GROUP OF EIGHT

The Changing PhD

Discussion paper

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Executive summary

The modern PhD developed in nineteenth century Germany where it required the completion of coursework, the performance of original research and the successful defence of a dissertation presenting the results of the research. This model proved attractive and spread rapidly to other countries so that today the PhD is the summit of formal educational achievement all around the world.

While there are variations between countries in the requirements for achieving a PhD qualification, a central element is always the need for independent research that makes a significant contribution to new knowledge. In Australia the Qualifications Framework defines the PhD as a level 10 qualification the award of which requires graduates to have undertaken a program of independent, supervised research subject to independent examination by at least two external examiners of international standing. The Australian PhD does not usually require a defence of the thesis and has traditionally involved less formal coursework than included in many other countries.

One measure of the global success of the PhD is the number of research doctorates produced each year: US universities awarded 49 010 in 2011, Australian universities 6 780. Many countries have targets to increase the production of PhDs. India aims to graduate 20 000 a year by 2020.

Governments recognise the importance of the PhD, especially because of the growing need for research to support national social, economic and environmental wellbeing as well as to address major global challenges. However, PhD graduates sometimes express concern at the employment opportunities available to them and the level of security, status and remuneration that these provide. Employers express concerns about the skills and knowledge that PhDs possess. This is leading to a broad debate about the role, effectiveness and quality of PhD education and the number of PhD graduates that universities should produce.

Factors impinging on PhD education include those internal to the education system and those flowing from changes outside academia that place more or different demands on such education or create new expectations about its outcomes. An important question is the extent to which PhD education has responded in an effective way to these changes.

Changes in the PhD learning environment include the increased number of research students and the greater diversity of the student cohort. This diversity relates to age, the growing proportion of part time students, gender, ethnicity, nationality, background experience, other work commitments, personal values and the path that has led them to work for a PhD. An overriding challenge for universities is to increase the number and quality of graduates without corresponding increases in funding.

External changes include those in the level, performance-sector and purpose of the national research effort and the management of research. These changes require researchers to have additional and different skills such as a more sophisticated approach to research management, an ability to cross discipline boundaries and an understanding of the pathways through which research can have impact. This can create tensions between the need for specialisation and the need to acquire more general skills and broader understanding.

In responding to the pressures for change, it is important to recognise the different and sometimes competing perspectives of universities, students, potential employers, governments and society as a whole.

The traditional purpose of a PhD was to provide the training necessary to start on an academic career. This is no longer the case and in some countries as few as five percent of PhD graduates find permanent academic positions. Another potential career pathway is as a researcher in industry. However, many PhD graduates find themselves in non-academic, non-research positions in which

they will not use their disciplinary knowledge and skills directly. For these reasons, discussions of PhD education are paying more attention to the importance of the more generic and transferrable skills and knowledge that research students develop and the need to pay more explicit attention to their development.

While the debate tends to focus on PhD education as a training activity, it is also important to recognise the substantial contribution that research students make to the national research effort. In Australia research students perform almost 57 per cent of higher education research (as measured by person years of effort). Nevertheless, a research student is not in employment but is undergoing training that will lead to employment. As valuable as the research outputs of the students might be, it is also necessary to ensure that students gain the attributes that will enable them to find worthwhile, meaningful employment that makes best use of their considerable intelligence, knowledge and skills. This means responding to the concerns expressed by potential employers and universities are doing this.

A major theme running through all recent reforms in all countries is the need to focus on student outcomes, not just on the research that they produce. Among other things this has involved recognising the diversity of employment trajectories that a PhD can follow and the need to prepare students for these in ways that will enable them to exploit their full potential.

Among the major initiatives underway in Australia are the detailed assessment and development of coursework and the creation of options tailored to student needs, recognising that these can vary according to student background and intended career; moves to make the pathway to an Australian PhD align better with international best practice, not least because the job market for PhDs is international; work to define and improve the quality of research training, taking into account a range of factors identified as important; and work to improve the overall teaching and learning environment by, among other things, ensuring that research training takes place within institutions that exhibit high standards across the whole range of their activities, including research.

This work will help maintain and improve Australia's reputation as a provider of high quality PhD education that is able to attract research students from around the world and whose graduates are sought by the top institutions in many countries. As the debate continues and programs develop, it is likely that a more diverse array of PhD education opportunities will broaden student choice while improving the quality of the training and the excellence of the outcomes they achieve.

Introduction

Nurturing talent is essential in a complex and rapidly changing world. National prosperity depends on having people with the skills, knowledge and expertise necessary to drive innovation and respond to the hugely complicated global problems and challenges which can threaten our current way of life. This is one reason why governments around the globe support education as a significant national priority. Even in times of economic crisis, governments will often maintain their investments in education, at least in nominal terms, despite cutting back in other areas. They recognise that a well-educated population provides the necessary foundation for a productive, prosperous and resilient country.

Providing everyone with an effective education is necessary to ensure that people have the capabilities and competencies necessary for day to day living. Just as important is that a good education is one way of helping people realise the full potential of their intellectual and creative powers, so that they can exercise them in their everyday work and social life. This benefits society as much as it benefits the people receiving the education.

Obtaining a PhD by research is the pinnacle of formal educational achievement and in principle PhD graduates have experienced an unrivalled opportunity to realise, cultivate and unleash their intellectual potential. Anyone achieving this qualification has demonstrated not only their ability to understand and use specific and specialised knowledge requiring the highest intellectual capabilities, they have also demonstrated their ability to go beyond what was already known to create new knowledge, new ways of thinking and potentially new opportunities for humankind.

The young people we select to undertake PhD training are by definition amongst the best and brightest we have in terms of their intellectual capabilities. We might expect them to become our future leaders and to contribute in many ways to the development of a prosperous, healthy and happy world – and hope they do so. Older PhD graduates, including those using PhD training as a retirement activity, have still made a substantial contribution to knowledge through their research; and their postgraduate education has the potential to enhance their ability to play a mentoring and supportive role in wider society.

Can we improve PhD programs?

While there is no doubt about the importance of the PhD as an educational qualification, or of the contributions that PhD graduates make to national wellbeing, over recent years there has been an increasing awareness that it might be possible to improve the effectiveness of PhD training and that the current system might not be providing the best, most efficient or most effective outcomes for society. Reports question the number of PhDs produced, or their quality, or the relevance of the training they receive given the employment opportunities on offer. There is questioning of whether the intent to increase the number of PhD graduates will be at the expense of their quality and whether the rewards of having a PhD compensate for the costs of acquiring one.

The purpose of this paper is to identify current concerns that different groups are raising about PhD education and PhD graduates; to set them in the context of broader trends affecting education more generally; and to point to some of the reforms and other changes already underway. The paper also identifies issues and views particular to PhD education. Its purpose is not to develop solutions or come up with necessary reforms but rather to provide the context for an informed debate on a matter that is of considerable importance to Australia – as well as to the many young (and not so young) people who are considering the educational strategies that can best take them where they are seeking to go.

The history of the PhD

Recent discussions about the need to modernise the PhD are not surprising given the long history of PhD training. The title 'doctor' goes back to the universities of the Middle Ages although the current concept of a PhD dates from the nineteenth century and the educational reforms that then took place in Germany, most strongly embodied in the model of the Humboldt University. The Friedrich Wilhelm University in Berlin, Germany, claims credit as the first university to award a modern PhD. This required the completion of coursework, the performance of original research written up in a substantial dissertation and the successful defence of the dissertation.[1] In outline this still serves as the model of a modern PhD, although the need for a successful public defence of the thesis can vary from country to country as can the requirement for formal coursework.

The German model proved very attractive so that foreign students, often already possessing a bachelor's degree, moved to German universities for further study. As a result, universities outside Germany started to offer similar opportunities.

While there seems to be some uncertainty about the detailed history of the PhD in the USA, Yale University claims to have awarded the first three PhD degrees in the United States in 1861[2] to students who had completed a prescribed course of graduate study and had successfully defended a thesis/dissertation containing original research.[3] The University of Pennsylvania followed in 1870; Harvard, in 1872; and Princeton, in 1879.[4] The history department of Johns Hopkins University, founded in 1876 as a modern research university dedicated to the discovery of knowledge, claims to be the oldest PhD program in history in the United States.[5] Johns Hopkins became the original model of the US research intensive university.[6]

At present over 400 institutions in the US award PhDs and another measure of the subsequent rapid growth in the importance of research and of PhD education is that US universities awarded more than 1.35 million doctorates between 1920 and 1999, of which 62 per cent were in science and engineering – itself a reflection of the way in which modern economies were becoming more dependent on technological development. In 2009, the United States produced 19 733 doctorates in the life and physical sciences alone[7] and in 2011 US universities awarded a total of 49 010 research doctorates, almost 75 per cent of which were in science and engineering fields.[8]

An interesting indication of the changes that were taking place in PhD training in the US over this period is that in 1920-24 the median time it took to complete a PhD (after receipt of a bachelors degree) was 7 years; by 1995-99 this had reached almost 11 years.[9]

This rapid increase in PhD graduates seen in the USA reflects similar changes taking place around the world – in some countries to an even greater extent. For example, China overtook the USA as the world's top producer of PhDs in 2008, even though China's PhD programs had been stopped during the Cultural Revolution and did not restart until 1978. According to a report in University World News:

