THE HOUSE OF REPRESENTATIVES INDUSTRY, SCIENCE AND INNOVATION COMMITTEE

Inquiry into research training and research workforce issues in Australian universities

RESEARCH TRAINING IN AUSTRALIA

SUBMISSION BY
The Australian Academy of Technological Sciences and Engineering
(ATSE)

27 May 2008

BACKGROUND

On 23 April 2008 the Minister for Innovation, Industry, Science and Research, Senator the Hon Kim Carr, asked the Committee to undertake an inquiry into research training and research workforce issues in Australian universities.

The Committee invited interested persons and organisations to make submissions addressing the terms of reference by Friday 30 May 2008.

This submission responds to that invitation.

TERMS OF REFERENCE

The Committee's Terms of Reference were:

The House of Representatives Standing Committee on Industry, Science and Innovation shall inquire into and report on research training and research workforce issues in Australian universities.

The Committee will inquire into the contribution that Australian universities make to Australian research training, and the challenges Australian universities face in recruiting, training and retaining quality research staff in Australia.

The Inquiry will examine:

1. The contribution that Australian universities make to research in Australia, including:
   - The contribution of research training programs to Australia's competitiveness in the areas of science, research and innovation;
   - The effectiveness of current Commonwealth research training schemes; and
   - The adequacy of current research training schemes to support Australia's anticipated future requirements for tertiary-qualified professionals in a wide range of disciplines.

2. The challenges Australian universities face in training, recruiting and retaining high quality research graduates and staff, including, but not limited to:
   - Adequacy of training and support (including income support) available to research graduates in Australia;
   - Factors for graduates that determine pursuit of a career in research;
   - Opportunities for career advancement for research graduates and staff;
   - Factors determining pursuit of research opportunities overseas;
   - Australia's ability to compete internationally for high quality researchers; and
   - Whether Australia's academic workforce is ageing, and the impact this may have on Australia's research capacity.

ATSE's submission responds to these specific questions.

RESPONSE SUMMARY

The Australian Academy of Technological Sciences and Engineering (ATSE)[1] views research training as a critical but somewhat neglected aspect of Australia's research performance and commends the Minister and the Industry, Science and Innovation Committee for undertaking this Inquiry.

The main points from this Submission are –

- **Well-trained and motivated researchers are a key factor in advancing Australia's international competitiveness.**
- **Research training, particularly in technology areas, must equip postgraduates not only with research skills but also with a range of attributes that include business and innovation skills, Intellectual Property (IP) management and entrepreneurship.**
- **Current funding arrangements, which emphasise competitive grant success, publications and completions, can negatively impact on the quality of research training and research trained graduates.**
- **Industry needs to be encouraged to play a greater part in research training, including providing relevant work experience, or sponsoring and supervising postgraduates.**
- **A greater government investment in research training is needed to better support those providing the training and being trained.**
- **Management and supervision of research training is variable and all universities need to be encouraged and supported to meet a minimum set of standard requirements.**
- **All parties involved need to address how more of the most capable Australian undergraduates can be encouraged to undertake postgraduate research training. Factors to be considered include stipends, the training experience, the value subsequently placed on postgraduate qualifications and the career structures available.**
- **Overseas experience for Australian researchers needs to be encouraged but conditions here need to be made attractive so experienced people return or relocate.**

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

SPECIFIC COMMENTS

1. The contribution that Australian universities make to research in Australia, including:

The contribution of research training programs to Australia's competitiveness in the areas of science, research and innovation

- Trained researchers, and the research, innovation and the incremental technological improvement that they foster, are essential if Australia is to maintain its international competitive position in the resource, manufacturing, agricultural and environmental industries.

- Well-trained researchers are critical if Australia is to be competitive but this is a necessary but not sufficient condition. No matter how well-trained researchers might be, unless they are adequately resourced, well-directed and properly motivated they will achieve very little. It is singularly important in the applied disciplines (especially applied science, engineering and technology which ATSE embraces) that trained researchers are familiar with the elements of innovation and are well prepared to work in multi-disciplinary situations.

