Business R&D in Australia

The Institution of

Engineers, Australia

Submission to the House of Representatives Standing Committee on Science and Innovation Inquiry into business commitment to Research and Development

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Contact:
Leanne Hardwicke
Director, Public Policy
Institution of Engineers, Australia,
11 National Circuit, Barton ACT 2601
tel. (02) 6270 6555, fax. (02) 6273 4200
email: policy @ieaust.org.au
http://www.ieaust.org.au/

Table of contents

1. INTRODUCTION

The Institution of Engineers, Australia, (IEAust) is the peak body for engineering practitioners in Australia and represents all disciplines and branches of engineering. The IEAust has almost 70 000 members Australia wide and is the largest and most diverse engineering association in Australia. All members of the IEAust are bound by a common commitment to promote engineering and facilitate its practice for the common good. The IEAust welcomes the opportunity to make a submission on business research and development in Australia, as the inquiry addresses many important questions relevant to the discipline of engineering.

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.

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. It 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. This must be borne in mind when looking at the question of R&D.

IEAust 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 IEAust believes that business expenditure levels on R&D must increase if there is to be significant growth for Australia in the future.

With regard to inhibitors and drivers of R&D and innovation, IEAust has identified the following issues as those that need to be addressed if business expenditure on R&D is to rise in the future.

- Corporate culture
- Availability of technology resources and strategic alliances
- Finance issues
- Informed clients
- Government incentive programs
- Education and skills
- A national strategic approach to R&D

IEAust has made various recommendations for consideration under each of these headings.

2. ECONOMIC BENEFIT FOR AUSTRALIA FROM GREATER PRIVATE INVESTMENT IN R&D

It is well recognised that innovation, both technological and non-technological, is a key driver of economic growth. The innovation process includes many factors. While R&D is not an isolated activity and is a means to an end, it is an essential element of Australia's innovation system.

Technological innovation is widely viewed as a prime driver of economic growth for nations. Essential to this is a strong R&D base. As recognised by the Mortimer report "Going for Growth" (1997)[1], innovation accounts for an estimated 50 percent of long term economic growth in advanced industrial countries. The report also noted that there was a high correlation between the wealth of nations and R&D intensity.

R&D (through the innovation process), can improve efficiency and productivity, and therefore the competitiveness of industry. R&D produces new and improved products and assists companies increase their capacity to compete in domestic and world markets.

As well, R&D can provide benefits beyond that originally envisaged by the company undertaking the R&D. There is strong evidence to suggest that R&D generates positive externalities among the users of R&D throughout the economy. This is because R&D benefits firms and individuals other than the original producer. New knowledge is rarely confined to one firm. Knowledge is disseminated to other companies, and can be used repeatedly at little extra cost to the users. As well, new knowledge can be generated from the initial R&D, which can, in turn, raise the productivity of other companies, and increase economic growth. Therefore, R&D can have a permanent positive effect on the long run rate of economic growth.

It must be noted that R&D is not costless, and that every R&D project will not generate externalities. However, in the aggregate, there are significant benefits for the Australian economy if there is an increase in R&D activity by industry.

Some other factors of increased R&D activity that impact on the economy include import replacement, foreign currency income from increased exports, and direct effects on employment, education and training,

For instance, a direct impact of increased private sector R&D is on import replacement. R&D can produce cost competitive, technically comparable and equal or superior quality Australian made products, reducing the need to import products. There appears to be a lack of appreciation that expenditure saved by purchasing local products is the same as income obtained from exporting.

Well-planned and executed research, development and commercialisation will obviously generate foreign currency income to Australia from exports.

Other obvious consequences of increased R&D and successful commercialisation are:

- Increased business activity and improved employment levels.
- Increased demand for training and skills development, with a consequent increase in University and TAFE enrolments.
- Increased need for immigration by skilled/qualified persons.
- Increased conversion from low priced resource exports iron ore, aluminium, etc, into higher value added finished goods or components.

[1] David Mortimer *Going for Growth, Business Programs for Investment, Innovation and Export*, Commonwealth of Australia, June 1997

- Reduced reliance on being a cost-effective exporter of minimum value added resources in a world market where low cost exporters of raw materials are increasingly driving down our export pricing.
- Increased overall earnings, which would have a flow on effect on spending, quality of life and affordable products within our community.

3. IMPROVING BUSINESS INVESTMENT IN R&D

R&D is one part of the innovation process. There are many factors that impact on a company's ability to innovate, which, in turn, impact on a company's R&D levels. Some of these factors can be categorised as follows:

Firm based factors: Commitment from management to innovate; availability of technology resources; financial constraints.

Distributive factors: Strategic alliances, including industry/university linkages; informed clients and customers; domestic and international market for services and goods.