1. http://www.ehow.com/about_5257288_history-phd-degree.html
2. http://www.yale.edu/graduateschool/prospective/about.html
3. http://en.wikipedia.org/wiki/Doctor_of_Philosophy
4. http://www.yale.edu/graduateschool/prospective/about.html
5. http://history.jhu.edu/graduate/
6. http://en.wikipedia.org/wiki/Johns_Hopkins_University
7. 'The PhD factory' 2011, *Nature*, 472, 276-279.
8. http://chronicle.com/article/Doctoral-Degrees-Rose-in-2011/136133/?cid=at&utm_source=at&utm_medium=en
9. http://www.nsf.gov/news/news_summ.jsp?cntn_id=108085

China's first PhD programmes in 1978 had only 18 candidates. In 1982, the first doctorates were awarded to six of the 18. Since then enrolment in PhD programmes has grown by some 23.4% annually and by the end of 2007 China had awarded 240,000 doctorates. But the number of qualified professors needed to supervise doctoral programmes has not kept pace, raising fears that quantity is not being matched by quality. ... each qualified Chinese professor has to supervise 5.77 doctorate candidates, much higher than the international level.[10]

Other examples are that Brazil increased its number of doctoral students by 100 per cent over the period 2000-2009,[11] the number of science doctorates earned each year in OECD member countries grew by nearly 40 per cent to 34 000, and in Egypt the number of students enrolled in PhD programs increased from 16 663 in 1998 to around 35 000 in 2009.[12]

In addition to the increases that have already taken place, some countries are setting ambitious targets for the increased production of PhDs or for increasing the demand for them. For example, Zimbabwe is requiring every university lecturer to have a PhD by 2015; Malaysia has set itself the target of achieving 60 000 PhD holders by 2023; the European Union is working to create one million new research jobs by 2020.[13] India is hoping to graduate up to 20 000 PhDs a year by 2020.[14]

Does increasing the number of PhDs improve economic outcomes?

The history of the PhD in Australia

Australia did not start awarding PhDs until the mid twentieth century, with the University of Melbourne awarding the first three Australian PhDs, all in 1948. However, by 1949 all the then Australian universities were offering PhDs.[15] An indication of the speed at which PhD education developed is that Australian universities awarded eight PhDs in 1950, 97 in 1960, 584 in 1970, 836 in 1980, 1 367 in 1990, 3 247 in 2000[16] and 6 053 in 2010. The total number of PhDs awarded by Australian institutions between 1948 and 2009 was over 94 000.[17]

Over the period 2000 to 2010 alone, the number of doctoral enrolments at Australian universities grew by 68 per cent from 27 966 to 47 066; and the number of completions increased from 3 793 to 6 053 per year. This rate of growth was greater than the growth in teaching and research and research only staff numbers.[18]

According to the most recent Census of Population and Housing conducted by the Australian Bureau of Statistics, there were 118 396 PhDs in Australia in 2011. Attachment 2 shows these broken down according to State and discipline. These numbers include those who obtained their qualifications overseas as well as those who graduated in Australia. Data presented in the government's Research Workforce Strategy shows that just under 50 per cent of doctorate qualified individuals in 2006 were born in other countries and that around 22 per cent of Australia's annual supply of doctorates to the workforce comes through international channels – either as international research students who

10. http://www.universityworldnews.com/article.php?story=20091127121544352
11. http://www.eua.be/Libraries/Doctoral_week_2012/Thomas_Jorgensen_Plenary_II_1.sflb.ashx
12. 'The PhD factory' 2011, *Nature*, 472, 276-279.
13. http://www.eua.be/Libraries/Doctoral_week_2012/Thomas_Jorgensen_Plenary_II_1.sflb.ashx
14. 'The PhD factory' 2011, *Nature*, 472, 276-279.
15. Ian R Dobson 2012: 'PhDs in Australia from the beginning', *Australian Universities' Review*, Vol 54, pp94-101.
16. http://www.aare.edu.au/03pap/eva03090.pdf
17. Ian R Dobson 2012: 'PhDs in Australia from the beginning', *Australian Universities' Review*, Vol 54, pp94-101.
18. http://www.lhmartininstitute.edu.au/insights-blog/2011/11/70-overseas-students-help-boost-australian-universities-research-profile

stay on in Australia upon completion of their studies or individuals who gained their qualifications in another country and entered Australia through temporary or permanent migration processes.[19]

Clearly, the number of PhD graduates in Australia has increased very significantly over recent years. In 2011, there were 6 780 PhD completions in Australia and a further 11 314 students started their PhD studies. It is necessary to add to these figures the number of immigrants with doctoral qualifications who entered Australia during the year. More generally, the students who completed masters' degrees by research or students completing the great number and diversity of postgraduate qualifications available through coursework added to the extent of the Australian population with postgraduate qualifications. This huge increase in numbers means there is now a much more diverse PhD graduate population than in even the recent past; moreover as an increasing proportion of the population acquire a qualification, its 'elite' nature tends to disappear as does the premium that can arise from having a credential that very few other people possess.[20] This is especially the case given the huge massification of tertiary and higher education that has taken place over the same period and the increasingly diverse range of postgraduate and lifelong learning options that has become available.

Does the status of PhDs depend on their relative rarity?

The Australian PhD

Before proceeding further, it is worth exploring in more detail what characterises the PhD as a top level qualification. The details of doctoral education programs vary between and sometimes within countries and institutions but all require independent research that leads to a significant new contribution to knowledge. In the US, for example, there is a greater focus on coursework and doctoral candidates may have to pass an examination (often involving an oral as well as a written component) to demonstrate their competence to continue with a PhD before they start work on their dissertation. Often course work can take up a significant proportion of time during the first couple of years and the research that performs the core of the program requirement can take three to eight years, depending on discipline, although some candidates can take considerably longer. Within Europe the Bologna Process is leading to a convergence of PhD programs across different countries and institutions, with the PhD comprising a three to four year program following a Masters degree. While the PhD program centres on a major research project, it increasingly also involves additional coursework to promote the development of generic or transferable skills to complement the disciplinary knowledge and skills that the research develops.

The original Australian model of PhD training differed from that US model (itself based on the nineteenth century German model) because it did not combine a program of coursework with the research. Instead, the Australian model followed the practice of the UK, taking the form of a research apprenticeship in which individual students worked closely with a nominated supervisor.[21] At present the Australia the PhD training model still largely follows this model.

The Australian Qualifications Framework (AQF) defines a PhD as a level 10 qualification, the highest

19. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/ResearchSkillsforanInnovativeFuture.pdf

20. This is very apparent at the bachelor degree level. A recent report by the University of Warwick in the UK identified a fall of 22 per cent in the difference between graduate salaries and average earnings over the period 2003 to 2011. See: http://www.theaustralian.com.au/higher-education/times-tough-for-uk-graduates-as-degrees-lose-pay-packet-premium/story-e6frgcjx-1226520670605. In the US a recent study found that "of 41.7 million working college graduates in 2010, 48 per cent – more than 20 million people – held jobs that required less than a bachelor's degree. Thirty-seven percent held jobs that required no more than a high school diploma." See: http://chronicle.com/article/Millions-of-Graduates-Hold/136879/?cid=at&utm_source=at&utm_medium=en

21. http://www.aare.edu.au/03pap/eva03090.pdf

level available. While the AQF recognises two forms of Doctoral degree (the Doctoral Degree (Research) and the Doctoral Degree (Professional)), this paper concentrates on the Doctoral Degree (Research). The award of this degree requires the candidate to have made a significant and original contribution to knowledge and to have a systematic and critical understanding of a complex field of learning and critical research skills for the advancement of learning.[22] In particular, the Framework requires that:

> *The Doctoral Degree (Research) qualification (leading to the award of a Doctor of Philosophy) is designed so that graduates will have undertaken a program of independent supervised study that produces significant and original research outcomes culminating in a thesis, dissertation, exegesis or equivalent for independent examination by at least two external expert examiners of international standing.*
>
> *Research in the program of learning will be for at least two years and typically two-thirds or more of the qualification. The program of learning may also include advanced coursework to enhance the student's capacity to make a significant contribution to knowledge in the discipline (or cross-disciplinary field). The advanced coursework may support but not replace the research outcomes.*

The AQF qualification-type descriptor sets out the purpose, knowledge, skills, application of knowledge and skills, and volume of learning (typically three to four years) for an Australian Doctoral Degree qualification. Important for later discussion is that the AQF requires accreditation authorities and those developing qualifications for accreditation to explicitly identify generic learning outcomes falling into the four broad categories of fundamental skills, people skills, thinking skills and personal skills that align with the level, type and purpose of the qualification.

One factor that has distinguished the traditional Australian PhD from many others is that the qualification flows only from an examination of the thesis and has not included an assessment of the student. Except in special circumstances, the assessment formalities have not required the student to defend the thesis; and while research students increasingly undertake courses as part of their doctorate program, their performance in these courses is not a factor in the award of their PhD. This is different from the situation in most other countries. For example, the Eurodoc statement of standards in the assessment, expectations and outcomes of doctoral programmes in Europe includes as a "minimum outcome and expectation" that

> *... the thesis has been defended against examiners both internal and external to the institution with suitable expertise in the subject area, ensuring that these examiners are chosen fairly.*[23]

The Standards for PhD education in biomedicine and health sciences in Europe similarly require an oral defence and also propose that this should be open to the public.[24]

In Australia the Group of Eight universities all require research students to present a completion seminar. While this is a public presentation on the research thesis (before submission) and publicly advertised across the university, it does not form part of the formal assessment process.

