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## **SUBMISSION TO THE REVIEW OF HIGHER EDUCATION IN AUSTRALIA**

The Australian Academy of Technological Sciences and Engineering (ATSE)<sup>1</sup> welcomes this opportunity to provide input to the Review of Higher Education. This is the latest in a number of reviews of the higher education sector over the past two decades, the most recent having taken place in 2002<sup>2</sup>. ATSE believes that the current Review is of particular importance, and wants to see it lead to carefully considered evidence-based changes that are of lasting significance.

### **Summary of ATSE's comments**

#### **ATSE:**

- believes that to be competitive, Australia needs to match or exceed the relative investment levels in higher education of other developed countries;
- sees the increase in university student to staff ratios and over-reliance on student fees, as a threat to the quality of university teaching and research in Australia;
- believes that the case for a sustained increased public investment in higher education is strong and compelling;
- urges a significant reduction in the regulation of higher education student enrolments and fees;
- wants more action to address shortages of science and engineering graduates;
- wants major new measures to increase Australia's level of post-compulsory qualification to that of comparable OECD countries;
- believes that the best way to ensure the quality of student experience in Australia's higher education is to provide adequate funding for teaching;
- supports the concept of VET and higher education having distinctive missions;
- wants academics who get involved in applied research to be appropriately recognised;
- urges funding and resource recognition of community engagement and knowledge transfer as components of higher education's core activities;
- recommends support for a range of collaboration mechanisms between higher education and business;
- advocates a number of improvements to the role and operations of AUQA; and
- provides some suggestions for ways in which higher education in the applied sciences, technologies and engineering could be improved.

<sup>1</sup> ATSE was established in 1975 with the mission to promote the application of scientific and engineering knowledge to the future benefit of Australia. ATSE is one of four learned national Academies, which have complementary roles and work together both nationally and internationally. ATSE has about 750 elected Fellows who are the leaders of applied science and engineering across the country. ATSE is comprised of experts from a diversity of professions many of whom have been consulted on this submission.

<sup>2</sup> Australia. Commonwealth Department of Education, Science and Training (DEST) (2002, April) *Higher Education at the Crossroads, Ministerial Discussion Paper*, Canberra: DEST; and (2003, May) *Our Universities: Backing Australia's Future*, Canberra: DEST Higher Education Consultancy Group.

### ***Introduction***

It is important that this Review is thorough and comprehensive. ATSE believes that this Review must have wide-ranging impacts at national, state, community and individual levels. Effective implementation of the Review recommendations will be just as important as determining the content of the recommendations. The Review is also expected to result in changes to the funding of higher education and influence cooperation between higher education institutions. It is therefore important that stakeholders are given opportunities not only to provide submissions but also to comment on the draft report of the Review. It is important that the final report of the present Review includes realistic estimates of the often considerable costs of implementation of any changes and that additional funding is provided for this purpose. This has not been the case in previous reviews, slowing their implementation.

ATSE considers that Australia's sustained economic growth and social development will increasingly be dependent on national investment in innovation and skills formation. *To be competitive, Australia needs to match or exceed the relative investment levels in higher education of other developed countries.*

ATSE argues that Australia needs to adopt strategies that will ensure a supply of well-educated and knowledgeable scientists, engineers and technologists. Shortages of engineers and technologists will limit our ability to benefit from innovation. *ATSE is concerned that university student to staff ratios have increased. Together with an over-reliance on student fees, this poses a threat to the quality of teaching and research provided by our universities.* There are also serious concerns about the lack of up-to-date infrastructure, particularly in engineering schools, for developing practical competence. ATSE considers that increased government and corporate sector support for cooperation between business and our universities could greatly assist research, teaching and learning, innovation, community engagement and knowledge transfer in Australia. New approaches are needed to encourage this.

Australia's higher education institutions should be funded to pay internationally competitive salaries to their staff. In addition, more consideration needs to be given to career pathways for our academics. These considerations will become more important as demographic factors impact of Australia's academic workforce.

### ***Functions and objectives***

ATSE would welcome an explicit statement that one of the objectives of higher education in Australia is to strive for excellence and aim to achieve world-class standards. ATSE welcomes the recognition of the importance of university research, alongside teaching, knowledge sharing and community engagement. ATSE has a particular interest in:

- encouraging students to study science, technology and engineering;
- research;
- the training of technological leaders and innovators; and
- the transfer of technology and knowledge between the higher education sector and business and industry.

Section 1.3 of the Review Discussion Paper should include, as its first point, "Provide intellectual leadership to the nation". ATSE would be concerned if the order of the list in this Section was taken to imply any ranking of the different capacities of the system.

The current ordering certainly does not reflect ATSE's view of the relative importance of these capacities.

### ***The importance of higher education***

*ATSE believes that the case for public investment in higher education is strong and compelling.* Section 2.1 of the Discussion Paper understates this case. For example, it does not reflect the indirect economic impacts nor does it provide information on the sector's contribution to Australia's GDP and our overall intellectual capacity, of which an important component is our skills base.

Higher education builds upon earlier stages of education and must therefore be closely linked to these earlier stages. It must also link with vocational education and training (VET), particularly where there are opportunities for students to move between VET and universities.

ATSE is concerned at the bureaucracy and constraints which the previous Government placed on the determination of student numbers and fees. The Australian higher education sector appears to be very over-regulated at the input level, with inadequate emphasis on performance reporting and outcomes.

In Section 2.3 the Discussion Paper rightly highlights the role universities play in development and dissemination of knowledge. What is missing is the emerging role they have played in establishing new businesses either directly or through their association with Cooperative Research Centres (CRCs). There are notable successes already (Cochlear, ResMed, Melbourne IT, etc.), but in comparison to USA and UK experience much more could be done.

While recognizing that the uptake of research often takes place through existing companies, ATSE hopes that the Review will recommend mechanisms that will encourage the creation of new companies based on university research. This will require closer partnerships with seed capital providers, a flexible approach to employment of people who might move out into the new venture but require a safety net to return in the event of failure, and an enlightened approach to IP management.

### ***Skills market issues***

*ATSE is concerned at the shortages of graduates in science, engineering and technology currently being experienced by some sectors of the Australia economy. While the new government has taken some steps to address this problem, more needs to be done at the secondary level to ensure that future shortages are averted.* Australia needs enhanced consultative mechanisms to provide business input on skills needs, to help identify emerging shortages and to advise on early remedial action.

A major investment is required in the area of matching student capabilities and interests with future employment opportunities. Far too often tertiary study options are based on tertiary entrance rankings (e.g. a reluctance to undertake a course with cut-off well below what had been achieved) and fashion (forensic science, media studies etc) rather than a considered analysis of demand and vocation. Delaying the time when a student needs to make a firm decision of their specific field of study (a feature of the new University of Melbourne model) may, in some cases, bring the advantage of better self-realisation of interests and a shorter period between when opportunities and interests come together for students taking decisions on their future. The problem is particularly

severe in engineering where only a little over half of students commencing engineering actually graduate.

Better information on the current and likely future demand for skills should be available to the higher education sector, both to identify and address the nation's capacity requirements in different sectors and to better advise students of their options. While some higher education institutions may focus on local and regional needs, others will take a national view. All should be free to select their own course profile and funding mechanisms need to be developed that encourages particular institutions to build on what they do best rather than feel compelled to offer a bit of everything to maximise their market appeal.

Where governments (state or federal) identify special needs and want the sector to establish or maintain courses that would otherwise not be viable, they should provide additional funding. This is particularly the case for state and territory governments, whose direct financial interest in university education is minor when compared to the Commonwealth Government, and when compared to the VET sector with its joint funding. Collaboration agreements between universities and state/territory governments, as exist in Tasmania and the Northern Territory, should be encouraged.