Framework conditions: Legal environment; government policy and programs; changes to the workforce; sufficient industry activity.

Skills base: Availability of adequate skilled staff; education and training policies.

As a contribution to the Federal Government's National Innovation Summit in 2001, the IEAust surveyed 71 companies who were awarded a National Engineering Excellence Award. The IEAust survey sought to ascertain the various impacts on the company's ability to be innovative and identifying external and internal influences on their innovation practices. The findings of the survey relate specifically to industry's ability to engage in R&D activities. Figure 1 identifies five main factors (both internal and external to the firm) that contributed to the company's ability to produce innovative products and processes over the past five years.

Figure 1 Incentives to Innovate

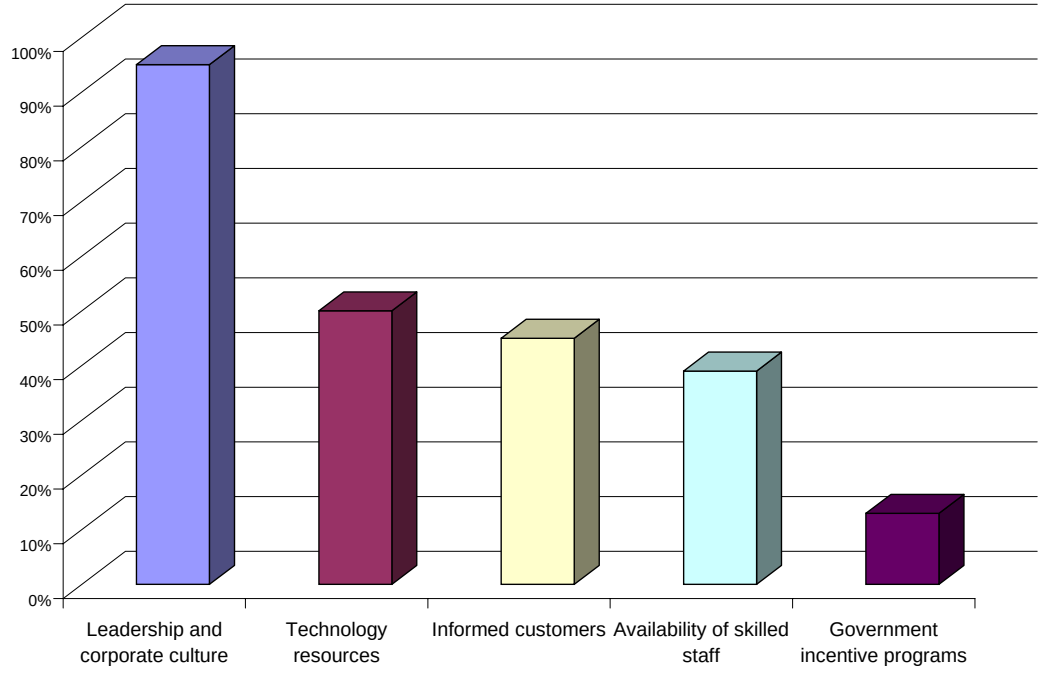
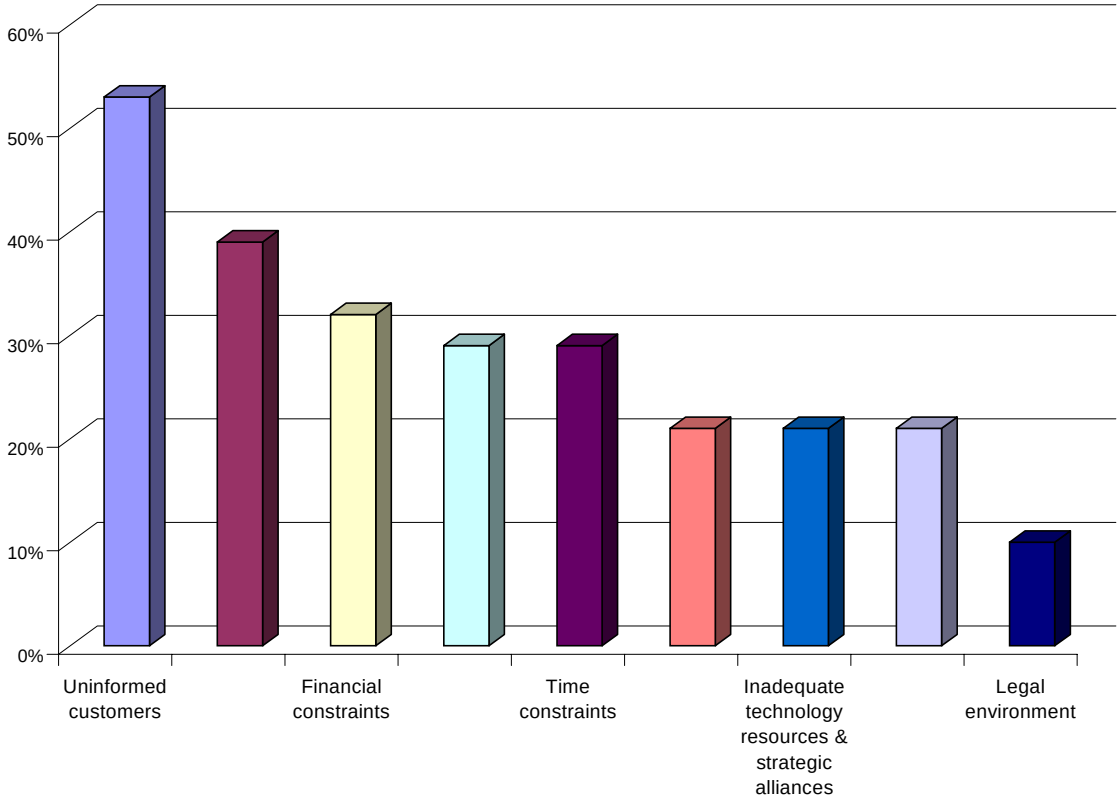