One reason for the Australian focus on the dissertation is the geographical isolation of Australia and the high cost of bringing external examiners, often from Europe or the USA, to Australia. However, a consequence of this is that without direct contact with the student, examiners may not be able to assess the more generic outcomes of PhD training that go beyond those that can be identified by examining the thesis. Indeed, given that students may be able to use the services of professional editors (albeit working to strict codes of practice) in finalising their thesis, there may even be questions

22. http://www.aqf.edu.au/Portals/0/Documents/Handbook/AustQuals%20FrmwrkFirstEditionJuly2011_FINAL.pdf

23. http://www.eurodoc.net/file/0706_ed_descriptor.pdf

24. http://www.orpheus-med.org/images/stories/documents/Standards-2012-01.pdf

as to whether the thesis provides an accurate indication of the candidate's ability to write clearly.[25] As discussed later, a finding of many studies on the employability of PhDs is that they have poor communication (including writing) skills.

Should all Australian PhD candidates have an oral exam?

New technologies and the ready availability of video conferencing may provide an opportunity to broaden the assessment process. As discussed below, a decreasing proportion of PhD graduates find employment within academia or jobs that require them to conduct research. For this reason an assessment process that extends beyond the research outputs themselves might be more helpful to prospective employers. Indeed, at least some Australian universities are already exploring ways in which they can extend the examination process beyond an examination of the thesis so that the examination and the outcomes it achieves are more compatible with best international practice. Some universities have introduced oral examinations.

Another difference between Australia and many other countries is that in Australia the requirement for admission to a PhD for domestic students is the completion of an honours degree (normally a one year addition to the bachelor's degree including a research project) and achieving at least a 2.1 in that degree. In other countries the entry requirement is generally having achieved a (two year) master's level qualification. For example, the European Bologna Process has PhD programs forming the "third cycle" of higher education based on advancing learning through original research and following the bachelor and master cycles.[26] The European standards for PhD education in biomedicine and health sciences note:

> *According to the Bologna process, a PhD programme follows a 1-2 year master's programme and a 3-4 year bachelor programme. Countries with only 4-year master's + bachelor programmes should supplement these with additional qualifications.*
>
> *Some countries do not follow the Bologna process, and here other studies or work experience that brings the student to master's level can be used in the admission criteria.*[27]

International standards for the PhD qualification

While universities around the world offer PhD education and there is considerable commonality in how they do this, there can still be differences between countries in the details of the training provided, the educational experience offered and the examination process used to distinguish successful PhD students. As well as varying significantly between countries, the requirements to complete a PhD can also vary over time and even within countries. Differences can cover matters such as the qualifications or experience necessary to start a PhD, the time necessary or the time usually taken to complete a PhD, the requirement for course work as well as research, the degree of independence of the research performed by candidates, the structural organisation of PhD training (from single supervisor to doctoral training centres) and the extent to which the assessment processes focus purely on the research (the dissertation) or take into account the broader competencies of the candidate. Even within an individual country, there can be issues of transparency, compatibility and credibility between different institutions.

25. Gerry Mulins and Margaret Kiley (2002) provide an interesting account of the dissertation examination process and the views of examiners in their paper 'It's a PhD, not a Nobel Prize; how experienced examiners assess research theses', *Studies in Higher Education*, 27, pp369-386. They note the reluctance of examiners to fail a thesis, given the work and resources that have inevitably gone into its preparation.

26. http://ec.europa.eu/education/policies/educ/bologna/bologna.pdf

27. http://www.orpheus-med.org/images/stories/documents/Standards-2012-01.pdf

These differences are not trivial because PhD graduates are often highly mobile and willing to move to different countries to take up relevant opportunities to work with the best people in their field, wherever they might be. Moreover, recruitment processes increasingly seek talented people, no matter where they might be in the world. There is intense competition to attract the best and qualifications provide a proxy measure for identifying the most creative and capable experts across countries. Uncertainty about the relative worth of similarly named qualifications, or about the set of personal competencies and attributes someone with the qualification should possess, can cause confusion and result in incorrect or inappropriate decisions. For this reason there have been attempts to set international standards for what a PhD should mean.

Are PhDs from different institutions and different countries equivalent?

One example is the publication *Standards for PhD Education in Biomedicine and Health Sciences in Europe*, published in 2012.[28] An international taskforce (appointed by the Organisation for PhD Education in Biomedicine and Health Sciences in the European System (ORPHEUS), The Association of Medical Schools in Europe and World Federation for Medical Education) prepared the document and the standards presented in the document are the result of extensive discussions taking place at ORPHEUS annual meetings since 2004, discussions at meetings of the Association of Medical Schools in Europe and many other societies, and at over 20 workshops and meetings held at universities and specialised organisations.

The standards presented in the document cover the research environment, program outcomes, admission policy and criteria, the PhD training program, supervision, the PhD thesis, assessment and structure – matters relating to the organisation responsible for providing the PhD education. Basic standards described in the document are those which must be met from the outset; quality development standards are those which accord with the consensus about international best practice and which institutions should strive to meet. An example of the latter is that PhD programs should include time in another laboratory, preferably in another country, to promote internationalisation.

Other work looking at developing standards is more exploratory and offering guidance and suggestions. For example, the Accountable Research Environments for Doctoral Education (AREDE) Project funded through the EC Lifelong Learning Program has identified the set of questions that it may be useful to ask in relation to the quality of supervision.[29] These include matters such as whether the institution taking on doctoral students has policies relating to:

- the maximum number of doctoral candidates per supervisor;
- obligatory training for supervisors;
- voluntary training for supervisors;
- a requirement or recommendation for a minimum number of meetings with the supervisor(s);
- a requirement or recommendation for supervisory teams;
- written agreements between supervisors, supervisees and/or institution;
- procedures for dealing with supervisor-supervisee conflicts?;
- systematic feedback collected from doctoral candidates?; and
- other, (specified) issues.

It is difficult to underestimate the importance of supervision and the quality of supervision in creating

28. http://www.orpheus-med.org/images/stories/documents/ORPHEUS-AMSE-WFME-standards-for-PhD-education.pdf

29. http://www.eua.be/Libraries/Doctoral_week_2012/Thomas_Jorgensen_Plenary_II.sflb.ashx

the PhD experience and in ensuring the completion of a PhD. Apart from anything else, supervision can help make the difference between someone behaving as a research assistant or being a genuine research student. An indication of the need for standards in this area comes from China where a recent study by Wuhan University's Research Centre for Chinese Science Evaluation found that one in six professors was supervising more than 10 postgraduate students each at some 30 universities, and one in 10 was supervising more than 20 students each.[30] Such numbers raise issues about the depth and quality of mentoring the students receive and whether such numbers enable a clear differentiation to be made between a research assistant and a research student.

The importance of the PhD

Governments and the public both appear to recognise the importance of PhD education. One consequence of this is that the number of PhD graduates around the world is increasing at an ever expanding rate. Unfortunately, the job opportunities available for PhD graduates and the security and remuneration these opportunities provide do not always appear commensurate with the opportunity costs involved in studying for a PhD, at least to the graduates themselves. Some PhD graduates find that the openings they expected to appear once they had acquired a PhD are not there or do not take the form they would like. The jobs on offer may lack security or status, be poorly paid, not use directly the particular skills or disciplinary knowledge the graduates acquired through the course of their PhD training, or may not even require a PhD qualification at all. In some cases people having a PhD are seen as overqualified or as being likely to be deficient in some of the generic attributes necessary for a good employee – effective communication skills, or an ability to work effectively as part of a team, for example.

Are student expectations about the value of a PhD reasonable or realistic?

The reasons for this situation are likely to be many and complex. Some doctoral students may have unrealistic expectations, others may have studied in areas of personal interest for which there is little direct demand among employers; some employers may not understand and appreciate the benefits of PhD training and fail to seek or reward PhD graduates accordingly; some PhD training may be inadequate or too specialised; lack of other work experience might make it difficult for doctoral students to articulate their skills and attributes in a way that markets them effectively to the private or government sectors; in certain areas we may be producing too many PhD graduates relative to society's needs or capacity to pay, in others we may be producing too few; and so on.

One issue contributing to this situation may be the extent to which PhD training has responded (or failed to respond) to the changed context in which it often takes place. For example, a 2012 report entitled Advancing Graduate Education in the Chemical Sciences by the American Chemical Society concluded that:

> *... the education of doctoral-level scientists has not kept pace with major changes in the global economic, social, and political environment that have occurred since World War II, when the current system of graduate education took shape.*[31]

As discussed later, research, the problems that research needs to address and the means through which the benefits of research flow through to the wider community are very different now from when the first PhD programs appeared in the nineteenth century. The question is whether the programs offered

30. http://www.universityworldnews.com/article.php?story=20121025111620913

31. http://portal.acs.org/portal/fileFetch/C/CNBP_031601/pdf/CNBP_031601.pdf

have responded to these changes in ways that add value to the program or have evolved in relative isolation from them.