In considering the issue of special needs, it is important that developing areas of Australia be supported. The Universities of Newcastle and Wollongong, now almost forty years old, have played a significant role in regional development. Some of the newer universities, created in the last twenty years, are now gaining the competence and reputation in teaching and research to enable them to be effective local drivers. They deserve the support of all levels of government.

*Australia's low level of post-compulsory qualifications is a cause for concern. Australia should aim to match or exceed the higher education attainment levels, as a percentage of the population, comparable with leading OECD countries.*

A critical problem in meeting future demands for skills starts in the schools, with far too many university entrants unable to seek places in technology oriented courses due to their having opted out of science and mathematics subjects after Year 10. The recent Review of Engineering Education<sup>3</sup> gave high priority to this problem. Current programs addressing this issue touch only a small proportion of students. ATSE is piloting a school program called STELR (Science and Technology Education Leveraging Relevance), which uses various small-scale renewable energy technologies in a laboratory setting to illustrate basic scientific principles. The main aim is to have secondary students retain an interest in science and mathematics by seeing it used in a practical manner in an area of interest to them. At the same time, STELR challenges students to think innovatively. More of these sorts of programs are required to inspire Australian secondary school students to continue their science studies at university. Such programs cannot be undertaken by the universities alone — they require partnerships and funding to make the partnerships work.

ATSE believes that postgraduate coursework programs provide an ideal way for graduates to update and upgrade their knowledge. The provision of these courses,

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<sup>3</sup> Carrick Institute 2008, Addressing the supply and quality of engineering graduates for the new century available at:  
[http://www.altc.edu.au/carrick/webdav/users/siteadmin/public/Grants\\_DBIprojec\\_engineeringquality\\_project%20report\\_25march08.pdf](http://www.altc.edu.au/carrick/webdav/users/siteadmin/public/Grants_DBIprojec_engineeringquality_project%20report_25march08.pdf)

particularly to mature age students, should be encouraged by the Commonwealth Government and should be supported by the corporate sector. *Formal Masters degree courses in engineering and the technologies are a significant way of keeping applied scientists and engineers current and providing a mechanism for quickly filling skills gaps.* In no longer providing government support for these and placing the financial burden solely on students, Australia lost what in the past has been a very useful way of enabling graduates to embrace new technologies and emerging interdisciplinary fields without introducing overly specialised undergraduate programs. Past very successful examples included environmental sciences, biotechnology, safety engineering, and petroleum engineering. Such courses are also highly attractive to international students and will continue to be so when the demand from overseas for undergraduate programs declines with the emergence of more places in quality Asian universities.

### ***Disadvantaged group participation***

In ATSE's view, the provision of higher education to Indigenous and low SES students need to be considered separately. Many of the issues that need to be addressed for these two groups are very different. While income support is critical to both groups, the issues for Indigenous students go well beyond this. Indigenous education needs to include education about Indigenous culture as a component of encouragement for widespread learning about, access to and research in Indigenous culture. The experience of Batchelor Institute for Indigenous Tertiary Education and of other universities with significant Indigenous enrolments has demonstrated that traditional universities are alien to Indigenous cultures. In determining directions for Indigenous higher education, the experiences of these institutions should be taken into account.

Increased participation in higher education by both Indigenous and low SES groups requires more attention to the primary and secondary education of these students. Government needs to take the lead in adopting policies to increase Indigenous and low SES higher education participation rates though both secondary and tertiary education, and providing specific funding so that the higher education sector can play a bigger role in addressing this issue. The higher education sector can do more to help to raise the Year 12 completion rates of indigenous and low SES Year 12 students, but is not currently funded to do this.

In ATSE's view, the Universities Australia study<sup>4</sup> that found one in six full time undergraduate students worked more than 20 hours per week during semester, provides substantial evidence of inadequate income support.

ATSE also draws attention to the effectiveness of industry-university scholarship programs that include some practical experience and a reasonable stipend in providing opportunities to good students from regional and remote Australia. As graduates these are exactly the people who are frequently willing to staff major resource facilities in remote locations. Securing appropriate tax support for such schemes should be a priority.

### ***Quality outcomes***

Quality of student experience and quality of outcomes are difficult to measure. Student course experience questionnaires have been a traditional source of feedback but it is not clear how much value they are. Many students complete them at the end of their course and have no incentive to be diligent in their comments, because they will personally not

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<sup>4</sup> Universities Australia 2007, Australian University Student Finances 2006: Final report of a national survey of students in public universities, Universities Australia, Canberra, August,

be affected. Further, they are rarely told if there was any follow-up on what they have said.

ATSE views declining staff-student ratios in Australia's universities over the past decade with concern. Australian universities must be funded to offer a quality learning environment if they are going to provide the graduates which our economy needs and, in addition, continue to attract international students. While the use of web-based teaching material has provided some offset to the declining numbers, large tutorials and difficulties in arranging personal contacts for those experiencing problems is making it difficult for the less capable students.

*The best way to ensure the quality of student experience in Australia's higher education system is to provide adequate funding for higher education teaching, research and for a range of community engagement and knowledge transfer activities.* In particular, this requires the full funding of research costs, eliminating cross subsidisation of research from teaching and other revenue sources. Quality assurance in the higher education sector should be more outcome-oriented.

Much more could be done to promote best practice in the system by blind assessing selected exam papers across institutions. This would also have the advantage of ensuring standards for honours were consistent across the system. (Within the same institution, checking how current standards compared with past decades can also be useful in this regard). For accredited courses such as engineering, accrediting bodies might need to give consideration to including more quality, rather than confining themselves to content assessments. Alumni groups could be enlisted to provide advice from their members as to how they value the quality of what they have been taught a few years after graduating. None of these in themselves will give a comprehensive quality assessment, but collectively they could paint a better picture than is available currently.

ATSE is also attracted to the professional associations having a more formal role in ensuring the quality of higher education programs for Australia's technical institutions. Of the thirty disciplinary areas that fall within the area of interest to ATSE, many have viable and active groupings (e.g. Engineers Australia, RACI etc) that accredit higher education programs. Most have strong links to the international professional community. By providing some government support and using them more effectively (a role that ATSE could facilitate) quality monitoring in the technologies and engineering could be effected. Further comments on quality assessment (via AUQA) are given on Page 12 of this submission.

### ***Higher education and VET***

*ATSE supports the concept of VET and higher education having distinctive missions and many employers of VET graduates would be very concerned if this distinction was not preserved.*

There is value in seeking to ensure that higher ability students achieving VET outcomes can articulate into higher education courses. Encouraging such movement can help to providing needed skills. Some universities do this well and make it a feature of their offering to students. They should be encouraged, and additional institutional support should be provided so that they can assist students to successfully cross this bridge.

Often neglected and perhaps even more important is the articulation from university into VET. For many positions in industry those graduating from the higher education lack employability skills and can benefit from additional vocational training. VET marketed as a postgraduate qualification would have the additional benefit of lifting the relative esteem in which the community holds the sector. VET providers need to be encouraged to make better provision for this type of articulation, particularly in determining credit allowed. They also need to more overtly provide a safe haven for those dropping out of higher education due to failure or lack of enthusiasm.

In ATSE's view, relative provision between the higher education and VET sectors should be demand-driven and recognising the need for Australia to significantly increase its level of post-compulsory qualifications.

Regarding technological training, ATSE sees benefit in specialist cutting-edge infrastructure in technological areas being established for shared use in higher education and VET programs. The Science Industry, for example, is quite keen to support such a development in Melbourne so that advanced micro-manufacturing skills can be taught. A mechanism is needed to fund such infrastructure.

