set up specifically for investment in R&D.

It must also be noted that the size of our market, and the predominance of SMEs means that companies rarely take a technology from inception through to development and then to the market (commercialisation). The venture capital model of preparing a business plan is inappropriate to many SMEs, particularly small business, as market research is often too costly to undertake relative to the size of the opportunity. Small business requires a model that provides better access to funding.

Informed Clients

Informed clients are a vital factor in encouraging innovation and attracting and retaining skilled people. In particular, government as an informed client can have a significant effect on the amount of innovation in the market place. The following are important factors:

- customers, including customer demand;

- clients willing to accept innovative solutions;
- access to projects requiring innovative solutions;
- knowledgeable customers;
- demand for better quality and service; and
- major projects that stretch the envelope.

Major infrastructure projects are usually unique solutions to a set of problems needing the application of scientific and engineering research without the luxury of intermediate stages. Much of the work of engineering consultants is in this category that requires willing and informed clients.

Customers who are unable to assess the technical components of new methods or products and are therefore unwilling to investigate them, are a major impediment to a company’s choice to innovate. The key factors inhibiting innovation are:

- customers unwilling to purchase innovative solutions;
- customer reluctance to be the first recipient of a new solution;
- selecting on price rather than ‘whole of life’;
- government institutions’ reluctance to embrace new techniques; and
- unwillingness of customers to accept alternatives.

This has an effect on implementing innovations in manufacturing and in infrastructure projects as mentioned above. There is also a link to the Professional Standards Legislation under consideration by the Council of Australian Governments (COAG) because it affects a client’s confidence in engineering services providers as well as risk management, and relates to professional indemnity insurance that is vital for such projects to proceed.

Government Incentive Programs

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 recently Ireland, have all invested heavily in supporting their R&D base. It is important in this context to recognise that in providing incentives that target R&D, the incentives need to fit that development model.

Incentives can take many forms. Market-based incentives can be in the form of grants, such as the R&D Start Program, repayable grants, loans, interest rate subsidies, and tax preferences such as the 125% tax concession, and the additional tax incentives offered under the Commonwealth government's *Backing Australia's Ability* (2001, 2004).

Direct government assistance is an incentive to innovation and R&D. For instance, the following should be retained and strengthened:

- collaborative government/industry grants;
- government incentives, including the R&D tax concession;
- finance from government schemes and rebates; and
- government grants to support student scholarships.

Business has been deterred from investing in R&D by frequent changes to incentives, and by the reduction in their value.

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.

It must be noted that changes to the value of the R&D tax concession are of concern. For instance, compared to the original R&D tax deductibility of 150% at the then company tax rate of 49%, the R&D deductibility at the current corporate tax rate of 30% would need to increase to 185% to return the same net tax benefit. The present 125% deductibility compares unfavourably with the earlier rates, and with overseas rates of deductibility, which in some cases reach 200%. R&D subsidies in Australia have also decreased significantly over the 1990-1999 period due to a reduction of

the R&D tax concession from 150% to 125%. In contrast, tax concessions as a policy instrument are on the rise in OECD countries.

The engineering 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 that have more than adequately covered the initial outlay.

It is vital to keep in mind that many companies feel that the ability to undertake value-adding R&D in their industry results from the impetus given by the tax concession. 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. There is general agreement that competing on a global scale with high-margin innovative products and services requires a commitment by government to fostering high export, high and new-technology industries. That support does not amount to 'business welfare', but rather is a strategic decision with huge payback for this country.

Education and skills

Government education policies must ensure that there is access to higher education, and to training opportunities if Australia is to have an adequate skills base in the future.

The availability of skilled staff, both in-house and within Australia more generally is a key component for increased innovation. Specifically, the following are important factors:

- staff, including access to suitable engineering expertise;
- availability of expertise within Australia;
- broad technical support network developed in-house to pursue innovation; and
- recruitment and holding staff at a high and technical range.

There are skills shortages in some areas at the moment. A skilled engineering workforce is essential if Australia is to achieve the quality

and standard of living to which we aspire in an increasingly competitive world. At present, Australia is importing a significant number of engineers every year to cover the shortfall in engineering skills.

The skilled migration program is essential to Australia’s future competitiveness. However, there is one particular area of concern. Most of the constraints on employers bringing specialist workers into Australia on a temporary basis have been removed, and employers no longer need to market test in order to establish that Australian residents are not available for the work in question. In a cost conscious commercial environment, there is a danger that employers will be tempted to make greater use of ‘off the shelf’ skills available overseas. This is especially true where there may be delayed access to such skills through local training.

The business skills migration scheme is essential to Australia’s future growth. However, it is vital that the business-skills migration scheme is used only where skills are not presently available to the required degree. It is essential that this category does not become a replacement for a reliable and valued Australian skill base. The business skills migration scheme cannot be seen as an alternative to educating and training a highly-skilled Australian workforce.

In the past engineers were mainly trained in the public sector. However, as the large government utilities were privatised and outsourced, there has been a fundamental shift in the employment of engineers, who are now on the whole private sector employees. Never before has the private sector had to take the major responsibility for the provision of training engineering graduates. The signals sent to the emerging private sector training market are of paramount importance. Graduate engineers, industry, private-training companies and universities will need to work together in the light of these changes.