- There is a real problem in many current training programs that basically train individuals to defend a thesis based on research in their specialised discipline. Whilst the production of a thesis and related refereed journal papers are one measure of the success of research training, they are not, from ATSE's viewpoint, a sufficient criterion. PhDs need the skills and attitudes to be important and effective members of Australia's innovative culture, something some universities are now recognising through the development of post-graduate attributes to sit alongside and complement the more broadly used undergraduate attributes.

- Australia's competitiveness depends on developing new technology using multi-disciplinary teams, ideally including members from inside and outside academia. In technology disciplines this requires a large cohort of researchers to have appropriate skills and attitudes, including an understanding of the business environment in which they will work. ATSE sees real benefit in ensuring cooperation between industry, universities and government in overcoming market failure to develop such skills through appropriately designed training programs and widespread consultation on the required post-graduate attributes.

The effectiveness of current Commonwealth research training schemes

- The Commonwealth-supported training schemes offered through Australian universities and research organisations are well regarded for the high quality of the researchers they can produce. Throughout the world Australian-trained researchers can be found in key positions in leading research establishments, a testament to the training they have received. However, Australia lags behind many other OECD countries in terms of numbers receiving post-graduate training. The Australian ratio of 2.3 doctorates per 100 undergraduates pales into insignificance when compared with Germany (11.2) or even the more appropriate benchmark, Canada (3.9)[2].

- Where the effectiveness can be questioned is in the numbers of suitable candidates choosing to pursue research training and the somewhat 'academic' orientation of most of those graduating from the system. The Australian research training system needs to produce more researcher entrepreneurs, people capable of using their research to create economic and social benefits. They must become capable of problem solving, not just in their own specific research field. For too long the role of university-based research training has been regarded as providing the "foot-soldiers" for their

[2] OECD (2007)

supervisors' own research or the "cannon-fodder" for future academic appointments. Until now its role in training individuals who can make a positive contribution to the Australian economy by ensuring that Australian industry is innovative and competitive with the world's best has not been closely examined[3].

- Effectiveness is also impaired by the criteria required under current university funding arrangements which influence performance and promotion, especially to younger academics. These are principally –

  - The amount of money obtained as competitive grants;
  - The quantity of publications in a specified range of media;
  - The number of PhDs and other higher degrees actually awarded

  These demanding drivers have little, or nothing, positive to do with quality: They force the younger staff to quantity production, and departments to present PhDs within a set time, irrespective of quality. The problem is less serious for senior staff, with established standing, who can generally command these criteria and achieve quality in their students' work.

  A further consequence of the criteria is that recruiting of new staff is now heavily biased to people adept in fulfilling them. Industrial experience and achievement is then a negative, so creating a major deficiency in the staffing of engineering departments and faculties.

- In part, the effectiveness of research training is influenced by the fact that it cannot be considered in isolation, it is part of a continuum reaching back into schools and undergraduate education. There are problems in terms of attracting high quality teachers and students into science, mathematics, engineering and technology studies throughout the education system. First year university teaching now has many remedial elements, to accommodate the deficiencies arising from inadequate schooling and the less rigorous entry standards adopted to fill quotas or fee revenue targets. All this adversely impacts on research training.

The adequacy of current research training schemes to support Australia's anticipated future requirements for tertiary-qualified professionals in a wide range of disciplines

- To a major extent the adequacy is discipline specific. Fewer fears are held for future adequacy in areas such as humanities, law and medical sciences than in disciplines such as engineering, physics and economics. In the former the training mirrors the need to produce new knowledge (although ideally addressing some elements of practical application) and is primarily directed towards producing the next generation of academics. In the latter technology areas, the focus should not ignore the basics but should afford high priority to producing individuals capable of inducing technological change, with an understanding of how such changes are implemented.

- What is frequently missing is the familiarisation of research graduates with the *modus operandi* of private sector R&D activities. Here ATSE is firmly of the view that there would be value in research trainees in appropriate disciplines spending some time during their candidature working with private sector researchers, much as in the requirement in certain undergraduate courses to have industrial experience prior to graduation. Possibly a minimum of six months should be mandated, working on a thesis-relevant topic, funded and supervised at least in part by the employer who would be eligible to claim the cost incurred under the R&D tax concession.