### ***Higher education and the National Innovation System***

Please see our submission to the National Innovation System Review (attached). For some higher education institutions, research is less important than teaching. Where staff in these institutions wish to undertake research and where they have the demonstrated capabilities, they should be encouraged and, where appropriate, assisted to access research facilities elsewhere.

*ATSE would welcome new government incentives to encourage greater links with business and industry.* ATSE supports ARC Linkage and the CRC Programs but would like to see the introduction of an intermediate measure that requires less commitment than a CRC while providing more assistance than currently available under Linkage.

ATSE believes that academics who get involved in applied research should be appropriately recognised. Publications should not be the only pathway to success. The impact of research in the higher education sector needs to be a factor in determining institutional funding and individual promotion. In particular, applied research, which is central to the Government's innovation agenda, needs to be valued and rewarded. Not all researchers are skilled in bridging the interface between the higher education and private sectors. Those who do it effectively should be recognised and rewarded. This is only possible if the impact of their efforts is taken into account because involvement in such efforts is likely to reduce publication rates in high impact journals.

With the recent focus on assessing research quality ATSE has become aware that there is a shift occurring in some institutions in regard to recruitment of engineering academics. It seems that the ability to write academic papers is being given preference over industrial experience. If this trend becomes universal it will have disastrous consequences in respect to the production of work-ready engineers in the future. Some of the best engineering schools overseas have a requirement for industry experience for all senior staff they recruit. ATSE realises this is impractical in Australia but would be alarmed if other pressures on universities resulted in active discrimination against practitioners.

### ***Higher education funding arrangements***

ATSE particularly welcomes recent comments by the Minister for Innovation, Industry, Science and Research that Australia has lost ground in the higher education sector. As Minister Carr noted, “Public funding for tertiary education fell 4 per cent in Australia between 1995 and 2004, compared to an average rise of 49 per cent across the OECD. We were the only OECD country to cut the total level of public funding for tertiary education during that time. The steady growth in research degree commencements we saw in the eighties and early nineties has collapsed in the last decade. Our OECD ranking on research collaboration between industry and universities has gone backwards. Our count of PhDs in the workforce is less than half the World’s best. And we aren’t just competing against developed countries anymore. The explosion of R&D investment in China and India is transforming the global innovation landscape”<sup>5</sup>. The Government should recognise that additional funding is essential. ATSE believes that the Government should see higher education funding as an investment rather than a cost.

*The funding arrangements for higher education in Australia are unnecessarily complex, provide inadequate levels of public funding and are overly reliant on student fees. There is a need to recast government funding formulae in the interests of transparency and accountability.* The funding provided to Australia’s universities needs to fully cover:

- teaching;
- research;
- research students;
- the indirect costs of externally funded research;
- knowledge transfer; and
- community development and outreach.

ATSE supports funding being linked to agreed individual missions and outcome targets for succeeding years. Recognition and rewards to staff needs to be aligned to teaching, research, community engagement and knowledge transfer activities.

The Commonwealth Government contribution to teaching should be provided on a formula basis, with funding which recognises the differences in the cost of delivering different courses in different locations to students with different backgrounds. At a minimum, the shift of higher education costs from the Commonwealth Government to students should be reversed to reflect the original balance at the time that HECS was introduced.

There is some evidence that as Australia’s international student numbers started to grow, they have absorbed marginal capacity and provided a valuable source of external income. In some higher education institutions much of the spare capacity is now fully utilised. The higher education sector is experiencing difficulties in providing additional facilities to accommodate current student numbers with many buildings needing refurbishment or replacement. Whilst higher education is an important export earner, this income should not continue to be used to offset reduced public funding or to be seen by the institutions as a major funding source for survival and refurbishment of buildings.

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<sup>5</sup> Senator the Hon Kim Carr, address to the International Symposium on University Costs and Compacts, Canberra, 14 July 2008.



ATSE notes recent comments by Minister Carr on compacts<sup>6</sup>, in particular that he expects them to accelerate cultural change, trigger structural reform, and increase international competitiveness. ATSE supports the Minister's view that Australia needs to get the best possible value for the public's money – we are a small country with finite resources, and we must use those resources effectively. The Minister also noted that compacts will help establish local and institutional priorities. They will allow each higher education institution to shape its own research agenda, consistent with the mission it negotiates for itself. ATSE welcomes the Minister's statement that compacts will also give universities more autonomy and increase diversity across the sector. However, such compacts will only work if they recognise the distinctive missions and interfaces of our higher education institutions, VET and schools and are totally transparent.

Research grants from competitive funding sources, including the ARC and NHMRC should cover all direct costs. Indirect costs should be fully met on a formula basis though a block grant program. These changes should be implemented immediately. The backlog in estate maintenance should be addressed through specific provisions in the proposed compacts.

Higher education institutions are not currently funded to undertake some of the community engagement and knowledge transfer activities<sup>7</sup> described as core functions in Section 1.2 of the Review's Discussion Paper. In ATSE's view, the UK experience demonstrates the value of providing separate funding for these activities. Australia should draw on that experience and, in doing so, recognise the many possible community interfaces and those particular to each institution.

In any new funding system it will be important to recognise the higher cost of quality teaching in the technologies. Tutorial work and laboratory classes are an essential part of technological programs. The current funding model fails to adequately recognise that technologies and engineering need access to large scale facilities if realistic laboratory work is to be undertaken. ATSE supports Universities Australia's National Internship Scheme or some similar form of university- industry partnership as a means of facilitating this. There have already been some interesting initiatives in this direction, an example being the establishment of an experimental coal mine in the Hunter Valley where mining engineering students gain practical knowledge of long wall soft rock mining.

### ***International issues***

ATSE strongly supports increasing international science and higher education links as a very effective way for Australia to build relations with fast growing economies in the world. Research cooperation and educational exchanges at undergraduate and postgraduate level are effective means of building relationships with these economies. Australia is well placed to continue to provide higher education to students from fast growing economies in the Asia Pacific region. Such higher education links can lead to mutually beneficial business and intergovernmental relationships for many years after.

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<sup>6</sup> Senator the Hon Kin Carr, address to the International Symposium on University Costs and Compacts, Canberra, 14 July 2008.

<sup>7</sup> Community engagement and knowledge transfer includes contributions to developing and maintaining a civil and sustainable society and building the national economy and regional economies within Australia as a major knowledge-based industry in its own right

In ATSE's view, the Review Discussion Paper does not adequately recognise the leading role of Australia's universities have taken in internationalisation and globalisation. From their establishment, Australian universities have recruited internationally and participated in international exchanges of researchers and students.

ATSE supports using international benchmarking as a tool, while not wanting to be overly driven by the rankings. Australia should aim to have a world class university system. The Australian university system should comprise institutions in the top league in several categories:

- large comprehensive universities with wide ranging research strengths;
- smaller niche universities;
- universities that are key drivers of growth in their region;
- technological universities; and
- universities delivering to distance students.

In the first category listed above, Australia should aim to have at least four universities in the top 100 Shanghai Jao Tong University ratings. Achieving this aim will attract students, researchers and research-intensive industries to Australia. In addition, because rating schemes such as this are mainly relevant to multidisciplinary institutions, Australia should support the development and use of rating scales for major disciplinary areas, thus enabling the identification of universities with world-class specialisations.

A strong, diverse university system will demonstrate to the rest of the world Australia's commitment to scholarship, cultural and educational achievement and research. Failure to increase Australian investment in education will see other countries in the Asia Pacific region overtaking us in standing and the quality of their higher education facilities.

Australia should be providing more scholarships to attract top quality students from the Asia Pacific region. Many of these will return to their countries to become future political and business leaders. Australia's experience with the Colombo Plan demonstrates the benefits from such a strategy. Many of the highest achieving foreign students should be encouraged to remain in Australia and help in further building our intellectual capital. Immigration regulations which discourage this should be removed.