Figure 2 identifies the nine main factors (both internal and external to the firm) that negatively impacted on the company's ability to produce innovative products and processes.

Figure 2 Impediments to innovation



On the basis of the survey and other research, IEAust has identified the following issues as those that need to be addressed if business expenditure on R&D is to rise in the future.

- Corporate culture
- Availability of technology resources and strategic alliances
- Finance issues
- Informed clients
- Government incentive programs
- Education and skills
- A national strategic approach to R&D

3.1 Corporate Culture

Ninety-five percent of respondents to the IEAust survey indicated that leadership was a vital influence in a company's decision to be innovative and to undertake R&D. Respondents made unequivocal statements that leadership is required to drive and influence management culture and practices. The key issues identified as drivers of innovation in this context were:

- A corporate culture the seeks continuous improvement and excellence
- A working environment which 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
- Continuing determination by the Board to support development of new products and services

Twenty-nine percent of respondents stated that lack of risk taking and leadership within management constrained innovation. Other constraints identified included:

- Difficulty in getting effective innovation work practices in place
- Tendency to "when in doubt-don't"
- Resistance to change
- Conservative "risk" management

Innovation is obviously not simply the production of ever-new technological products. In identifying leadership and corporate culture as the major ingredient in a company's decision to be innovative, the respondents clearly highlighted this point. The 1995 Karpin Report, *Enterprising Nation*,[2] identified this issue and focussed on the need to develop an enterprise culture in Australian management. Given that leadership was so emphatically identified as the main factor influencing innovation, educators need to address this issue as part of business courses. As well, industry should encourage future potential business leaders within individual organisations.

Creating the conditions in which leaders are willing to take risks cannot be simply addressed once people are in senior management positions. Many of the attributes need to be developed earlier on in people's lives. Therefore, opportunities should be offered to students throughout their school lives, exposing them to new ways of thinking, thereby creating new conditions for this learning to occur**.**

Recommendations - Corporate Culture

- *Curriculum programs on innovation should be developed in conjunction with the teaching profession for inclusion in school programs.*
- *Business and management students should have access to basic science and technology subjects as part of their degree program.*

3.2 Availability of Technology Resources and Strategic Alliances

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 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.

[2] Industry Taskforce on Leadership and Management Skills, *Enterprising Nation: Renewing Australia's Managers to meet the challenge of the Asia Pacific Century*, Australian Government Publishing Service, 1995.

Fifty percent of IEAust survey respondents stated access to resources, including networks that provide a stimulating environment and provide information, are major incentives to innovation, and identified the following as incentives:

- Alliances, partners and technology
- Access to resources, including finance
- Availability of technology
- Investment in and utilisation of internal and external R&D
- University resources including infrastructure and equipment

Twenty-one percent stated that a lack of resources such as test facilities caused problems. They also identified the following as disincentives to innovation and R&D:

- Lack of appropriate test facilities on a specialised basis
- Limitations of development facilities
- Lacking appropriate networks
- Limited infrastructure in Australia

There are some significant government programs developed at a Commonwealth and State government level to assist with collaboration and linkage issues. One of the most successful is the CRC program, and IEAust believes that funding for this program should continue into the future. However, programs such as the CRC program generally benefit the larger companies, rather than the small to medium sized enterprise.