Some of the changed environment for doctorate training flows not from changes in the external environment but from the more diverse student cohort undertaking PhDs. This diversity relates to factors such as age, gender, ethnicity, nationality, background, previous work experience, values and the pathways that have led to a PhD.

Contrary to past experience, in many disciplines it is now unusual in Australia for PhD students to move directly from an undergraduate degree to postgraduate training and to be working on their PhD fulltime. In 2011, the average age at commencement of a PhD was 33.[32] Another indication of the aging cohort of research students is that 10.4 per cent of the respondents to the 2010 National Research Student Survey were in the age group 50 to 59; and 65 respondents were aged 70 and above. This means not only that people start their PhD training with a more varied background than formerly; it also means that they experience a different training environment. For example, among the research students responding to the survey:

> *... 45.6 per cent were in full-time work and 9.6 per cent in part-time work as their main activity in the year prior to commencing their studies. About one-quarter (24.0 per cent) entered their degree straight from an undergraduate course and a further 16.2 per cent made the transition from other postgraduate studies. These pathways differ greatly across the fields of study, with many science students making the transition straight from undergraduate studies (43.3 per cent), while architecture and education students were the most likely to have entered their research degree from full-time work (64.8 and 63.9 per cent, respectively). Importantly, the majority of those in full-time work before they began their degree were in jobs directly related to their studies.*[33]

The survey also found that around 60 per cent of respondents were in other employment at time they were working on their research degree (although nearly 75 per cent of these were working in the university sector).

Part time students often have very significant commitments – financial, work, and family – outside of their PhD work. Among other things this can make it more difficult for them to operate as part of an academic community with its creative tensions and constant exchange and testing of ideas from across as well as within disciplines. Indeed, a common complaint of many PhD students is their sense of isolation. The 2010 National Research Student Survey found that more than 40 per cent of respondents felt that they had never really belonged in their department and almost 25 per cent agreed with the statement that they felt lonely and isolated in their studies. One factor contributing to this may be that 30 per cent of research students said "... they primarily undertake their study for their research degree at home" and over 5 per cent identified their main study location as "at work outside the university."[34]

Another factor that has changed the context in which PhD training takes place has been the very considerable increase, in absolute terms, that has taken place in public investment in research. While this has helped to support the increased number of research students, it has also led to greater public and government scrutiny of the investment and more emphasis on public accountability. One issue this can raise is the relative balance of public and private returns on PhD training.

How are PhD programs changing in response to the changing student cohort?

32. Margaret Kiley 2012, 'Postgraduate students' award choices and university practices: room for alignment?' http://chelt.anu.edu.au/sites/default/files/people/dr-margaret-kiley/QPR_2012_proceedings.pdf

33. http://www.cshe.unimelb.edu.au/people/bexley_docs/RAW_Combined.pdf

34. Ibid.

In general doing a PhD by research has been seen as providing significant public good benefits (and it certainly contributes significantly to the higher education sector's output of research). For this reason a domestic student doing PhD training in Australia does not pay tuition fees, which are covered (at least in part) by the Research Training Scheme block grant. As the number of research students increases, and as more students work for a PhD towards (or even after) the end of their career, rather than at its beginning, it becomes important to at least question whether the balance between public good and private return remains the same – and whether this has implications for the funding of such training.

Other consequential factors that have changed the context of research training include changes in the nature of research and its management; the increasing complexity of the problems that society expects research to address; and the more explicit expectations that now exist about the ways in which researchers and research will provide direct economic, social and environmental outcomes that contribute to the improved wellbeing of the nation.

Whatever the reasons for the current concerns with PhD training, there is a need to identify, understand and respond to them. The consequences of making bad decisions would be serious. Among other things they could include the short-changing of some of our most talented young people; and failing to meet society's need to harness our best equipped experts to the serious challenges we face both domestically and globally. Inappropriate responses to perceived or real problems might also decrease the returns on the considerable public and private investments that go to support PhD training.

We need the best education system we can achieve and we need to develop the highest quality PhD graduates we can. This requires the careful analysis of any problems that might exist and the detailed consideration of possible reforms, not a knee jerk response. A focus on quality might also require a change in the emphasis of much of the current policy discussion which still often aims at increasing the number of PhD graduates, irrespective of the employment opportunities that currently exist or of the excellence of the training provided or outcomes achieved.

Pressures on and in national education systems

Increasing demand for higher education

Over recent years there have been significant changes within national education systems. A primary driver of many of these changes has been the increasing demand for tertiary education. This reflects a more widespread understanding of the direct personal benefits that can result from higher qualifications (such as greater earning capacity[35] and the decreased probability of unemployment[36]), as well as the more intangible benefits of personal development.

Some of the tangible benefits of higher education are the result of the growing need for highly skilled people. There is an argument that the proportion of available jobs requiring higher levels of skills and knowledge is constantly growing. In part this is because technological development is playing an ever more important role in structuring the economy, so that the opportunities for unskilled people are disappearing or moving overseas. In a highly competitive jobs market, credentials can be vital in getting a foot in the door. However, increasing demand for higher education and greater competition for jobs may also reflect or result in the inflation of credentials, such that postgraduate qualifications become the entry point for employment that formerly required only a bachelor's degree. Indeed, a recent paper on the future of graduate education in the USA noted that:

> *...in the knowledge economy, a graduate degree will become the new bachelor's degree, the minimum education credential that high-skills employers require.*[37]

One unemployed Australian PhD has reported being told by a recruiter:

> *A PhD is not enough these days ... You need something else to make you stand out. Go do an MBA or a graduate diploma in clinical trials or a masters in patent law.*[38]

Greater cohort diversity

One characteristic of an education system that is growing in both absolute terms and in terms of the proportion of the population taking advantage of it, especially at the tertiary level, is that the system tends to become more diverse. This can happen at two levels.

First, there is inevitably a much more varied group of people taking advantage of the educational opportunities on offer. More means different.[39] This is both a cause and an effect of the expansion. Because people's aspirations (for themselves and for their family) tend to increase in line with their level of education, expansion can create even greater demand for expansion, and at all levels.

35. The Graduate Careers Australia *Postgraduate Destinations 2011* report found that median salaries for graduates in first full time employment was $58 000 for those with a postgraduate diploma/certificate, $57 000 for those with a coursework masters and $68 000 for those with a research masters/PhD. See http://www.graduatecareers.com.au/wp-content/uploads/2012/09/Postgraduate-Destination-Report-2011-secured.pdf

36. In 2011 the unemployment rate for postgraduates was around 2.7 per cent, compared with 3 per cent for bachelor degree holders and 7.1 per cent for people without any post-secondary qualification.

37. Commission on the Future of Graduate Education in the United States, 'The Path Forward', April 2010.

38. http://www.theaustralian.com.au/higher-education/opinion/no-gold-at-the-end-of-the-rainbow/story-e6frgcko-1226401538010

39. In his notorious essay in *Encounter* in the mid-1960s, Kingsley Amis argued that "more means worse". But this begs the question – worse at what?

Second, and in response to this broadening range of interests, capacity and motivation, there is often an increase in the diversity of education providers and an increase in the variety of the educational services offered by individual suppliers. This leads to more diverse ways and means of learning. For example, there may be growth in the number and type of private suppliers as new entrants respond to new market opportunities; many more part time courses; the tailoring of courses, including postgraduate courses, to particular market needs; and more formal and informal learning opportunities at work, including those provided by employers. Whether these factors are changing the traditional model of PhD education or not is an important question.

Lifelong learning is a reality and people may decide to take up higher education and training at any age, responding to their personal circumstances and the changing demands of their employment. From the perspective of an institution providing education services, this means not only that the cohort of students taking a particular course can include many age groups, it also means that each cohort can encompass a wide range of experience and ability.

Another important factor increasing cohort diversity has been the development of higher education as an important service sector export. For example, the proportion of international commencing PhD students in the total Australian cohort increased from 21 per cent in 2002 to 37 per cent in 2011 when there were 7 147 domestic commencing PhD students at Australian universities and 4 167 commencing international students. This cultural enrichment has advantages for PhD education (and can potentially help increase the pool of talent available to Australian employers) but can also create challenges as international students sometimes face problems or issues different from those that domestic students experience and may require additional or different kinds of support.

One consequence of this increasing diversity within any cohort is that students taking the same course are likely to have different needs and expectations, as well as a range of unique individual situations that will affect their ability to participate in the course directly and as part of a broader learning community. Some students may be seeking credentials that will help advance their careers or employment opportunities, others may be there to follow up personal interests, hobbies or even to use the course as a retirement activity.

Do PhD programs need to become more diverse as the student body becomes more diverse?

This diversity of interests and expectations can exist at any level from specific vocational training to a PhD, although the issues it can create may (or should) be easier to deal with at the PhD level. This is because PhD training is by its very nature bespoke, individual and intimate – it does not usually involve large numbers of students all being taught the same material. Each PhD student follows an individual learning and training trajectory. However, the impact of increased student numbers and greater diversity at the undergraduate level could well have an effect on the preparedness of students completing undergraduate degrees to undertake a PhD by research. An increase in numbers may also make it more difficult to maintain the breadth and quality of individual supervision that research students receive.