ATSE draws the Review's attention to the particular issue of postgraduate students in engineering and other technology disciplines. A very high proportion of postgraduates are foreign students with no entitlement to permanent residence in Australia. This is partly a consequence of insufficient local graduates aspiring to undertake postgraduate study but it does have implications for Australia's future research performance and academic recruitment. Some consideration as to how residency status can be linked to postgraduate study progress might address what is seen to be a serious emerging problem as traditional sources of postdoctoral staff become harder to access due to the rate of economic growth in their home countries.

Australia currently derives substantial service sector income from the Asia Pacific region. Higher education programs should be appropriately internationalised to ensure that graduates are able to function effectively in overseas environments. Having overseas students studying in Australia helps in breaking down cultural barriers, but some curricula need to be internationalised. Further, Australian students should be encouraged to contemplate exchange periods at leading universities in our region, not just in the USA or Europe. Many now offer instruction in English.

ATSE believes that international students that graduate from Australian universities institutions should be fluent in English. International students undertaking Masters and PhD studies need a minimum average IELTS score of 6.5 and a minimum score of 6.0 in writing. Universities that accept graduate students with lower IELTS scores than this must be willing to provide the tuition necessary to achieve these levels before studies commence.

In ATSE's view, the best way that governments can help the Australian higher education system to further internationalise is to ensure that our facilities in this sector are world class.

### ***Community engagement and knowledge transfer***

The Australian higher education sector contributes to Australia's economic, social and cultural development. Our different universities each make their distinctive contributions. With the provision of specific funding, this contribution could be significantly enhanced.

*In ATSE's view community engagement and knowledge transfer activities should be encouraged through separate funding along the lines of the UK's Higher Education Innovation Fund.* ATSE notes that small and medium enterprises (SMEs) are major beneficiaries of the UK scheme. In addition, this scheme helps universities to contribute across other interfaces, including schools and public bodies.

A major stumbling block to overcome is the need to better recognise community engagement and knowledge transfer activities in staff performance appraisal and promotion. Academic staff need to be encouraged to see that supporting community development ranks alongside research and teaching when it comes to rewards and prospects.

ATSE supports the Australian Vice Chancellors' Committee 2006 statement, cited in the Discussion Paper, on knowledge transfer as a key role of higher education institutions. While such activities may result in revenue flows to the higher education sector, this should not be their primary objective.

### ***Governance***

ATSE supports the creation of a 'buffer body' (but dislikes this terminology). A small statutory authority at arms length from the bureaucracy should provide publicly available evidence-based advice to the responsible Minister, and manage the funding of the higher education sector.

As noted above, the Government intends to fund universities through 'compacts'. These agreements are going to take time to negotiate so steps are needed to streamline the process and recognise the diversity of the student intake, the range of programs, the range and depth of research activity and the diversity of community interfaces. Universities should be rewarded for the outcomes that they achieve. The sector should develop a standard set of verifiable performance indicators that could be included in the compacts. Some performance indicators may not be applicable across all institutions.

The level of regulation of the higher education, especially at the input level, should be the minimum to ensure accountability and transparency. Some parallels are seen with how public companies are regulated in Australia, allowing considerable freedom to operate

within a set of clearly defined conduct and accountability guidelines, with sanctions applied for breaches.

Now that the first round of Australian Universities Quality Agency (AUQA) audits has been completed ATSE believes there should be a shift in emphasis from the past focus on process to providing more emphasis on outcomes. More importance should be given to the institutions' internal audits. These are generally believed to be very valuable as they allowed identification of problems in a methodical way and corrections to be initiated, usually independently from the external audit. Future AUQA audit rounds should see an update of the portfolios but a main focus on identified risk areas. This updating process should be less resource-intensive — a major criticism to date has been the costs entailed in the whole audit process.

Future AUQA audits need to avoid some of the criticisms of the first round, where many formed the conclusion that AUQA had some idealised model in mind for how the policies and procedures in a university should operate, drawing up a list of commendations when they satisfied this ideal and providing recommendations when they did not.

*ATSE's suggestion to the Review is to recommend an entirely different approach by AUQA.* While it is necessary to undertake process audits these should be labeled as such and become only a minor part of future activities, focusing on risk and on the problem areas identified in the first round. The main activity could become total system disciplinary reviews. However before adopting this suggestion it would be necessary to analyse the benefits and disadvantages of the system of discipline reviews that were undertaken in the mid-1980s.

This change would mean adopting an approach similar to that of the mid-1980s, where each year a small number of disciplines (for instance all medical faculties or all architecture schools) would be selected to be reviewed to determine whether, as a whole, the needs of the profession(s) they service were being met. This would mean audit panels could be structured to bring the required professional expertise, including the need for representation from employers of graduates and the sponsors of university research. Satisfaction surveys of employers could be commissioned, employability of graduates assessed and adequacy of overall numbers determined. If this revealed some institutions were performing better than others, AUQA should not be frightened to say so. After all, there are any number of ranking processes already taking place using far less information than would be available from this process.

Higher education governance should be covered by the performance indicators referred to above. In their financial stewardship, Australia's universities should be encouraged to become more business-like. ATSE itself has much in common with a higher education institution and has recently changed its governance arrangement to address exactly the same types of problems faced by large university councils/senates with designated representative members. Modern governance calls for smaller governing bodies.

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## **SUBMISSION TO THE REVIEW OF THE NATIONAL INNOVATION SYSTEM**

In summary, Australian Academy of Technological Sciences and Engineering (ATSE) believes that there is an urgent need to strengthen Australia's national innovation system. Some of the key actions required are listed below.

- Develop and adopt a ten-year strategic plan to increase innovation in Australia. This strategic plan should include investment milestones and performance indicators and its development should engage all key stakeholders.
- Develop a strategic national intelligence capability that explores critical emerging issues through horizon scanning, technology roadmaps and foresight; and provides findings that can be understood and acted on.
- Recognise the high costs and risks in later stages of technological innovation and provide assistance measures that will address this need.
- Establish a new mechanism to fund collaborative research for projects that are smaller (and involve shorter time frames) than a CRC, but are bigger than ARC Linkage grants.
- Increase the R&D tax concession to 200 per cent, raise the turnover limit for the R&D Tax Offset and adopt other improvements to fiscal incentives in order to increase business expenditure on R&D.
- Include an element in the new university block funding formula which rewards investment in proof-of-concept and innovation/ commercialisation activities.
- Assist firms (especially SMEs) to develop products that government agencies are interested in buying.
- Increase the numbers of science, technology, engineering and mathematics (STEM) graduates from our universities by mechanisms such as reducing fees in these disciplines.
- Improve the teaching of STEM in our schools by making teaching more attractive to STEM graduates and providing better teaching resources.
- Establish an annual Prime Minister's prize for innovation based on the application of Australian-developed scientific discoveries.
- Improve the commercialisation of public sector research results by supporting training and adoption of best practice in knowledge commercialisation.
- Promote greater cooperation between Commonwealth, State, Territory and local government in encouraging innovation.

The Australian Academy of Technological Sciences and Engineering (ATSE) is an association of some 750 professional men and women of outstanding achievement in the application of science, technology and engineering to Australian society. ATSE seeks to promote the application of scientific and engineering knowledge for practical purposes, and to encourage:

- the development and practice of existing and new technologies;
- the development of technology for more effective management of natural resources and improved competitiveness of industries and services;
- the study of the effects of technology on the quality of life of the community and on the physical and sociological environment;
- public services dependent on technological sciences and engineering;
- the development of technology for national security and the prevention, control and mitigation of natural disasters; and
- technology for ecologically sustainable development.