IEAust believes that there needs to be an increased focus on encouraging collaboration between small and medium enterprises with universities, TAFE's, and other publicly funded organisations, such as the CSIRO. Most small and medium enterprises know nothing about assistance packages for collaboration or what facilities are available within research organisations. If this collaboration was better understood and utilised by small and medium enterprises, and taken further by the universities, TAFE's, and government R&D organisations, it would be another source of income for all concerned. It would also have the flow on effect to those small and medium enterprises that benefited from the collaboration, to employ higher qualified persons, thus increasing enrolments in the Universities, and TAFE's.

Strategic linkages between organisations with complementary skills and competencies have been identified as a critical factor in successful innovation systems. Knowledge systems are, by definition, complex systems and mapping the key components of what goes to constitute a successful whole is vital in understanding the connections between knowledge workers and operational components such as design, production and marketing. In engineering companies, the vital networks required are those to do with accessing leading edge design and research skills, as well as venture capital, and export and domestic marketing. These networks facilitate both the generation of new ideas and their advancement to market.

University/industry linkages were identified as an important component of strategic alliances within companies. Industry has long argued that university research should be more clearly aligned with industry needs. Placing students into industry to specifically research current issues facing particular companies has been very successful in the UK through its Teaching Company Scheme.

Over 600 companies and all UK universities are involved in the program. Australia has a similar program in Graduate START, however, it has not enjoyed the same success due to a poor understanding of the program, and limited promotion to industry, the higher education sector and students.

Recommendations - Availability of Technology Resources and Strategic Alliances

- *Funding for the CRC program should continue into the future.*
- *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.*
- *There needs to be an increased focus on encouraging collaboration between small and medium enterprises with universities, TAFE's, and other publicly funded organisations, such as the CSIRO.*
- *Government needs to better promote the Graduate Start program, including a retitling and relaunch of the scheme as the Graduate in Industry Program. The scheme requires a national program director be appointed to oversee the promotion and monitoring of the scheme. The national program director should have responsibility for meeting such targets as ensuring that all Australian universities participate in the scheme, that there is connection with similar international schemes, and that other research institutions are made aware of the scheme to encourage participation.*

3.3 Finance Issues

It is unlikely that R&D 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 size 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.

Thirty-two percent of the IEAust survey respondents cited internal constraints such as capital availability as a constraint on innovation and R&D. They also identified the following constraints:

- Availability of external funds
- Basic capital availability
- Financial constraints
- Lack of funding from private sources

R&D projects require finance. Funds can either be raised internally, by borrowing or by raising finance on equity markets. The availability and cost of finance is a major factor affecting whether R&D is to be undertaken.

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.

Venture Capital

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.[3] 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.

Venture capitalists must provide a return to shareholders on the capital they invest and are consequently takers of minimum risk. This invariably translates to investing in projects where the research has been done (ie the company has taken all of the commercial risk) with the venture capital company willing to invest in the (D) development and commercialisation (C) stages. This is understandable, as they need to show a positive return on their shareholders and they lack the ability (in the majority of cases) to understand the science/engineering associated in the research phase.

Even after the venture capitalists consider investing in the D&C phases, they use a 20% to 25% compound growth target figure to determine if their investment will achieve their financial goals in a 2-4 year time frame, which is the maximum time they want to be involved.

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 measures 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 SME's 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 SME's, 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 for R&D.

[3] Australian Research Council, *Research in the National Interest: Commercialising university research in Australia*, July 2000, p 17.

Recommendations - FinanceIissues

- *Macro-economic policies should continue to impact on interest rates to ensure they remain at relatively low levels.*
- *Capital gains tax should be internationally comparable to retain investment within Australia, and to attract international investors.*
- *Encourage superannuation funds to play a greater role in the provision of venture capital.*
- *Consideration to be given to 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*
- *Development of a model that provides better access to funding for R&D for small business.*

3.4 Informed Clients

Informed clients were identified by IEAust survey respondents as a vital factor in encouraging innovation and R&D. In particular, government as an informed client can have a significant effect on the amount of innovation in the market place. Forty-five percent of responses to the IEAust survey indicated that informed consumers had a major influence on their company's innovative practices. They identified the following as important factors:

- Customers, including customer demand
- Clients willing to accept innovative solutions
- Access to projects requiring innovative solutions
- Knowledgable customers
- Demand for better quality and service
- Major projects that stretch the envelope

Fifty three percent of respondents stated that customers who were unable to assess the technical components of new methods or products and were therefore unwilling to investigate them, were a major impediment to their companies choice to innovate. The key factors inhibiting innovation and R&D were:

- Customers unwilling to purchase innovative solutions
- Customers 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
- Unwillingness of customers to accept alternatives

Partnerships between the public and private sectors are vital in achieving effective markets in technology services This is particularly important given the changes to the engineering workforce, via policy changes such as privatisation and outsourcing, resulting in the movement of engineers from the public to the private sector.