The changing needs and values of students

In addition to the pressures for change resulting from the increasing supply of students and from the demands of society in general and of employers in particular, there can be significant tensions resulting from the changing characteristics of the students entering the education system – especially the higher education system. One factor here is the increase in diversity previously mentioned, itself a necessary

consequence of increasing numbers and their broader catchment. For example, the relevant non-academic work experience of mature students will often exceed that of their supervisors; and the level of preparation for learning, the motivation and the level and quality of background knowledge among students can vary considerably, even within a single cohort. This diversity can have major benefits because the students themselves contribute in important ways to the quality and effectiveness of the higher education learning environment.

A more diverse student body bringing in a broader range of knowledge and experience has the potential to lead to more productive interactions between students and a higher quality learning experience. Nevertheless, having a more diverse student cohort can make the process of providing higher education more complex and more difficult, which means that continuing to provide education services in the same ways as in the past may no longer be viable or effective. Moreover, it may be difficult to capture the benefits of a diverse student cohort when significant numbers of students are part time and unable to participate fully in the informal as well as in the formal activities centred on the university campus.

Another source of tension can be the changing values of students across generations. Values can affect factors such as attitudes to work-life balance (not just as a student but post-education); the preparedness to consider and use different forms of technology for learning; the receptiveness to different forms of pedagogy; the wished-for balance between teaching and learning; attitudes to working in groups rather than as an isolated individual; the sought-for balance between in-depth and broader approaches to the acquisition of knowledge and skills; institutional loyalty, including the propensity to move from one job or task to another; and even career aspirations. These changing values and preferences, especially when combined with the more sophisticated demands of employers and new kinds of job, as well as the opportunities created by new technologies and by research into cognitive development, mean that it is important that universities and other education providers do not apply the assumptions of a twentieth century workforce or pedagogy when creating the workforce of the mid twenty-first century.

Reconciling specialisation and generalisation

Pressures and opportunities for change occur at all levels of the education system. However, the demands placed on the system become increasingly complex with higher levels of education. One reason for this is that the competing and sometimes conflicting demands of specialisation and of the development of high level generalist skills become especially difficult to address as the intensity of education increases.

Does a PhD research project always require specialisation?

Working for a PhD entails doing research that makes a significant new contribution to knowledge. Almost inevitably, this will result in a narrow focus. One reason for this is the large numbers of researchers addressing any broad topic, such that a high degree of specialisation may become necessary to ensure the work does not duplicate research conducted elsewhere; another is that an ability to provide new knowledge significant at a broader, strategic level will usually require a breadth of experience that a typical research student is unlikely to possess.

Specialisation is not necessarily bad: society needs and will always need subject experts with great in-depth knowledge and an ability to examine in detail highly specialised areas based on extensive but focussed experience; on the other there is also a need for broad, strategic and creative understanding flowing from the application of high-level analytical and conceptual skills that build on broad, cross-disciplinary knowledge.

Each of these complementary but different ways of working requires high levels of education combined with relevant experience. An individual's degree of comfort with these different approaches can be as much a matter of personality as of education, but a sound education can help realise the potential for both. Different styles of pedagogy and of learning may be necessary to achieve these dissimilar but complementary outcomes but even at the extreme ends of the spectrum the educational experience has to offer the opportunity to hone intellectual skills beyond the needs of quotidian demands and in a supportive and relatively low risk environment, such that the consequences of failure (an inevitable outcome of risk) are acceptable.

The need to master technical detail as against an ability to operate broadly across fields and strategically can change, even within an individual. For example, as a career progresses to higher positions with greater responsibility for broader leadership, the ability to operate with a more general and broader strategic perspective becomes increasingly important, even though the first steps on the career ladder may demand the ability to operate in a highly specialised and focussed way involving great detail and in-depth knowledge. One solution to this is to encourage graduates to gain multiple qualifications at different times, as appropriate; another is to consider changes to the learning content of individual qualifications by using an holistic approach to balance specialisation with complementary breadth. However, teaching general and higher level skills before there is a need to use them may not be effective. This is why life-long learning is important and why even though a PhD may be the summit of educational achievement it should not mean the end of formal education.

Need for flexibility

A further major challenge is that education services and outcomes need more than ever before to recognise and embrace the importance of contingency in everyday life. The unforseen is always with us. The interrelationships between different parts of our economy and the interdependencies between different parts of the world place a premium on an education system that supports flexibility.

An effective education system leads to a population having the ability to respond to unexpected events in thoughtful and creative ways that take advantage of the new circumstances while still retaining the ability to respond to subsequent (equally unexpected) changes. Higher education has to aim at creating adaptability and resilience as essential outcomes for its students if they are to prosper in the modern world.

Adaptability has to cover both the ability to apply existing knowledge to unexpected or new problems and the ability to move from one career to another as opportunities arise or change. Maintaining such flexibility while focussing on very narrow areas of specialisation can be difficult. However, if PhD training does not facilitate adaptability and broader creative responses to unforeseen circumstances, it not only fails the students, it also means that society is losing the potential of some of its most talented and thoughtful people.

Funding constraints

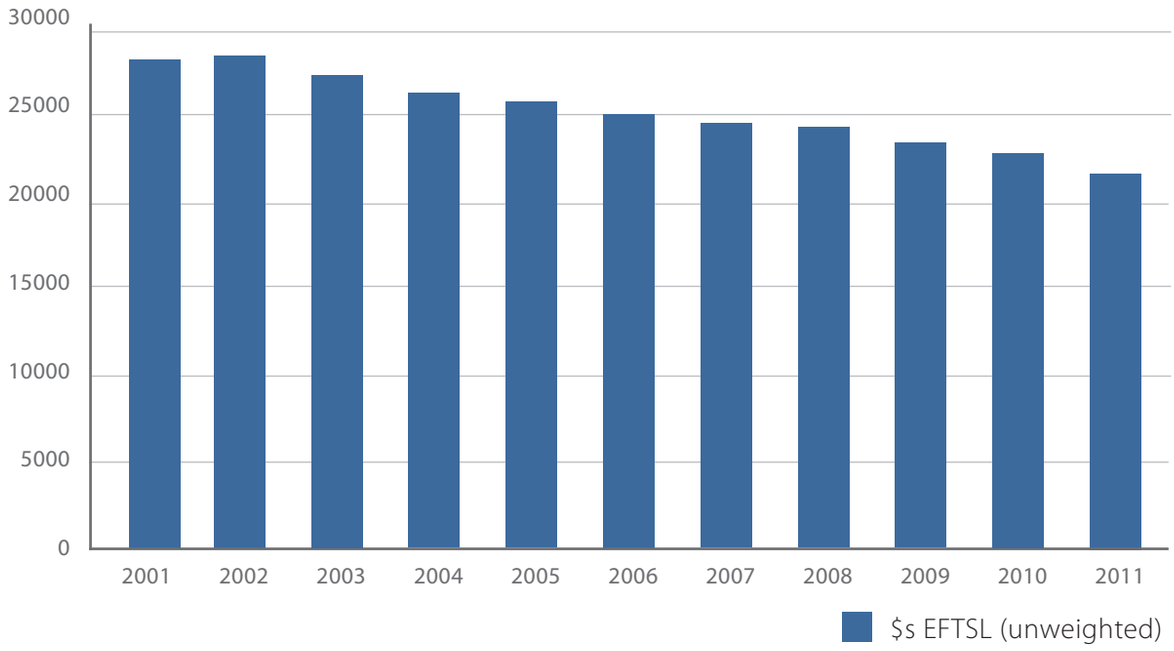
Universities in Australia and elsewhere are facing challenges as their costs increase, funding from all sources is becoming less certain and the market for students is becoming global and more competitive. This creates problems for all areas of university activity and PhD education is at much as risk as other areas.

In Australia, for example, funding for the Research Training Scheme (RTS), a block grant that supports

research training for students undertaking research doctorate and research master's degrees, has not increased since its introduction in 2001. Annual indexation has failed to keep pace with inflation, with the result that RTS funding declined by around 14 per cent in real terms over the period 2001 to 2012. Over this same period the domestic HDR load increased by 10 per cent, so that RTS funding per domestic HDR equivalent full-time student unit decreased by over 23 per cent over the same period. [40]

It is clear that the RTS does not cover the investment that universities make in research training and independent analysis has confirmed this. In 2011 the Department of Innovation, Industry, Science Research and Tertiary Education commissioned Deloitte Access Economics to undertake a study investigating the full costs of research training in universities. While the analysis had some limitations resulting from data compatibility issues, its conclusion that the RTS underfunds research training costs by almost 30 per cent was in accord with university expectations and experience.[41]

RTS $s (2010 prices) per Australian HDR EFTSL (unweighted)



This situation is especially difficult at a time when there are pressures to make changes to the PhD learning experience to improve its quality and the quality of its outcomes. Possible changes, such as the introduction of formal but tailored coursework, are likely to increase costs both directly but also by lengthening the time needed to complete the degree. Increasing the number of PhD students would also require additional resourcing.

Another problem relating to the lack of full cost funding relates to the opportunities that universities can provide PhD students in research environments outside the university – something increasingly seen as contributing to the quality of the PhD learning experience.

Who should pay for the increasing cost of PhD programs?