ATSE believes that it is strongly placed to provide input to this Review. Its membership includes Fellows with expertise in a wide range of different aspects of innovation, as well as in the design, implementation and review of measures to support innovation. ATSE Fellows have a real base of experience in making innovation work.

### **The importance of innovation to the Australian economy**

Australia must increase its investment in innovation. Governments in both developed and developing countries have recognised the importance of innovation<sup>1</sup> to economic growth and have been addressing the need to improve their innovation performance. In spite of previous review processes at both Commonwealth and State Government level, Australia's innovation performance is widely acknowledged as lagging behind many other OECD countries. We cannot afford to delay tackling this problem — the rest of the world is making major strides in strengthening national efforts to increase innovation. For example, China and India are now investing in education and research at levels much higher than that of Australia. Without urgent action, Australia's relative international competitiveness and our standard of living will inevitably decline.

To ensure that Australia improves its innovation performance, ATSE recommends that the present Review should result in the development and adoption of a ten-year national innovation strategy. Such a strategy would address all of the elements required to make Australia a successful innovating nation with a strong knowledge base and the ability to rapidly translate this into new products and services. This national innovation strategy should include an investment plan based on consultation between government and business, performance indicators to track progress towards strategic goals, and an annual stock-take of progress. One element of this strategy would provide a mechanism for identifying challenges as they arise, and bringing together the teams needed to solve them.

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<sup>1</sup> “An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations”, OECD Glossary of Statistical Terms, (<http://stats.oecd.org/glossary/index.htm>).

Australia needs to develop a significant national capability in strategic intelligence to support innovation. This capability would address and explore critical emerging issues for our society and economy, through a combination of horizon scanning, anticipatory intelligence, technology roadmaps and foresight. Outputs from these activities would need to be in a form which government, industry and the community can understand and act upon. The processes involved are illustrated in Figure 1.

Technology Foresight	=>	Analysis of threats and opportunities	=>	Identification of priorities for action	=>	Implementation of appropriate action
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Fig 1 – Use of Technology Foresight to address challenges

ATSE wants to see the use of this strategic intelligence process made an integral part of the proposed ten-year national innovation strategy. Previous technology roadmaps and technology scans have tended to be information documents, adequately describing the state of the art but not always translating these observations into practical suggestions (or warnings) about what individual firms, organisations or governments (including their regulators) should do about the material provided. Technology Foresighting provides a structured process that engages all key stakeholders.

In ATSE’s view, there is scope for the Government to make better use of the Academies and the National Academies Forum (NAF) as sources of advice and expertise to explore some of the challenges we face as a nation. The Academies should play a key role in the development of the ten-year national innovation plan. An expanded consultation process could be established to decide and review an annual work program for the Academies/ NAF.

Innovation is profoundly transforming all aspects of human activity, and needs to become an integral part of all areas of business, government and education activity in Australia. ATSE believes there is a need for new ways of thinking about innovation. While the main focus of this submission is technological innovation — an area where ATSE has significant expertise — ATSE does not discount other types of innovation, which can be just as important.

Innovation needs to be embedded in the Australian community, in firms, educational institutes and government. Innovation involves continuous change and improvement, responsiveness to lateral thinking and new ways of achieving outcomes. Competition is an important driver of innovation.

Knowledge of all kinds contributes to innovation. Knowledge can be derived from R&D. Just as important as a source of innovation however, is the adaptation and adoption of technology from Australia and overseas. All aspects of innovation, including R&D, need to be encouraged and supported by government. Just as the social and economic benefits of innovation flow across our economy, there should also be a sharing of the costs involved.

ATSE believes that, at present, Australian support for innovation is too focussed on assisting research. New mechanisms are required to support innovation. However the development and demonstration phases of innovation can involve much larger investment, while still involving high risk. This is illustrated by the work of Holt<sup>2</sup> in the figure below, which shows how costs vary for coal technologies at different stages in innovation and deployment processes and that not all technologies are at the same level of maturity. In areas such as energy, which are critical for Australia, the development stage tends to be particularly capital intensive, with associated high technological risks, making the need for government support even more critical.

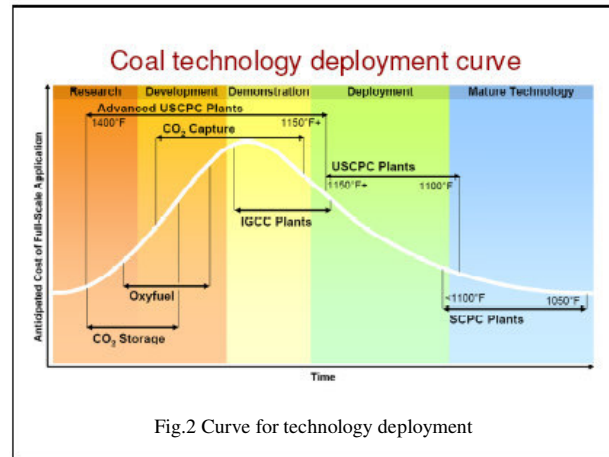


Fig.2 Curve for technology deployment

Demonstration projects involve ‘learning by doing’ — a well-recognised but expensive phase of many innovation processes. Typically for many technologies, every dollar spent on research can lead to a requirement to spend \$10 on development and \$1000 on the demonstration phase. Early stage adopters of new technologies face considerably higher risks. The claim that near-market innovation involves fewer or smaller risks does not stand up to close scrutiny. Even if it did, the substantially higher costs in development and demonstration phases offset any reduction in risk. All this argues for an extended government support role, which could involve grants for demonstration projects or tax concessions for other later-stage innovation phases such as clinical trials. The nature of assistance appropriate for these phases may be different to that provided to support R&D —for example. Tax measures could be available on a project-by-project basis, but subject to merit review.

International collaboration plays an important role in assisting innovation by facilitating access to foreign sources of knowledge. Australia produces around 2 per cent of new knowledge and must rely on accessing the other 98 per cent through a range of networks, programs, publications etc. A key role for government is to provide policy settings that encourage all types of international collaboration to foster innovation, not only amongst researchers but also between businesses, public

<sup>2</sup> Holt, N., *Preliminary Economics of SCPC & IGCC with CO<sub>2</sub> Capture & Storage*, 2nd IGCC & XtL Conference, Freiberg, Germany, 9-10 May, 2007; see <http://www.tu-freiberg.de/~wwwiec/conference/conf07/pdf/9.2.pdf>



officials, regulators, service providers etc. Anything that reduces the costs and complexity of international collaboration will assist Australia to innovate.

ATSE believes that Australia must increase collaboration between private and public sectors, and between research providers and the users of research outcomes. This requires top-down facilitation including additional funding. It also requires the creation of an environment in which bottom-up collaboration increases. Business should be able to readily access public sector research skills.

ATSE advocates the creation of a new mechanism to fund collaborative research. This new approach should be able to respond quickly to opportunities, reward cooperation between public sector researchers and business, and require some financial commitment on the part of the businesses involved. This new mechanism would support projects that are bigger than the average ARC Linkage grant but smaller than for a Cooperative Research Centre (CRC).

Australia needs to enhance the *demand* for innovation on the part of the public and private sectors. At present Australia is too driven by the supply side — the need for innovators to commercialise their ideas — rather than on creating a demand for innovation. Industry, governments and consumers should be encouraged to support companies that supply innovative products and services. For government, this means providing assistance to firms that can develop products that government agencies are interested in buying. This assistance should be able to be rapidly accessed and should not require the recipients to match government funding. A program along the lines of the former National Procurement Development Program would be appropriate. Governments also need to make Australia's business environment more conducive to growing SMEs. In ATSE's view, government programs need to be more generous to SMEs in their first five years.