[3] While ATSE has no statistics available there is some evidence that post graduates completing their degrees working in a CRC or under an APRA-Industry scholarship have a more broad understanding of the commercial world and are seen as more 'industry ready'.

- Although, on average, the research training schemes used in Australia are adequate, their implementation can be very patchy due principally to resource issues within the universities. Faculties are over-stretched in terms of their teaching and administration workloads and under pressures to produce results from their own research for their own advancement and the need to satisfy their employers' requirements to publish to improve their funding and external rankings. Although less prevalent than in the past there are still supervisors who manage their research students in the interests of their own careers, demonstrating the need for the universal introduction of quality supervisor appraisal schemes.

- Research training can become a low priority for existing staff, though the Research Training component of the existing block grant funding for university research does contain an "efficiency component" in the evaluation of time to graduate of research students. Through the new ERA scheme for research block grant funding, it is hoped that the Government will encourage universities to pay close attention to the quality of their research training. Universities that have demonstrated that they have implemented quality improvement programs for supervisors should be rewarded in some way, possibly through preferential allocation of new post-graduate places.

- Within post-graduate training there is a need to include education in knowledge and IP management, research project management, entrepreneurship, innovation and industry collaboration, ideally through coursework supplemented by some practical exposure to the issues arising.

- The Commonwealth-accepted length (and period of candidate financial support) of PhD programs does not reflect the peculiarities of particular disciplines (eg: in the agricultural disciplines, where plant and animal growth is tied to seasonal cycles). If it is accepted that in relevant areas postgraduates should spend time in industry and acquire business skills through coursework, then consideration will need to be given to increase financial support to four years.

- There has been no comprehensive evaluation of the 'best' mechanism for research training. The UK system, which Australia has adopted, relies heavily on the apprenticeship approach and the comprehensiveness of research training relies on the quality of mentoring provided by the supervisor. By contrast, the US system embodies substantial coursework, which ensures that PhD graduates have a systematic development of the fundamentals of the relevant engineering discipline and at least a basic set of research-related skills at graduation. Due to deficiencies in some undergraduate courses and students electing to undertake their postgraduate studies in a different discipline, this need is growing.

- There is a need in undergraduate courses to ensure that the approaches taken are not overly vocational. Students must receive an adequate grounding in basic sciences if they are to successfully undertake postgraduate research studies. This is seen to be a particular problem in the applied environmental sciences.

- ATSE is aware that it is increasingly difficult to recruit quality Australian PhD students in the current business climate. Industry supplementation of stipends would be desirable, with fiscal incentives (by way of the R&D tax concession) a possible way of bringing this about.

2. The challenges Australian universities face in training, recruiting and retaining high quality research graduates and staff, including, but not limited to:

Adequacy of training and support available to research graduate students in Australia

- Research training is essentially a one-on-one exercise although most universities have recognised the need for some type of post-graduate centre that can assist in more

broad ranging areas such as IT, thesis preparation, research ethics, etc. Some places are very much better resourced than others in this regard and consideration could be given in research funding mechanisms to earmark resources for support centres for those being trained in research.

- Training research supervisors is also an area where performance is patchy, even though it has been subject to numerous reviews in the past. There is no need for further reports on this topic as there is general agreement that in an ideal system each post-graduate student should –

    - Be assigned a well-trained supervisor and co-supervisor,
    - be able to access a pro-active departmental level post-graduate co-ordinator,
    - have mechanisms in place to resolve problems which inevitably arise with one-on-one supervisory arrangements,
    - be aware of, and participate in, procedures for evaluating supervisor performance,
    - have signed a contract setting out the undertakings and obligation entered into by both parties and
    - be able to utilise a university-wide resource centre dedicated to research training.

    Few universities can claim to meet all these requirements in all their faculties, departments or schools. Even fewer are able to meet them in a way that avoids further layers of bureaucracy. Some AUQA audits have examined provisions for post-graduates but in future they could well pay more attention to this area.