For example, many students already enrolled in Go8 member PhD programs work in non-university research organisations such as Cooperative Research Centres (CRCs), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), medical research organisations and others able to offer a different but still high quality research experience. In many cases the universities negotiate funding arrangements with the host research organisations in arranging such secondments. However,

40. http://www.go8.edu.au/__documents/go8-policy-analysis/2012/go8backgrounder31_financing_.pdf

41. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/FullCostofResearchTraining.pdf

these negotiations are difficult because the universities themselves receive significantly less than the actual costs of the training and services they provide to the students. Full cost funding of research training would make it easier for universities to broaden the research training they provide by working with non-university research providers. Such funding would need to cover all the costs of training, supervision, infrastructure, consumables and student support services, noting that these can vary significantly between disciplines and areas of research.

While it is important to take into account that funding provided through schemes such as the RTS does not cover the full cost of research training, it is also necessary to recognise that such funding achieves outcomes which go beyond the training of researchers. This is because such training produces genuine and often important research outputs that would otherwise not exist. Moreover, doctoral students contribute to the setting of institutional research strategies by developing ideas and knowledge which diffuse through research student interactions both with each other and with other players in the innovation system. These all add value and enhance the overall academic research environment and are a direct outcome from the funding provided for research training.

Need for innovation

The various changes taking place within the education system combined with the changing societal expectations about what education will provide and the increasingly varied requirements among employers for new and specialised sets of skills, competencies and knowledge, all provide an opportunity for innovation within the broader education sector. They also create the need for such innovation in order to meet society's demands for more and better education in efficient and cost effective ways. Increased diversity within the system is both a driver and an outcome of innovation.

Innovation in education can involve a wide range of factors. These can include changing the timing and length of courses in recognition of students' competing responsibilities, revising or adding to course content, promoting interdisciplinary approaches and opportunities, making better use of work placements and opportunities outside the narrow confines of the educational provider, providing education services within the workplace, and making better use of the opportunities presented by new technologies, existing facilities and even the non-university commitments of students. Innovation might also involve the development of completely new kinds of qualification which better meet the needs of society and the constraints on potential students. Such opportunities can exist at both undergraduate and postgraduate level.

Significance for the PhD

While these broad issues are important across all levels of a national education system, they become especially important with respect to PhD education. This is because the PhD provides the summit of educational experience and the highest level of qualification. PhD candidates are chosen from the most talented students and undergo a rigorous additional period of training and education before they graduate with a doctorate. As such, PhDs represent an elite group (although the extent to which this is the case is becoming arguable as the proportion of doctoral graduates in the population increases and because of a greater awareness of the often low status jobs that PhD graduates can sometimes find themselves occupying). Moreover, PhD education is expensive, and not just in money terms.

Debates about PhD training take place in the context of the issues impacting on education and the education system in general but there are also many specific issues peculiar to the experience of PhD training, its value, its purpose and scale. However, before exploring these in more detail, it is worth exploring in more detail why we need PhD graduates.

Why we need PhDs

Expectations

The considerable individual and public investment that feeds into PhD education creates expectations (personal as well as societal) about the important roles PhD candidates will play after graduation, whether this is in academia, government, business or the non-profit sector. Because it aims to start with the best and most able students, PhD education should add value and opportunity, not decrease them; it should broaden opportunities, not narrow them; and it should justify the public and private expenditures it consumes in terms of the public and private outcomes it achieves.

One of the critical roles that PhD graduates have traditionally filled was that of future university teachers with responsibility for the education of upcoming generations of higher education students. In the past a PhD was in effect a licence to operate as an academic and this was often its principal purpose, although at all times PhDs have worked and contributed across many sectors of society. Nevertheless, many PhD students, at least at first, aspire to become academics.

The importance of academics in developing the next generation of national thinkers, leaders and business people has served to underline the vital significance of PhD training. This is because the quality and effectiveness of PhD training and the attributes it can or should develop in PhD candidates provide a necessary foundation for the effectiveness and quality of the future higher education system.

As the number of PhD graduates has increased, however, a decreasing proportion of them is able to find employment in academia and the majority now find work in other roles. Moreover, the nature of academic work has itself changed, both in terms of its day to day requirements and in terms of the security and status that it offers. Over recent years the trend has increasingly been to part time and casual employment, often dependent on the availability of external funding. This lack of security is not always attractive at the life stage that new PhD graduates have reached. It is noteworthy that the OECD *Science, Technology and Industry Scoreboard 2011* reports that over 23 per cent of doctoral graduates hold fixed term appointments in the first five years after graduation in 10 out of the 16 countries for which data are available; and that in the majority of countries temporary employment remains more frequent for doctoral graduates than for other employees.

Concerns about the often poor conditions of those PhD graduates who do find research jobs is widespread, as shown by the establishment of the cross border International Consortium of Research Staff Associations (ICoRSA). This has the specific objective of advocating for better working conditions and to promote policies which address early-career challenges including low wages, limited career prospects, mobility restrictions and inadequate recognition.[42]

Does a move to a knowledge economy increase demand for PhDs across all disciplines, or only some?

An argument for the increasing importance of PhD training that goes beyond the need to ensure a supply of high quality academics has been that such training plays an especially crucial role in modern societies because PhD instruction involves training in research through the conduct of research. PhD candidates are as much part of the research system as they are of the education system; and after graduation many of them will become (or at least have the potential to become) researchers – in business and government, as well as in academia. The competitiveness of national economies, the quality of social services and even the sustainability of our natural and constructed environments

42. http://www.nature.com/naturejobs/science/articles/10.1038/nj7407-397c

depend to a growing extent on the quality of the research that underpins our interventions in them. Underlying the quality of research is the quality of the researchers and this depends in considerable part on the quality of the research training they have received. However, it is well to remember that research training can take place on the job in business as well as more formally (although still on the job) in universities. Not all research positions in business require a PhD.

In the USA the Bureau of Labor Statistics has prepared projections of the number of jobs that require a doctorate or professional degree for entry. These projections forecast an increase of 20 per cent between 2010 and 2020, a growth rate which is greater than the projected growth for all occupations of 14 per cent. Taking into account the demand resulting from the need to replace workers who retire, the Bureau estimates that by 2020 there will be 1.7 million openings in the US that will require a doctorate or professional degree. The largest projected increases in occupations requiring an advanced degree are marriage and family therapists, physical therapists, audiologists, medical scientists, mental health counsellors and veterinarians.[43] These clearly seem to represent the personal service demands of an aging population, are not necessarily the areas that one might anticipate form a move to an innovative, knowledge economy, and seem to focus more on professional rather than research degrees.[44]

In Australia the data provided in the government's Research Workforce Strategy envisage that the number of employed individuals with a doctorate by research qualification will rise by 3.2 per cent per year over the period to 2020, given the government's aspirations for expanding university education, increasing business investment in research and the need to address major problems such as climate change.[45]

Employment destinations of PhD graduates

While theoretical arguments about the importance of PhD education are interesting, it is worth examining the empirical data on where PhD graduates find employment and on the extent to which they find that their doctoral education was necessary or useful in fulfilling the responsibilities of their job. This could provide the information necessary to examine the fit between PhD education and the skills and knowledge needs of the careers that PhD graduates find for themselves. Unfortunately, the data necessary to do this are in short supply.

Some of the most useful, interesting and important information on this topic comes from the Royal Society's 2010 report *The Scientific Century: securing our future prosperity*.[46] A diagram on page 14 of the report shows that 53 per cent of science PhDs in the UK take up careers outside science on graduating, 17 per cent move to non-university research positions and 30 per cent take early career research positions in universities. However, only 3.5 per cent of the original cohort eventually achieves the status of permanent research staff in universities and 0.45 per cent become professors. In other words, while 30 per cent take up early career research positions in universities, the vast majority of these eventually move to presumably better paid, more certain and secure careers outside academia – and potentially outside of science.[47]

43. http://www.cgsnet.org/march-2012

44. The US Bureau of Labor Statistics had earlier estimated employment projections 2008 to 2018. Of the 30 fastest growing occupations, 12 required short-term on the job training, 5 required moderate-term on the job training, 1 long-term on the job training, 2 work experience, 2 postsecondary vocational awards, 1 an associate degree, 5 a bachelor's degree, 1 a first professional degree and 1 a doctoral degree. See: http://www.bls.gov/opub/mlr/2009/11/art5full.pdf

45. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/ResearchSkillsforanInnovativeFuture.pdf

46. http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2010/4294970126

47. Andrew Hacker and Claudia Dreifus in their book *Higher Education? How Colleges Are Wasting Our Money and Failing Our Kids — and What We Can Do About It* provide a complementary perspective to that of the Royal Society – but one which leads to a similar conclusion – when they note that the USA produced 100 000 doctoral theses over the period 2005-09 when there were just 16 000 new professorships.