There are significant 'holes' in the research infrastructure in some industry sectors in Australia that are inhibiting the path from discovery to commercialisation, forcing venture capital firms to take promising novel technologies offshore to access enabling technologies. A specific example of this is the lack of a centre of excellence with medicinal chemistry expertise in Australia, to build on the world-class research being done by the medical biologists. This is needed if the biotechnology and fledgling pharmaceutical companies are to survive in Australia. There are several possible solutions to filling these 'holes', including attracting teams from overseas, or setting up a new centre of excellence around a specially recruited research leader. In the longer term, ATSE would also like to see NCRIS fund facilities where researchers can interact with Australian industries to ensure that promising technologies are exploited.

ATSE want to see stronger public promotion of science, technology and innovation. Australia needs a strong innovation culture, which is rewarded and promoted within our education system at all levels. National reward schemes that recognise business sector innovation and the commercialisation of public sector research need to be enhanced. The Australian Technology Showcase Awards and the ATSE Clunies Ross Science and Technology Awards need support from state and Commonwealth Governments.

ATSE believes that an additional Prime Minister's Prize to recognise the application of Australian-developed scientific discoveries is needed. Such a Prize would not only assist the resolution of a conundrum regularly faced by the Prizes Committee — how to balance the excellence of the pure science with its impact or application. It would also send a strong signal to the community that the Government wishes to see its investment in research translated into commercial or other benefit.

ATSE observes that a central theme of the Review Panel's paper is the focus on the process – innovating or being innovative – and emphasising interactions between the components of the system.

### **The Review's Terms of Reference**

ATSE has developed a series of observations on each of the Terms of Reference. These are set out in abbreviated form here but could be further elaborated if necessary.

#### **Identify a set of principles to underpin the role and participation of the public sector in innovation.**

- The costs associated with innovation should be shared between innovators and the government (on behalf of the public) just as the benefits arising from innovation are also shared. Innovation generates benefits that go beyond those parties immediately involved. It also involves risk to investors. Public support through government funding results in a sharing of risks and costs. Public policy settings need to ensure that innovation is strongly encouraged. Without increased innovation, Australia's relative international competitiveness will decline.
- Public sector research has an important role to play in Australia's national innovation system. Public research priorities must have a strong focus on assisting innovation in both public and private sectors. Commercialising innovations arising from the public sector requires improved commercialisation capability in our research-performing institutions, improved understanding of risk of success/failure, and better access to skills and finance. Public sector research that underpins the development of new industries and companies should be strongly supported by government.
- Public sector Intellectual Property policies need to facilitate the adoption of innovative practices and products by industry and government. These policies should be transparent, be administered in an expeditious manner, and not impose excessive costs or reporting burdens on those whose main objective is to use the IP in an innovative way. The Government should consider placing requirements such as time limits on the commercialisation of government-funded research, similar to those of the US Bayh-Dole Act.
- The Government should help universities and public sector research organisations to raise the standards of research commercialisation, working through Knowledge Commercialisation Australasia. This assistance should focus on training, and the adoption of best practice in licensing and IP management, and a better understanding of the timeframes that industry and investors need to work to.

- Australia must attract more students into STEM studies, as well as ensuring that all levels of education and training encourage innovative behaviour. The supply of skilled human resources is critical to Australia's success in generating economic and social benefits from innovation. Australia is not currently training enough science, engineering, technology and mathematics (STEM) graduates to meet future needs. Shortages of engineers and technologists will limit our ability to benefit from innovation. We need to ensure that school students are well advised on career choices, that university HECS fees for science and engineering students are reduced so as to increase their numbers.
- Science teaching must be made more attractive to graduates. Curriculum initiatives are needed in science, technology and mathematics. These must be based on a highly relevant context. New curriculum support materials and professional training for teachers is essential and science subjects must be taught by science graduates. ATSE's STELR initiative is described later in this submission.
- More scholarships are needed for honours students in science and engineering. Strong research resources – research personnel, research students and research infrastructure — must be a key public sector priority, especially if the private sector is to be persuaded to make better use of them. A high-quality research base provides an environment in which innovation flourishes. World-class R&D increases the likelihood of innovation.
- While not advocating that Government should 'pick winners', ATSE believes that there is a need for a forward-looking view to identify technology opportunities and threats for Australia that take our existing strengths and capabilities into account. Australia also needs to encourage development of innovation support clusters in the public sector, focussing on some of these technology areas where a critical mass of activity is required before growth can become sustainable.
- The innovative performance of individuals should be rewarded. Public sector research performing bodies should recognise innovation by staff, as distinct from peer-group academic recognition, in their promotion procedures for example.
- Within the context of our proposed ten-year national innovation strategy, performance indicators will be needed to monitor achievements. These can be set at national level, at institutional level, or even by sector. Success in promoting innovation should be an important institutional performance indicator for applied science disciplines such as engineering and biotechnology in the higher education sector.

**Develop a set of national innovation priorities to complement the national research priorities, ensuring the objectives of research programs and other innovation initiatives are complementary.**

- National innovation priorities that complement the National Research Priorities and the objectives of research programs and other initiatives can be established in a number of different ways. For example, they could be quite independent of National Research Priorities, and address such matters as:
  - ensuring an adequate the supply of human capital;

- increasing levels of business R&D;
  - improving links between public sector research and the business sector.
  - investing at a very targeted level in research and technology capability building in key emerging fields;
  - embedding innovation as a key performance criterion in all organisations, through Annual Reports, evaluations, etc.;
  - building principles and experience of Technology Foresight and innovative behaviour into all levels of formal education;
  - use Technology Foresight to ensure that Australia has the all the necessary capabilities to exploit our research strengths and to take up emerging technologies;
  - identifying, celebrating and rewarding innovation throughout our society; and
  - development of a national strategic intelligence capability to better address the challenges of the future through innovation.
- Another approach to innovation priorities, which could operate in parallel with that described above, would involve developing innovation priorities for each of the four National Research Priorities. Thus an appropriate innovation priority relevant to the first National Research Priority ‘An Environmentally Sustainable Australia’ could be ‘Using technologies to enhance Australia’s environmental sustainability’. Innovation in this field would be assisted by government programs that assist the development and implementation of more cost-effective solutions, particularly in the areas of greenhouse gas emission abatement and climate change adaptation. These will eventually become commercially competitive, but need investment in scale-up, demonstration plants etc and possibly the implementation of other policies such as an effective emissions trading scheme to achieve this.
  - In relation to ‘Promoting and Maintaining Good Health’, the innovation priority could be ‘Translating research into new products and practices to improve human health and well-being’. This would include application of results of research from around the world, and would promote innovation by linking public sector researchers and industry. This would reduce the capability gap that occurs when Australian public sector researchers, supported by public funding, reach the limit of the product development process. This capability gap often leads to lack of take-up of Australian research outcomes by domestic industries and loss of valuable IP offshore. Germany and the USA are implementing strategies to close this gap using public funding further along the research and development pathway and Australia needs to do so too.
  - For ‘Frontier Technologies for Building and Transforming Australian Industries’ the innovation priority needs to see such technologies, including, those developed elsewhere in the world, implemented so could be stated as ‘Improving Australian Industries’ capacity to adopt new technologies beneficially’.
  - For ‘Safeguarding Australia’ the priority could be along the lines of ‘World-class technology, procedures and products to safeguard Australia’.