Australia is experiencing a growing shortage of graduates across the engineering, science, and technology base. For engineering, anecdotal evidence suggests that there are shortages in rail, power, software and systems engineers. Other areas have yet to be examined.

The number of enrolments, particularly in the engineering field, is declining. Commencing

student numbers in Engineering have not increased for five years. In 1998, only 7% of degrees awarded in Australia were in the essential ‘translator’ areas of engineering and technology (converting ideas into internationally competitive products, processes and services) placing Australia at the bottom of the international league. (By comparison, Finland had 26%.)

The balance between science and engineering as fields of study is also out of alignment, with Australia currently producing twice as many scientists as engineers, which is in contrast to countries such as Singapore and Taiwan, who produce more engineers than scientists.

Similarly, within OECD (1995) countries Australia produces the lowest percentage of engineering graduates and the highest percentage of biological scientists.¹ This comes at a time when we should at least be equally focused on converting ideas into products, as we are with discovering new ideas, and relates specifically to the D component of R&D, and our future capabilities and growth prospects.

If Australia is serious about developing an innovative culture, these imbalances need to be addressed. Australia needs to produce more scientists, engineers and technologists, but also monitor the ratio of graduates across these fields to ensure sufficient numbers of both generators of new ideas and translators of them into innovative commercial products for the world market. Long-term strategies need to be implemented if Australia is not to face serious skills shortages.

To increase the number of engineering and science graduates from our universities, children must be given the opportunity to develop an interest in engineering, science and technology issues throughout their primary and secondary education.

Primary school curriculum should include units that explore how science and engineering can solve the country’s most pressing social and environmental problems. Secondary schools must provide students with the potential and ambition to undertake a science/ engineering degree, with programs in Years 11 and 12 to ensure they have adequate preparation to readily progress to science and mathematics studies in the first year of university. Additionally, part of the education budget should specifically be allocated to training

teachers capable of fostering science and engineering in schools.

Current funding levels to public universities are insufficient to service increasing demand in engineering education. Since the mid-1980s (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 resources 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 already inadequate resources. 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 impacts on a university's ability to access new research partners in industry and to access outside sources of funding. These two factors place limits on the ability of universities to provide the required research infrastructure and the high standard of undergraduate teaching necessary to create the skilled workforce vital for Australia to remain a significant player in the world economy.

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. Tertiary funding must be seen through such parameters as staff student ratios, practical content in courses and access to modern technology.

Australian industry in general has a poor record of supporting engineering, science and technology education. With 64% of business R&D performed in firms of less than 500 employees, it is difficult for Australian industry to articulate its changing needs to academia. Most industry-academic liaison is on an ad-hoc, one to one basis, and is not coordinated

by industry associations or clusters of companies. Therefore, the results are mostly short term.

Cohesive industry involvement in course design and university research programs requires greater involvement and coordination by industry associations and individual businesses. Industry associations must develop ongoing liaison with key universities and become more involved in curriculum development.

References

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Footnotes

¹The Institution of Engineers Australia was first established in 1919 and was granted a Royal Charter in 1938. It now operates within the terms of the Supplemental Royal Charter granted in 1993. In March 2003 it adopted a common name, ENGINEERS AUSTRALIA.

http://www.ieaust.org.au/about_us/index.htm

Attachment 1

Engineers Australia recommendations submitted to the Department of Education, Science and Training (DEST 2002) in response to the issues paper, Striving for Quality: learning, teaching and scholarship.

Recommendation 1: Active involvement in research and scholarship should continue to underpin university teaching. Universities should look to find a balance between these endeavours, which fits within their mission statements and areas of strength or specialisation.

Recommendation 2: Where the courses are accredited by well recognised, high quality external agencies, such as IEAust accreditation program for engineering courses, this assessment should be regarded as eliminating the need for any other external assessment of quality standards.

Recommendation 3: A scheme should be implemented in all universities to provide in-service opportunities for teacher training and to actively encourage staff to attend.

Recommendation 4: Specific funding should be provided to institutions to put in place mechanisms to externally validate academic standards. These mechanisms should include the use of external examiners and international benchmarking.

Recommendation 5: A national data agency to collect and publish all higher education data on the outcomes and performance of Australia's universities and higher education providers should be created.

Recommendation 6: An external statutory body should facilitate the formalisation of credit transfer arrangements between institutions.

Recommendation 7: Engineering schools, with the support of government and industry, should establish a program to collaborate on the production of innovative engineering courseware.

Recommendation 8: The Commonwealth should act to support cooperative education programs where industry training is combined with formal degree programs.

increase funding to a level that supports a return to the student:staff ratios of the 1980s.

Recommendation 10: Given the financial pressures placed on students while studying, any review of higher education must consider new methods of student income support if conditions for effective student learning are to be created.

Recommendation 11: One-off funding allocations for universities and groups of universities to quickly update and purchase laboratory equipment to meet present or future requirements should be considered, especially where inadequate equipment is undermining undergraduate teaching.