This has meant in the technical expertise is not located within government at a time when that expertise is increasingly important, given mega-contracts and increasing technological complexity.

Government needs to acknowledge that it can influence innovation by influencing value perception (not simply price) and should develop mechanisms for accessing technical expertise when required, within the contracting process.

Recommendation - Informed Clients

- *Government should implement purchasing processes that reward value and innovation. Client/contractor relationships should be reviewed so that, consultant selection criteria place highest weighting on innovation and expertise, rather than price alone.*

3.5 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 Backing Australia's Ability.

Thirteen percent of IEAust survey respondents cited direct government assistance as an incentive to innovation and R&D.

Respondents identified the following as useful:

- Collaborative government/industry grants
- Government incentives, including the R&D tax concession
- Finance from government schemes and rebates
- 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. Thirty-nine percent of IEAust survey respondents said that changes to government incentives such as the reduction in the R&D tax concession had affected them. They cited the following as having a negative impact on innovation and R&D:

- Reduction in R&D tax rate from 150%
- Removal of the syndication R&D program
- Insufficient R&D incentives

R&D Tax Concession

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.

A significant incentive for business to invest in R&D has been the R&D tax concession. The tax concession has been a successful measure for increasing business expenditure on R&D. It was first introduced in 1985 at 150% level, and was reduced to its current level of 125% in the 1996-97 budget. The R&D tax concession is a major component of the Commonwealth Government's support for R&D. Annually, its value is approximately $460m.

Figure 3 R&D tax concession

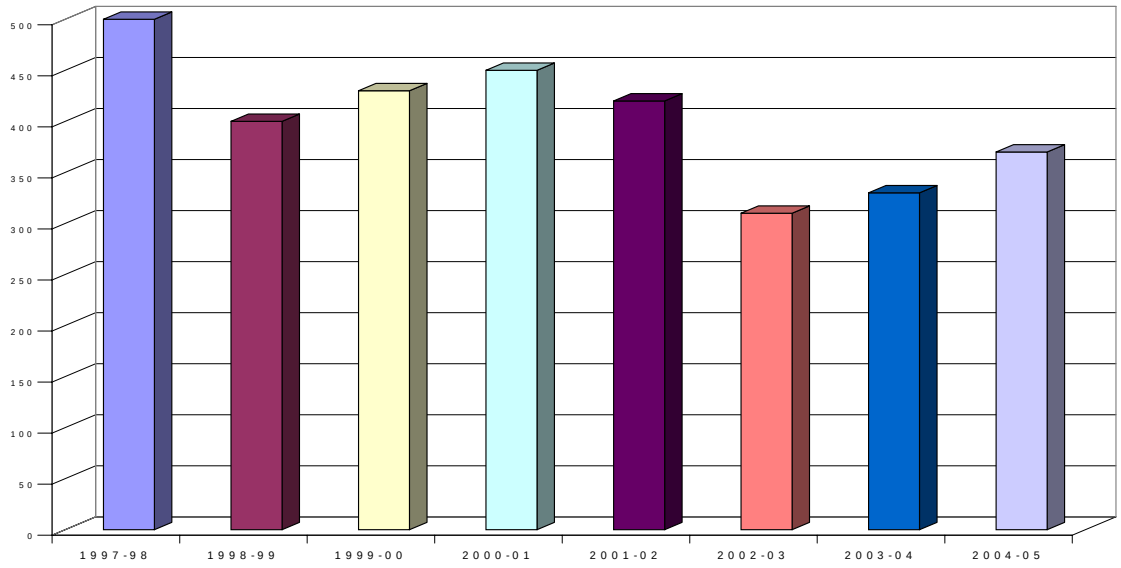


Figure 3 outlines the amount claimed and projected claims for the R&D Tax concession.[4] The highest amount claimed was in 1997-98 ($500m). 1998-99 saw a $100m drop, only rising slowly to $450m in 2000-01. As can be seen, government is expecting a drop in claims for the normal concession in the years following 2001-02. This expectation is based on the introduction of two new concessions, namely, the R&D tax rebate for small companies, and the premium tax concession for additional R&D expenditure.

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%.