**Identify regulatory and other barriers to innovation and recommend ways to minimise these.**

- Expensing of the capital involved in R&D and allowing flow through of tax losses, as they are incurred, to shareholders or fund providers would make investing in innovation more attractive.
- There is an urgent need for further simplification of tax laws on partnerships for investment vehicles.
- Competition policy must recognise the need, at times, for Australian competitors to collaborate at least until an Australian-sourced product or process is established in world markets. Regulators need to understand that Australian companies need to be able to compete in a global environment.
- In relation to finance sector participation in innovation, ATSE hopes that the Review will examine the extent to which funding for innovation is provided by the financial industry (venture capital, private equity, superannuation funds) and also the role of the ASX, to determine whether changes in government policy or industry practices could stimulate innovation in industry, both in small businesses and large. The superannuation industry's need to invest, coupled with a growing venture capital industry, suggests that there should be new possibilities to pull through innovative technologies into start-up companies.
- ATSE supports continuation of the Innovation Investment Fund (IIF) Program and its expansion through the provision of additional funding to established venture capital firms to support the training of cadet investment managers who would help to meet skills shortages in this area.
- Identify and remove any regulatory restrictions preventing the formation of industry-wide, levy-based corporations aimed at innovation to maintain technological leadership by Australian industry in specific industry sectors

**Examine the scope for simplifying and reducing program duplication and ensuring that any support provided is well-targeted and easy to access.**

- ATSE believes that the Commonwealth Government should seek to bring business assistance programs, where appropriate, under the umbrella of the Innovation Australia Board. The Board should seek to harmonise information requirements for the programs that fall within its purview.
- ATSE is not aware of any significant overlap or duplication between Commonwealth and State/Territory Programs and notes that a 2003 study<sup>3</sup> found good complementarity in this area. The 169 programs that are sometimes mentioned include programs offered by individual State/Territory governments to firms located within their jurisdictions which are therefore not available to firms located elsewhere. ATSE believes that there is a role for State/Territory and local government in supporting innovation.
- A driving principle for innovation programs should be a requirement to minimise the cost imposed on applicants, and subsequent reporting requirements, consistent with the need for accountability.
- ATSE urges the establishment of a Commonwealth-State Innovation Ministers' Council to encourage cooperation between different levels of government in achieving strong innovation outcomes across Australia.

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<sup>3</sup> The Allen Consulting Group, 2003 *The Contribution of the States and Territories to Australia's Science and Innovations System*, a report to the Science and Innovation Mapping Study.

**Consider the appropriateness, effectiveness and efficiency of the Research and Development (R&D) Tax Concession Scheme in promoting innovation and make recommendations to improve innovation outcomes.**

- ATSE believes that the R&D tax concession should be raised to bring the level of assistance closer to that which applied when it was first introduced, when it provided a very effective stimulant to business investment in R&D, this would mean moving to 200 per cent. When the R&D tax concession was introduced the concession was 150 per cent linked to a company tax level of 46 per cent. Now, the tax concession is 125 per cent with the current 30 per cent company tax rate. When compliance costs are taken into account, many firms see no incentive in the current R&D tax concession. Unless Australia offers an effective tax incentive for business R&D, some firms will choose to do their R&D in other countries.
- ATSE considers that new firms and SMEs making R&D tax concession claims for the first time should be treated more generously, to encourage more to participate by sponsoring genuine research and compensate them for the establishment costs for setting up research activities, monitoring and reporting systems.
- The tax concession is only of use to firms who are paying tax. In ATSE's view, lifting the current \$1 million limit on R&D tax offsets, and tapering the benefit above the new limit, would help research intensive start-up companies, particularly in capital intensive research areas such as energy, resources, pharmaceutical development and manufacturing.
- Consideration needs to be given to introducing a new measure that allows investors to benefit from the tax concession where they provide funding for R&D undertaken by companies. Individual proposals could be approved by the Innovation Australia Board. The annual cost to revenue could be capped, with limits and transparency required in relation to fees for intermediaries, and regular monitoring of progress<sup>4</sup>.

**Consider ways to improve the governance of the national innovation system to support higher expectations of government agencies and industry.**

- The governance of the national innovation system needs to be primarily in the hands of the innovators – any government role should be as supporter/facilitator and to ensure accountability for public funding.
- In ATSE's view, credit should be given in the university system and the new Excellence for Research in Australia (ERA) initiative for patents and commercial publications, as well as publications in leading research journals. Ideally credit should also be given for industry R&D funding, major conference presentations, sponsored consultancy reports and other mechanisms where research work is reported to those who will potentially use it to underpin innovation. ATSE is also attracted to the Proof-of-Concept

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<sup>4</sup> Vision Systems provides just one of a number of illustrations of the potential of this approach. By forgoing around \$100 million in tax revenue the government saw a major business established which eventually created 1200 full time jobs and returned a taxable \$1 billion to shareholders.

metric<sup>5</sup> as a means of quantifying the level of early stage innovative activity in research performing institutions.

- Grant applicants should be asked to provide information on the potential for innovation arising from their proposal, in the event of success. The relevance of potential research outcomes to Australia also needs to be given more attention.
- The ARC and NHMRC should report publicly annually on the extent to which their sponsored research has improved the nation's innovative output.
- ATSE believes that public research organisations and universities need to be provided with greater incentives to form risk-sharing partnerships with industry.
- ATSE believes that there is a need for a senior person within government who will provide leadership on innovation and serve as a bridge between the innovators in the community and the government. This person should have responsibilities that include addressing the effectiveness of existing and possible future programs, skills issues and improving interfaces between publicly supported researchers and industry. ATSE recognises that the existing Chief Scientist role provides a valuable bridge between the science community and the federal government and sees this new position as having a distinctly different function.

**Assess the appropriateness, effectiveness and efficiency of the Cooperative Research Centres (CRC) Program and make recommendations to improve innovation outcomes.**

- The CRC Program is valuable and should be retained. The Program has achieved excellent outcomes and has helped to improve research management in Australia.
- The CRC Program should be continued, expanded and diversified. There is scope for two (or possibly more) categories of CRCs, each with some common characteristics but having different guidelines, depending on their objectives. There should be scope for both CRCs with commercially focussed outcomes and CRCs that are primarily directed towards non-commercial objectives. More flexibility is required in the Program to accommodate different sizes and funding durations for CRCs.
- As noted earlier, ATSE advocates the creation of a new mechanism to fund collaborative research which would support projects that are bigger than the average ARC Linkage grant but smaller than a Cooperative Research Centre (CRC).
- The costs of preparing a CRC proposal must be substantially reduced and the reporting requirements made less arduous. ATSE is concerned that the administration of the CRC Program has become overly bureaucratic.
- Industry associations should be encouraged to become members of CRCs, in order to act as a conduit for SMEs to better access this program;

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<sup>5</sup> The Proof-of-Concept metric is a measure of the number of innovations that have been developed to the level of rigorous investment appraisal by external parties. Proof of concept Guidelines are available at <http://www.innovation.gov.au>

- The procedures for establishing a new CRC involve high legal costs. New simpler models are needed to streamline CRC establishment and minimise transaction costs.
- More flexibility is required, to allow CRCs to adapt research programs to changing circumstances, replacing the present approach that tends to lock CRCs into plans drawn up years earlier.
- CRC need to think more creatively about strategies for their eventual exit from the Program. More thought needs to be given to ways of helping CRCs to transition to alternative arrangements.
- CRCs should be able to have their funding extended at least once if they are successful, but possibly with progressively reduced proportions of government funding.
- Agreed methodologies need to be developed to assess public benefit CRC results — methodologies which allow valid comparisons with the current main focus of the program, that of commercialisation of technology and generation of private benefits.

### **Comments on questions posed in the Issues Paper**

The *Call for Submissions* posed seven questions. The Academy's response to each is summarised below.