These figures suggest that almost 80 per cent of people achieving PhDs in science in the UK will eventually find careers outside science. There is no reason to suppose the situation is any different with respect to the social sciences, humanities or creative arts, especially given that PhDs in these disciplines are often less directly vocational than those in STEM disciplines. Neither is there any reason to suppose that other developed countries are different. This raises important issues about the purpose of a PhD. If most PhD graduates work in positions that do not draw upon their specialised disciplinary knowledge, it may not always be reasonable to assume that PhD education is about creating "stewards of the discipline" as proposed by The Carnegie Foundation for the Advancement of Teaching. [48]

An article in Nature (titled "The PhD factory" with the subheading "The world is producing more PhDs than ever before. Is it time to stop?") presents some similar information for other countries. This report noted that of the 1 350 people awarded doctorates in natural sciences in Japan in 2010, just over half (746) had been able to find full time jobs by the time they had graduated. Of those who had been able to find jobs, 21 per cent had positions in academic sciences or technological services, 34 percent had jobs in industry, 34 per cent in education and 5 per cent in government.[49] The same report stated that in Germany just under 6 per cent of science doctorates eventually find full time academic positions although it also made the comment that "the relatively low income of German academic staff makes leaving the university after a PhD a good option". A recent article in The Atlantic noted that:

> *In life sciences, such as biology, [PhD] graduates now have a far better chance of being unemployed when they get their diploma than of having a full-time job. ... In disciplines like physics and chemistry, the percentage of employed have also fallen just below the unemployed.*[50]

Unfortunately, Australia does not have any recent longitudinal data that will allow an assessment to be made of the longer term career prospects of doctoral students. However, in 2006 around 26 per cent of people in Australia having doctorates worked as university and vocational education teachers, while 18 per cent were natural and physical science professionals, 2.1 per cent were school teachers, 2.5 per cent general managers and administrators, 3.8 per cent miscellaneous business and information professionals and so on.[51] In 2008, 28 per cent of recent PhD graduates worked in higher education, with the remainder being dispersed across a wide range of public and private industry employment sectors.[52]

Is the long term career trajectory of Australian PhDs likely to mirror the experience of PhD graduates in countries for which better data are available?

Information on the immediate employment destination of graduates is available in the Graduate Careers Australia's report *Postgraduate Destinations 2011*. This noted that 83.1 per cent of PhD graduates responding to the survey were in full time employment at the time of the survey, although some of these would have been working full time while working on their PhD on a part time basis, as shown by the fact that only 28.6 per cent of research masters/PhD graduates were working in their first full time employment.[53] It is noteworthy that 10.7 per cent of research masters/PhD graduates in full-time employment were working overseas. Of the research masters/PhD graduates working full time, 38.4 per cent were in the higher education sector, 25.5 per cent in the private sector, 10.8 per cent in the health sector and 7.3 per cent in the government sector.

48. See Chris M Goldie et al 2006, 'Envisioning the future of doctoral education: preparing stewards of the discipline'.

49. 'The PhD factory', 2011, *Nature*, 472, 276-279.

50. http://www.theatlantic.com/business/archive/2013/02/the-phd-bust-americas-awful-market-for-young-scientists-in-7-charts/273339/?goback=.gde_1844342_member_216145934

51. http://www.cshe.unimelb.edu.au/people/bexley_docs/RAW_Combined.pdf

52. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/ResearchSkillsforanInnovativeFuture.pdf

53. http://www.graduatecareers.com.au/wp-content/uploads/2012/09/Postgraduate-Destination-Report-2011-secured.pdf

An earlier study completed by the University of Queensland Social Research Centre in 2007 on: *PhD graduates 5 to 7 years out: employment outcomes, job attributes and the quality of research training* found that for Go8 PhD graduates:

> *Fifty-three percent of all respondents worked in Education and Training, 22 percent in Professional, Scientific and Technical Services, seven percent in Health Care and Social Assistance, five percent in Public Administration, and four percent in Manufacturing. The remaining nine percent of respondents spread across 14 other industry sectors. Most (963) of the 1028 respondents who worked in Education and Training worked in Higher Education. 242 of the 418 respondents who worked in Professional, Scientific and Technical Services were part of Scientific Research Services.*[54]

In defining the positions they occupied within these sectors, 82 per cent of respondents identified themselves as professionals and 14 per cent as managers and administrators.

As a decreasing proportion of people with doctoral qualifications move to university positions, whether through choice or necessity, it becomes more important to understand the criteria for success and employability in these non-academic positions and their relationship to the learning and teaching outcomes produced by doctoral programs. This is because important and significant as the non-academic jobs that PhD graduates move into may be, they will often require a set of attributes different from those characterise a good academic. This can raise questions about the extent to which PhD education has or should change to reflect this wider set of employment destinations and the skill sets necessary to be successful in them.

Concerns about the value of PhD training

Global concerns about the employment destination of doctoral students raise serious issues about the purpose of PhD training and are one reason why the PhD and PhD education are receiving increasing and often high profile attention. In particular, the apparent employment destinations of PhD graduates suggest that for many the generic skills that they acquire, often implicitly through some kind of osmosis, may be more important in future employment terms than the discipline specific knowledge and techniques that are usually the focus of PhD education. This raises the issue of whether PhD training should have as one of its aims the preparing of its graduates for employment or of whether it has some other broader purpose. Should the outcomes of PhD education in some way align with the needs of potential employers and does it matter if they do not?

Does it matter if the careers of PhDs do not make use of their disciplinary knowledge or specific research skils?

A recent UK report on postgraduate education by an independent inquiry by the Higher Education Commission noted that:

> *We did not anticipate that so many contributors would express concern about the structure and breadth of the PhD. A sizeable number of people giving evidence to the inquiry, scientists and economists, Vice Chancellors and industrialists, thought that the PhD was too narrow, with candidates knowing everything about a tiny area and not enough about the broader discipline.*[55]

54. http://researchsuper.chelt.anu.edu.au/sites/researchsuper.chelt.anu.edu.au/files/797summaryresultsgrad(2).pdf

55. http://www.policyconnect.org.uk/hec/sites/pol1-006/files/he_commission_-_postgraduate_education_2012.pdf

An American Chemical Society report found that:

> *Current educational opportunities for graduate students, viewed on balance as a system, do not provide sufficient preparation for their careers after graduate school.*[56]

Recent international examples which indicate the scale and nature of the debate include an article in The Economist of 16 December 2010 headed: *The disposable academic: why doing a PhD is often a waste of time*;[57] and a series of articles in Nature in April 2011. These included an overriding editorial titled *Fix the PhD*[58] and an online column with the title: *Reform the PhD system or close it down*.[59] The first sentence of this online column by Mark Taylor reads:

> *The system of PhD education in the United States and many other countries is broken and unsustainable, and needs to be reconceived.*

In Australia there has been media coverage such as an article in the Australian titled No gold at the end of the rainbow by Anna Bellamy-McIntyre, an unemployed scientist when she wrote it, which starts:

> *I was at a dinner the other week to celebrate one of my friends finishing a doctorate. Instead of being a jubilant, euphoric affair, there was a very cynical, jaded edge to the celebrations. You see, at a table of seven very well-educated (five PhDs, one PhD student and a masters student), late-20 to early-30-somethings, only one person had a full-time job.*

And goes on to say:

> *The job market for research scientists is dire. Hundreds of people apply for each job that comes up, many are far too overqualified for the position. ... About 50 per cent of my friends with PhDs are now entering the world of the long-term unemployed. These are very smart, capable people.*[60]

A recent Australian report Career support for researchers: understanding needs and developing a best practice approach found that graduate students "felt that they needed additional skills outside their research topics to become job-ready".[61]

The purpose of PhD training

In discussing the effectiveness of PhD training and the concerns that some people have about its outcomes, it is important to start from a common understanding of the purpose of the PhD. Having a clear understanding of purpose is necessary in order to design effective PhD programs but also to ensure that students taking such programs know what they can expect in terms of outcomes and the employment opportunities these will create.

As a starting point it is useful to consider that a major aim of PhD training is to ensure a continuing supply of high quality researchers without at this stage considering what this means about the number of PhD graduates Australia needs or the disciplines in which we need them.

It is a commonplace that having a ready supply of excellent researchers is becoming more important as research plays an ever more central role in modern life. The Australian Government's *Research Workforce Strategy* states:

56. http://portal.acs.org/portal/fileFetch/C/CNBP_031601/pdf/CNBP_031601.pdf

57. http://www.economist.com/node/17723223

58. http://www.nature.com/nature/journal/v472/n7343/full/472259b.html

59. http://www.nature.com/news/2011/110420/full/472261a.html

60. http://www.theaustralian.com.au/higher-education/opinion/no-gold-at-the-end-of-the-rainbow/story-e6frgcko-1226401538010

61. http://www.tossgascoigne.com.au/docs/CareerSupportForResearchers.pdf

A strong and vibrant research workforce is paramount to Australia's future prosperity. Our researchers are a vital asset which needs to be recognised and supported.

The strategy presents a framework:

... intended to position Australia to meet a significant expansion of demand for research skills in future years and higher expectations of our research graduates and researchers.[62]

Similarly, the government's 2014-2016 template for university compacts includes the specific Commonwealth objective (section 5.2.1):

Significantly increase the number of students completing higher degrees by research over the next decade.

From a government perspective the purpose of PhD training is to produce a sufficient number of researchers and to prepare Australia for an environment in which the demand for research will increase as the economy restructures into areas of higher value-add based on high quality innovation, driven at least in part by research. Such an aspirational policy objective raises questions about the timing of an increased demand for researchers, the particular sectors and disciplines in which it will occur and the non-educational policies and programs that will lead to the increased demand. It also raises issue about the quality of PhD graduates and the need to provide the training in areas which match the areas of increased demand.