- Contrary to some perceptions research training does not need to be expensive. The provision of online support programs (such as the LEAP program developed and run through the ATN universities[4]) has proven to be effective and does not place a large drain on resources.

- The development of Australia-wide focused training programs for research students in specialist areas should be encouraged and appropriate funding provided. While many CRCs and possibly APRA-I scholarships do fulfil this role very effectively, relatively few research students are captured under this umbrella. Attempts to do similar things in non-CRC areas have not infrequently languished because of lack of funding.[5]

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[4] ATN LEAP is a collaborative venture across the five universities that form the Australian Technology Network. All the universities in this network share a heritage of working with industry. They are using that knowledge to provide their postgraduate research students with the opportunity to increase their employment prospects through an increased awareness of key issues that increase their employability. http://www.atn.edu.au/students/LEAP.htm

[5] An example of this is the Australian Course in Advanced Neuroscience (ACAN) founded in 2004. This is a non-profit course for early career scientists in the neurosciences. The students are late-stage PhD or early stage postdoctoral researchers. During a three-week stay, 12 students learn from more than 20 instructors drawn from around Australia and around the world. This is a transformational course for the students, because they learn the latest research techniques from the world's experts, and they have a chance to discuss their projects and plans with those same experts. They go back to their labs with a vast storehouse of experience equivalent to what they would get from working for a couple of years in an overseas laboratory.

The students are chosen through a competitive application process. The instructors volunteer their time. The board that manages ACAN includes a senior neuroscientist from every state and the president of the peak neuroscience body (Australian Neuroscience Society).

The course is funded by philanthropic grants, corporate sponsorships and by corporate in-kind donations and, even though the instructors are unpaid, other expenses mean the course costs about $130,000 per year to run.

Clearly ACAN is worthwhile but under current legislation cannot obtain tax deductibility, meaning it is difficult for philanthropic organisations to contribute. The NHMRC do not have any mechanism for supporting advanced training courses.

Factors for graduates that determine pursuit of a career in research

- In an ideal world academic achievement and career ambition should be the determining factors for graduates contemplating pursuing a research career. Unfortunately financial considerations and long-term career prospects overwhelm the decision-making process. Post-graduate scholarships for graduate students in their 20s and beyond, some with family responsibilities, are well below what would be deemed to be adequate to maintain a respectable life style so, inevitably for most, outside employment is necessary. This provides a distraction as well as prolonging the time taken to complete, which compounds the financial stress. For a fortunate few, undergoing training while working in a CRC, CSIRO or industry eases the burden but there is little wonder that the situation is critical in areas such as mining engineering where new graduates can command annual salaries in excess of $100,000 a year.

- During past business cycles, bright first-degree graduands in the technologies and engineering have sometimes chosen to complete a PhD while awaiting an improvement in business conditions. Fostering this by increasing PhD scholarship availability during downturns would seem a sound way to increase participation in research training and to enhance skills available during the subsequent upturn.

- More might be prepared to make the financial sacrifice if the long-term rewards were attractive. They are not. While there will be always multiple attractive opportunities for brilliant postgraduates meeting all the required professional and personal attributes, there will always be many who will confront more difficult choices. A career in the university system, with a few stellar exceptions, is more often chosen for life-style and personal interest reasons than for financial reward. Outside universities employers are rarely prepared to recognise post-graduate qualifications through higher remuneration, particularly after the first few years in employment where on-the-job performance counts for far more than qualifications. This is not the case in technologically advanced overseas countries where possession of a PhD is seen as an essential qualifier for entry into career paths that embrace areas of fast technological change and where appropriate rewards for the higher qualification are provided.

Opportunities for career advancement for research graduates and staff

- There is no doubt many opportunities in the university system, both in Australia and overseas, for high quality researchers. There are looming staff shortages in most tertiary institutions as existing staff get older and in many places recruits can only be found by recruiting from countries with lower living standards than Australia. The problem in technology-related areas, in particular, is that there is an inadequate number of long-term Australian residents electing to undergo training in research and those that do are not always the best and brightest. The top echelon of graduates is pursued by private employers vigorously in the worldwide search for talent.