#### **“Can we imagine a better world? Are we asking the right questions?”**

ATSE's vision of a better world starts in our schools. In preschools and in early primary schooling, children test the patience of parents and teachers by regularly asking 'Why?' As they grow older this innate curiosity is not always encouraged – often learning becomes more a one-way flow of information and ideas. Our education system – primary, secondary and tertiary — must always encouraged students ask 'Why?', to question information they do not understand or believe, and to contest ideas they do not agree with. Innovation is a way of thinking and both curricula and pedagogy must provide continuous challenges to those being taught, to imagine how things could be made/ done better.

ATSE believes that school science should involve experimentation and discovery. Practical learning followed by the development of an understanding of the theoretical underpinnings is vastly superior to the converse. This process promotes not only greater interest and understanding, but also a more innovation-oriented culture. There are a number of interesting overseas programs that can provide exemplars for Australia.

ATSE is piloting a school program called STELR (Science and Technology Leveraging Relevance), which uses various small-scale renewable energy technologies in a laboratory setting to illustrate basic scientific principles. The main aim is to have secondary students retain an interest in science and mathematics by seeing it used in a practical manner in an area of interest to them. At the same time, STELR challenges students to think innovatively. More of these sorts of programs are required.



All universities should aim to include innovation among the attributes of their graduates, a quality that needs to be demonstrated in their coursework. A number of university engineering schools are embarking on assessable, practical, multidisciplinary team exercises to illustrate engineering principles, which at the same time will promote innovative thinking. A greater emphasis on ‘being innovative’ is needed. This needs to be matched by practical measures to ensure it is something more than just an aspiration. Australia’s universities should be challenged to demonstrate that their courses provide graduates trained to be innovative. Our universities should be encouraged to offer work experience in industry as part of science and engineering degree courses, in order to provide graduates and post graduates with a better understanding of innovation and its application in product development.

**“How do we solve the big challenges we face as a country, an industry or as a community?”**

Most of the big challenges Australia faces can only be solved through interdisciplinary approaches. ATSE believes that a ‘silo’ mentality pervades some research institutions, as well as in business, government bureaucracies and service providers. These barriers need to be broken down if the big challenges are to be addressed successfully. Interdisciplinary research and innovation, inter-business and intra-government collaboration, and increasing communication between all sectors are already occurring, but much more is needed.

One of the ways we can solve big challenges is to establish a process for ensuring that innovation contributes to their resolution. Thus ATSE has recommended the development and adoption of a ten-year national innovation strategy. One element of this strategy would provide a mechanism for identifying challenges as they arise, and bringing together the teams needed to solve them.

ATSE is concerned that a wide gulf exists between researchers in Australia’s public-sector research organisations and the potential users of research outcomes from that source. Australia has limited skilled human resources undertaking research. We need to make best use of these resources and this means ensuring that the relationship between researchers and the users of the outcomes is strong, enduring and well-supported.

As noted earlier, there is scope for the Government to make better use of the Academies and the National Academies Forum (NAF) as sources of advice and means of exploring some of the challenges we face as a nation.

**“Could we do everyday things better?”**

ATSE believes that, with some adjustments to current programs, governments can do better in promoting innovation. For example, it is ATSE’s view that pre-seed funding should be allocated to industry associations, regional development agencies and university commercial arms on a competitive basis. The present venture capital/equity-based approach for this program should be abandoned in favour of direct grants – the government should recognise that the pre-seed stage is too early for sensible equity-based government assistance.

Australia's business R&D tax concession needs to be increased to provide a real incentive for business increasing its investment in this area. We have addressed this in more detail earlier in this submission. The rules for claiming the cost of 'supporting' activities in relation to business R&D should be tightened. Changes are also required to the R&D tax offset.

**“How do we get more firms and organisations to use the best available tools and techniques, from anywhere around the world, in what they do?”**

ATSE supports the concept behind Government's new Enterprise Connect Program and believes that more centres will be needed to deliver this program across the country. ATSE believes that regional development bodies could play a useful role in this regard.

Australian firms and organisations need good sources of information on such things as new technologies and market trends, in order to stay ahead of their international competitors. Austrade and Invest Australia could help in this regard by bringing to the attention of Australian enterprises innovative practices being adopted in similar organisations elsewhere in the world.

As noted previously, Australia needs to develop a significant national capability in strategic intelligence to support innovation. ATSE would like to see the use of this strategic intelligence process made an integral part of our proposed ten-year national innovation strategy. Technology Foresighting is a structured process that engages key stakeholders.

**“How do we make it easy for people to use tools or apply ideas in novel ways?”**

While innovation is driven by far more than research, ATSE believes the full potential of the research community to contribute to innovation in Australia is far from being realised. Expanded and better-directed support mechanisms are warranted. As noted elsewhere in this submission, restoring the incentive value to the R&D tax concession scheme, new measures to encourage public-private collaborative activities, improving the CRC Program and a range of other initiatives will make it easier for people to use tools and apply ideas in novel ways.

Scaling back the enormous growth in compliance and accountability requirements, albeit driven by justifiable objectives, poses a significant challenge. However the net effect of striving for very high levels of compliance is that the creative space for innovation is diminished. A truly innovative culture requires a shift, particularly on the media's part, in understanding that risk taking is inextricably part of an innovative society and that a failure often leads to greater understanding and to future success.

**“How do we educate and equip our people to be creative and innovative, life-long?”**

As previously noted, embedding innovation in curricula and pedagogy should be a priority. At the same time the environment needs to change, to better reward success and risk taking rather than to penalise failure. Rewards systems in enterprises need to

shift to penalise people for not trying to innovate, rather than for innovating unsuccessfully.

Employee share options are important in growing innovative firms. They help to retain key employees and reduce employment costs. In ATSE's view, this needs to be encouraged in Australia as it is in other countries. For example, if a UK employer offers an employee shares in the company as part of a government approved share scheme, the employee gets certain tax advantages. In the USA, share options in the early years of new technology-based companies are deemed to be valued at significantly less, often from as low as 10 per cent, of the price paid by investors for preference shares. ATSE believes that Australia should consider a similar approach. The present Australian tax treatment of share options needs to be examined by the forthcoming taxation Review with the objective of making these options more useful to helping to grow technology-based firms.

Public programs that communicate with and engage the public should be an important element of any effort to increase interest in science, technology and innovation. These programs can enhance public interest, confidence and understanding. They can also ensure that public concerns are identified and addressed. The UK engages the public in discussions on emerging issues in science, technology and innovation, through its Sciencewise Program. While Australia's annual Science Festival and Innovation Festival perform valuable roles, we need to make a greater investment in this area.

**“As a relatively small country, how does Australia prioritise its innovation efforts to make the most of what it has or can do?”**

Mechanisms for determining and reviewing Australia's innovation priorities should be part of Australia's ten-year national innovation strategy. Research establishments and funding agencies have made establishing priorities part of their planning processes. Procedures vary, and priorities range from the perceived excellence of the research through to solving defined problems. However, the priorities of research-performing bodies are strongly influenced by funding formulae. ATSE believes that if we want to encourage innovation by rewarding research that addresses national or business problems, the funding formulae must reflect this.

ATSE believes that, in funding research programs and establishing research priorities in the public sector, more attention needs to be given to the consequences of success – to what happens next if all objectives are met. This requires specific plans, not just vague aspirations. Discovering something and then setting out to do something about taking it to the next stage is a far more hazardous path

## **Preparation of Submission**

This submission was prepared under the guidance from a Working Party of Fellows:

- Robin Batterham (President)
- John Bell (Editor)
- Chris Fell
- Jim Fox
- Carrie Hillyard
- Ron Johnston
- Peter Laver (Chair)
- Vaughan Beck

and Trevor Evans (CEO).

A number of other Fellows provided comments on a previous working draft posted on the ATSE website.