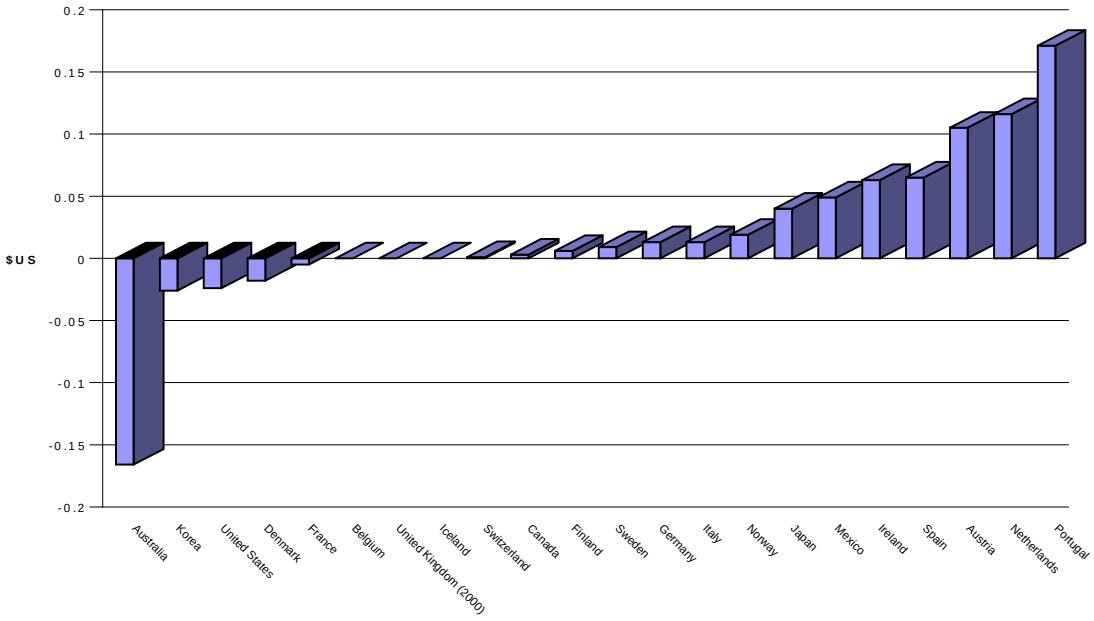
Business expenditure on R&D is low by international standards with Australia ranking 19 out of 24 international economies.[5]

[4] Department of Treasury, table 5.1 *2001 tax expenditure statements*, www.treasury.gov.au
[5] Department of Industry, Science and Resources, *Science and Technology Budget Statement 1999-2000*.

Expenditure is estimated to be 0.79 percent of GDP compared with an average of 2.08 percent for the United States, 1.22 percent for the United Kingdom and 1.57 percent for Germany.[6]

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 as Figure 4 demonstrates[7]:

Figure 3: Change in the rate of tax subsidies for 1 US dollars of R&D large firms, between 1990-1999



The competition among nations for foreign direct investment in R&D is intense. If foreign direct investment in Australian R&D is to be competitive, nationally and globally, a significantly increased R&D tax concession may be a key to efficiently encouraging investment in the sector.

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, which 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.

Measures recently introduced by government, while welcomed, have also brought with them some concerns.

[6] Australian Research Council, *Mapping the Nature and Extent of Business-University Interaction in Australia*, February 2001, p 20.
7 OECD Science, Technology and Industry Scorecard Indicator Table A.6.6

The introduction of a premium rate for R&D has raised some questions and concerns. The 175% premium concession has an element of complexity that will make it difficult to apply. One area of concern relates to its applicability to all eligible companies. If a company does not have a claims history or has not received grants, they will be unable to access the premium concession. This issue needs to be addressed so new entrants into the market are not disadvantaged.

Another area of major concern is the continual attempt to change the definition of R&D in the Income Tax Assessment Act. In 1998, there was considerable discussion about changing the definition of R&D. Changes were not made because of the strong concerns expressed by industry. In 2001, the R&D Board determined that the definition needed to be tightened, with the requirement that all claims were to meet both the "innovation" and "high technical risk" tests. The application of the exclusion list was to be extended to cover supporting R&D activities. It is pleasing to note that these changes did not take place.

IEAust does not see any good reason to change the existing definition of eligible research and development. While it could be argued that all innovation implies technical risk or that overcoming technical risk necessarily requires innovation, the distinction between the two terms in common understanding is sufficient to assist in highlighting the range of activities for which a measure of incentive is desirable. To seek to reduce that range by requiring that projects involve both innovation and technical risk is likely to have several undesirable consequences (apart from sparking a new round of definitional arguments).

For example, the suggestion has been made that software development may be innovative, but not technically risky, and would therefore be excluded by the proposed definition. Common sense indicates that software development, by virtue of the very complexity of the systems concerned, invariably involves significant levels of technical risk.

IEAust strongly recommends that the existing provision, under which projects must involve either innovation or technical risk, be retained. Engineering companies are familiar with the current definition and associated requirements and any changes would have the potential to create confusion. In legislative terms it is clear that certainty comes from dealing with and operating under a particular Act's terms. Familiarity is essentially what provides certainty.