- Another problem, particularly in private industry (but also in publicly funded research organisations), are salary scales which induce discipline specialists to seek promotion to more general managerial roles. Many have resorted to dual ladder reward schemes to allow experienced researchers to stay researching by being promoted to positions like Senior Research Associate rather than Research Manager, but the problem has not disappeared.

- For those research graduates choosing to pursue a research career in the public sector, other than by accepting a tenured academic appointment, there remains the job uncertainty associated with grant success. In this regard ATSE recommends that a mechanism to provide some measure of job security insurance be considered to allow such individuals, who have already committed to an extensive period of their lives in research training, to find alternative employment.

- ATSE is also attracted to a scheme whereby the Commonwealth would fund, fully or on a shared basis, a number of postdoctoral fellowships in industry for the applied disciplines. These fellowships could be associated with small or medium enterprises (SMEs), thereby providing a mechanism whereby Australian SMEs could be exposed to the benefits of having a research trained individual on their staff.

Factors determining pursuit of research opportunities overseas

- While money would be a factor in many instances, it is rarely the main reason for researchers deciding to work overseas. It is difficult to find any senior successful researchers who have only ever worked in Australia and all would strongly believe that their overseas experience was essential to their career development. Research relies heavily on peer interactions and esteem, and having a deep understanding of what is happening internationally in one's discipline area.

- Overseas opportunities should be actively sought out, encouraged and supported for Australian researchers. The introduction of a postdoctoral fellowship scheme where a mandatory period of the fellowship is spent with an appropriate research group overseas is seen as highly desirable. Competition for suitable places in USA and UK universities, the traditional destinations for Australian post-doctoral students, is far more intense than in the past, so to reap the benefits of overseas experience so necessary for aspiring research leaders some assistance might be needed.

- The challenge is getting researchers who pursue such opportunities to return; programs like Federation Fellowships have been useful for some high-flyers and family ties or children's education can help also. The new Future Fellows scheme promises to assist in retaining skilled people in Australia. Workplaces as well-equipped, and salaries comparable to those paid in the best research institutions elsewhere in the world would of course attract many back. The Government should strongly explore ways to encourage expatriate Australian researchers to return by providing incentives to individuals and companies to make this happen.

Australia's ability to compete internationally for high quality researchers

- In spite of not always being able to provide the remuneration and facilities to match the best in the world, there are still many researchers attracted to work here. Lifestyle can account for this to an extent, restrictive immigration rules in USA are benefiting Australia and in some fields the world leadership role we have assumed is acting as a magnet. More could be done in terms of streamlining entry procedures, simplifying tax arrangements and assistance with spouse employment – for instance – to ensure Australia remains competitive in this regard.

Whether Australia's academic workforce is ageing, and its impact on research capacity

- In the technological and engineering disciplines Australia's academic workforce is ageing. Physical age is however less important than research productivity and a significant number of retiring academics choose to stay involved with research groups, contributing their expertise and wisdom on a voluntary or part-time basis. Fostering this involvement, which, for example, is routine in the USA, is one positive way that universities can maintain research supervisory capacity and is seen by many academics as a positive feature of their scholarly life – a period when they can concentrate on research alone. Providing merit-based mechanisms to make this happen is strongly recommended.

- To date, replacement of departing academics has been able to be met by overseas recruitments, often from Asia, but improving economic conditions in many Asian countries will make this task harder. Government policies aimed at improving the attractions of a research career and the quality of research training offered to Australian

citizens will thus become increasingly critical as reliance on immigration for the academic workforce's needs becomes more problematic.

FINAL COMMENTS

- ATSE firmly believes that Australia cannot develop an innovative culture unless close attention is paid to the quality of research training in science and engineering and the other applied disciplines.

- Improvements to research training in universities will not occur unless funding formulae for research encourage appropriate attitudes within training bodies

- Industrial organisations need to be provided with incentives to join in an effort to ensure that the quality of research training in Australia is representative of world's best practice.

- A focus on the more applied and translational aspects of research by PhD students will be more likely if the new ERA reports that such research is not always published in the 'top" journals and appropriately recognises this. Research which results in patents and other IP, or in industry innovations must be encouraged and recognised in research performance evaluation.