Successful engineering companies have repeatedly indicated their preference to continuing to undertake their R&D in this country, but it is essential that they be given a clear message about its value from Government.

IEAust believes that no changes need to be made to the existing definition of R&D and urges the Government not to further erode the contribution that the tax concession through its support for innovative and leading edge companies, makes to the Australian economy.

IEAust also supports an increase in the concession for those companies that undertake R&D in areas of national priority. This concept is further discussed in section 3.7.

Recommendations – Government Incentives

- *When providing incentives for R&D, the incentives need to fit a model that targets growth.*
- *Government to continues to provide the R&D Tax concession.*
- *Incentives should be applied consistently over the long term so that business can undertake long term planning.*
- *Government must maintain the current definition of activities eligible for the R&D tax concession*.

3.6 Education and skills

Skilled labour is fundamental to R&D and education and training policies will affect the capacity of companies to undertake R&D projects. There must be a sufficient high quality skills base to draw upon and there must be a sufficient demand for education. The taxation and welfare systems can impact on the incentives to improve 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.

Thirty-nine percent of IEAust survey respondents observed that in their companies, the availability of skilled staff, both in-house and within Australia more generally was a key component for increased R&D and innovation. Specifically, they cited the following as important factors:

- Staff, including access to suitable engineering expertise
- Availability of expertise within Australia
- Broad technical support network developed in-house to pursue innovation
- Recruitment and holding staff at a high and technical range

Twenty-one percent stated that the lack of availability of skilled staff was a major problem. In particular, they found the following to be inhibitors to R&D and innovation:

- Lack of qualified/experienced engineers
- Lack of suitable graduates
- Sufficient skill base available in the industry
- Lack of experienced professionals

IEAust believes that there are areas of skills shortages in some areas at the moment. IEAust believes that 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 to "off the shelf" skills available overseas. This is especially true where there may be delayed access to such skills through local training.

IEAust believes that 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.

With regard to education policies, it is essential that the quality of graduates remains high. The current review of higher education by the Department of Education Science and Training is examining the issue of quality. IEAust has submitted recommendations on this issue, which we believe will decrease the pressure on universities, and also assist in ensuring a high standard of graduates. The basic recommendations are contained at Attachment 1. The full submission is available on our website *http://www.ieaust.org.au/policy/submissions_by_year0.html*.

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.

Programs, such as group training schemes provide a mechanism for allowing companies to share their resources, allowing graduates to move between companies gaining practical training experience. A best practice example of this the HunterNet Scheme, which was established in 1996, because the companies identified a shortage of skilled labour and recognised there were insufficient resources in small companies to provide training. The companies have all signed a Code of Ethics, and there is an agreement by companies not to make unsolicited offers of employment to any trainee not of the parent company. Government has assisted the Scheme by providing the essential administrative support to develop the network. This Scheme, designed to providing training opportunities within the private sector, should be examined to ascertain whether it can be extended to other areas throughout Australia.

Engineering, science, and technology are major contributors to the Australian economy, particularly through the contribution they make to the innovation process. Engineering provides a bridge between science and technology, and between technology and commerce. It 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. Scientific research does not by itself easily translate into technical practice.

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 countries Australia produces the lowest percentage of engineering graduates and the highest percentage of biological scientists.[8] This comes at a time when we should be 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 curriculums 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.

IEAust takes the view that current funding levels to public universities are insufficient to service increasing demand in 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 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.

[8] OECD 1995, Education at a Glance

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.

Recommendations – 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 business skills migration scheme cannot be seen as an alternative to educating and training a highly skilled Australian workforce.*
- *Retain the quality of higher education graduates by implementing the recommendations outlined in Attachment 1.*
- *Government education policies must clearly focus on engineering in a similar fashion to the current focus on science.*
- *Develop programs to increase the number of engineering and science graduates, ensuring that the ratio between the two is balanced.*
- *Specifically allocate part of the education budget to training teachers to foster engineering and science in primary and secondary schools.*
- *Increase funding to public universities to secure a strong skills base.*
- *Facilitate industry involvement in course design and university research programs.*

3.7 A Strategic Approach

A fairly substantial proportion of Australia's R&D occurs in the manufacturing sector, and this is concentrated in the medium-low and low-tech sectors of manufacturing. The current small size of the manufacturing sector, and the focus on medium and low-tech manufacturing are factors that act as barriers to an overall increase in business R&D in Australia. Australia's R&D performance in medium-high tech industries remains poor by world standards.[9]

In creating industries into the future it will be important to assess the viability of growing industries which will return opportunities both in growing wealth and employment. Government has recently done this in allocating resources to the biotechnology and information technology sectors.

[9] House of Representatives Standing Committee on Industry, Science and Resources, The Effect of Certain Public Policy Changes on Australia's R&D, August 1999, p 21

It is IEAust's view that Australia needs a long-term technology plan, which should include a comprehensive statement of national priorities for science, engineering and technology research.

Australia needs to be "competitive" as compared to other nations. To do this, Australia must produce a high and rising standard of living for its citizens through national productivity gains and a continual upgrading of itself. Some analysts have taken the view that this means all Australian industries must be competitive. IEAust believes that it is unnecessary and unrealistic to expect every industry to be competitive for Australia to be considered competitive in the world market. Rather, Australia's competitiveness depends on the success of particular industries or technologies.

Governments have focused on the drivers of competitive advantage, namely the macroeconomic environment, education, taxation and financial regulations, which provides the environment for companies to become more innovative. However, it is IEAust's view that clear signals must be given to industry that there are areas of activity where Australia is able to gain a present and future advantage. This approach will provide guidance to business on areas of strength and potential market opportunities, will improve business cooperation, promote risk sharing, and make business and government take an active part in addressing the changing global environment. This approach will also provide industry, market analysts and investors with greater confidence to invest in R&D, particularly for high-risk technologies.

It is IEAust's view that one of the key determinants of establishing and maintaining a competitive advantage is a very focused R&D program. While increased R&D expenditure may be needed, it is IEAust's view that it is just as important to focus on where that expenditure is occurring. Australia's research effort is thinly spread across a wide area, which can be directly attributed to market driven R&D activity and the approach by Governments and major research agencies to encourage innovation in all sectors.

The predominant view has been that it is better to allow the market to determine priorities. However, this can and does result in low returns due to the small scale of the investment.

There is also an often-expressed point of view that the only way to successfully pick winners is ex post, and that government cannot pick winners even at a sectorial level. Rather, winners will emerge in all sectors and will tend to be at the firm, rather than at an industry level. This may be true to an extent, but we also need to recognise that there are risks associated with this approach, and low levels of business R&D is one of the indicators that this approach is not as effective as it could be.

Given its size and limited resources, Australia should not be aiming to be globally competitive in all sectors. IEAust does not believe Australia has the luxury, as a small global player, to spread its research efforts so widely. Australia can no longer try to be competitive in all industry sectors, as this will lead to fewer results in the short to medium term.

R&D is an essential contributor to our social, environmental and economic future. Because of Australia's small economy, and consequently the problem of achieving economies of scale in R&D, it is essential that we address how best to allocate R&D funding.

To achieve competitiveness at a national level, Australia must build on the base of well-established industries and institutions to determine where our core competencies are located. There is a much greater likelihood that Australian industry will achieve breakthroughs or innovations of strategic importance where there is a more focused approach.

With the exception of a few areas such as biotechnology and ITC, and more recently, the priorities set for a portion of the ARC funds, Australia remains without a government-endorsed comprehensive statement of national priorities for science and technology. IEAust recognises and fully supports current government actions to set priorities for a proportion of government science bodies, and this will make a great contribution to a national approach. However, if this exercise is not expanded to industry, it will not be a truly national approach.

IEAust recommends that government consider applying priority setting for incentives for business R&D as that being undertaken for public sector research agencies. IEAust is not recommending a lessening of funds for existing R&D support programs, but rather, increased incentives to businesses that undertake R&D in areas identified as national priorities. This could occur through the R&D tax concession, for instance, by allowing a 200%-250% concession or by additional funds being provided under the R&D Start Program, which has proved to be very popular and successful.

The nature of industry research would necessarily need to focus on applied rather than basic research. Applied research is original work undertaken to acquire knowledge with a specific application in view. Basic research is good for science, as it allows us to broaden our knowledge base and increases our understanding of natural processes. However, it is not as good for technology, as there is too little focus on translating this knowledge into outcomes.

The priority process could also concentrate on experimental development. That is, using existing knowledge gained from research or practical experience that is directed at producing new materials, products or devices, installing new processes, systems or services or improving or substantially those already produced or installed.

It is clearly outcome driven inquiry that will be most advantageous to business and will provide more incentive for business to undertake R&D.

Recommendations – A strategic approach

- *Develop a long-term technology plan for Australia, which should include a comprehensive statement of national priorities for science, engineering and technology research.*
- *Apply a priority setting for incentives for business R&D similar to that being undertaken for public sector research agencies.*
- *Do not decrease funds for existing R&D support programs when implementing the priority process.*
- *The priority process could be delivered through the R&D tax concession by allowing a 200%-250% concession or by additional funds being provided under the R&D start program.*
- *The priority setting process should focus on applied rather than basic research, and on experimental development.*

Attachment 1

Institution of Engineers Australia recommendations submitted to the Department of Education, Science and Training 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.

Recommendation 9: The Government should 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.