Demand and supply issues

The number of PhD graduates has been increasing rapidly and a not uncommon view is that this needs to continue. The report of a regional workshop supported by the Department of Innovation, Industry, Science, Research and Tertiary Education and run by the Australian Council of Deans and Directors of Graduate Studies started by noting:

In common with Australia, many of the countries in our region recognise the need for a substantial increase in their PhD-qualified workforce. These countries share many of Australia's concerns about issues of quality in the education of the future research workforce at a time of increasing global demand for highly trained researchers.[63]

The Australian government's Research Workforce Strategy argued for the need to lift the supply of research skills in the Australian workforce, anticipating "significant expansion of demand for research skills in future years" which would derive from:

... the combined influence on Australia's research workforce of a number of factors including: age-related retirements; employment growth in relevant sectors; increased demand for high-level research skills across the economy; and a stalling in domestic student uptake of research degrees.[64]

It takes many years to train a researcher and research skills and knowledge are not fungible. An entomologist cannot easily become an expert in etymology, a molecular biologist cannot easily become a quantum physicist, or even a meteorologist become a metrologist. Moreover, the specialist technical and disciplinary knowledge developed through the course of a PhD quickly becomes outdated and it can be difficult for a researcher who moves to a non-research position to move back into research. The shelf-life of a PhD can be very short, at least to the extent that it signifies an ability to

62. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/ResearchSkillsforanInnovativeFuture.pdf

63. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/DoctoralResearchTraininginOurRegion.pdf

64. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/ResearchSkillsforanInnovativeFuture.pdf

conduct current research in a competitive job market.

This is why one of the issues that has been stimulating debate about PhD education is the view that at least in some disciplines universities are producing too many PhD graduates. In part this view stems from a recognition that many PhD graduates are unable to find academic positions and that a high proportion of those that do may find themselves working in casual or part time appointments. The adage that a research student is someone who foregoes current income in order to forego future income can have an element of truth, at least in some disciplines.

Is there a need for balance between PhD training and the employment opportunities that require a PhD?

Bob Williamson, Science Policy Secretary of the Australian Academy of Science, has said that while only a few years ago PhDs awarded annually numbered a few hundred:

> *... we now award about 2 500 every year in scientific and medical research. There are still only a small number of jobs, and many of these are temporary ... there is no guarantee of a future as a research leader any longer . . . Most new PhDs face many years of insecurity, at just the time they are thinking of settling down ... we must broaden PhD and post-doctoral mentoring and education so that researchers can move easily into other rewarding fields such as teaching in schools and industry where PhD skills... are needed.*[65]

Concerns about the oversupply of PhD graduates exist around the world. For example, a recent report in University World News opened by stating that:

> *Education Ministry officials have expressed concern over the large number of postgraduates in China, as students with masters and PhD degrees are finding it even harder than graduates with lower degrees to find employment in a sluggish jobs market.*

The report went on to note that the employment rate of students with postgraduate degrees leaving universities in China had been lower than the employment rate of undergraduates for the three consecutive years since 2009, and that postgraduate employment rates had been dropping since 2005.[66] This is one reason why China is now putting emphasis on growing the number of professional PhDs and on moving research to industry.

A recent report (*Advancing Graduate Education in the Chemical Sciences*) of the American Chemical Society suggested that:

> *Departments should give thoughtful attention to maintaining a sustainable relationship between the availability of new graduates at all degree levels and genuine opportunities for them. Replication in excess is wasteful of resources and does injustice to the investment made by students and society.*[67]

A different, contrasting view is that it is important to maintain or grow the supply of PhDs because with their abilities and training they have the potential to create new businesses and new jobs, not just take up existing opportunities. This raises the issue of the extent to which PhD training helps (or should help) to develop entrepreneurial attitudes and skills. A related view is that the natural abilities and training of PhD graduates should make it possible for them to add value beyond what someone without a PhD would add, even when taking up a position which does not require a PhD. (Most people who have sat on selection committees will have experienced this argument, whether put directly or indirectly).

There is also the view that while there are natural caps to the number of research students that

65. See 20 June 2012 report at: http://www.the-funneled-web.com/

66. http://www.universityworldnews.com/article.php?story=20121025111620913

67. http://portal.acs.org/portal/fileFetch/C/CNBP_031601/pdf/CNBP_031601.pdf

universities can accept, there should otherwise be no restrictions on access to research training because this training has benefits for individuals and society that go beyond matters of employability. For example, the Russell Group has argued that:

> *There is no optimal number of postgraduate students. There should be no limits on access to higher skills training, which provides life-enhancing opportunities for individuals. However, the practical demands of some subjects, which require access to specialist laboratories and facilities, means that there is a de facto cap on the number of students who can be educated at any one time. For research students specifically, numbers are also limited by the number of active researchers who are able to supervise students and provide them with the one-to-one support needed.*[68]

This is a complex and difficult matter. As well as looking narrowly at the academic employment prospects for PhD graduates, it is also necessary to consider what expectations exist among users and providers of PhD training and among the whole set of potential employers of PhD graduates. Given that PhD training receives public funding, it is important to consider matters relating to private versus public benefit, especially given the personal cost and sacrifices (going beyond the financial) that completing a PhD can involve.

Will increasing the number of PhDs produce economic benefits in itself?

On one hand is the view that it is not possible to have too much education. From an individual point of view the more education you have, the greater its potential to change your life, open new opportunities and make you an even more valued member of society. From the national perspective there is a view that the more highly educated a population, the more productive, prosperous and humane it will be and the more robust its civil institutions. From a market perspective, a growth in the supply of the most highly educated people relative to demand can make them cheaper to employ. A facile perspective is that the more PhDs the better.

An alternative view is that far from broadening them, PhD training and its associated specialisation serves to narrow employment opportunities. Such training is expensive and involves considerable costs – both to society and to the students undergoing training. This creates expectations among graduates about the type of work they can expect and the level of remuneration they should receive. However, these expectations will be unrealistic if the jobs they find do not demand the specialised knowledge and skills PhD graduates can provide. Providing more PhD graduates than is necessary is inefficient. There are also claims it is also unfair to the people graduating with PhDs who are unable to find the satisfying and remunerative work that allows them to use the knowledge, skills and broader competencies their PhD education has developed. Unfairness is seen as particular issue when PhD graduates believe the employment they do obtain does not recompense them for the effort they put into achieving their qualification, or the personal sacrifices they had to make.

Does a PhD broaden or narrow employment opportunities?

This potential mismatch goes beyond simple numbers because the number of research student openings in different disciplines has no relationship to number of jobs that will be available at the time of graduation. (But this is equally true at the undergraduate level.) Universities do not allocate PhD places on the basis of labour market need but by using criteria such the academic excellence of the candidates, the research excellence of the proposed project, the availability and needs of potential supervisors, the research strategy of the university, the need to grow particular areas of research capacity, the requirements and decisions of different funding bodies, and so on. In principle, it is quite possible to have an excess of comparative theologians and mediaeval historians but a shortage of

68. http://www.russellgroup.ac.uk/uploads/Russell-Group-submission-to-postgraduate-review-FINAL-2.pdf

photonics experts, statisticians or agricultural scientists.

A rigorous application of the argument that the supply of places in different disciplines should relate to some assessment of demand implies the need for succession planning and an assumption of stability in demand which is unrealistic and highly unlikely. Even academic departments wax and wane in response to external factors, including the changing balance of research funding flowing from business as well as from government decisions.

The oversupply argument often focuses on the lack of academic careers for graduating PhD students. Focussing on academic careers ignores the data that demonstrate PhD graduates tend to have high rates of employment, even if most are in non-academic positions. Research students are sufficiently intelligent to be aware that they have only a small chance of obtaining permanent academic positions. Moreover, at least in the physical and natural sciences, doctoral students show a decreasing interest in academic careers the further they are into their degree program.[69] The major reasons for taking a PhD relate to an intrinsic interest in the subject and personal satisfaction.

Supervisors and research students should all know that in principle PhD training provides benefits for many career paths, including those going beyond the performance of research in other sectors. Moreover, at least some part-time PhD students are already working in their chosen career and are taking a PhD for personal interest and enrichment or to help advance their existing career. Nevertheless, taking a broader view of the career trajectories that a PhD can expedite does raise issues about the balance of outcomes that PhD training should explicitly aim to achieve.

In any case, labour market planning is always difficult and often out of kilter with business and other cycles. A University of California report on workforce projections and job market trends for graduate and professional degree recipients emphasised the difficulties involved by noting that a review of major national PhD workforce studies and projections:

> *... indicates that different analyses have reached sometimes conflicting conclusions regarding future Ph.D. demand and supply, with some analyses projecting large Ph.D. shortages and others projecting large Ph.D. surpluses.*[70]

There are many aspects to the debate on the appropriate balance between the supply of PhD graduates and the demand for them. The perspectives of students, employers, universities, PhD supervisors and others can be very different because they each have a different view about the purpose and value of a PhD. For example, producing graduates unable to find opportunities to use the narrow, specialised knowledge they have acquired through the qualification they have achieved may seem wasteful. However, the research performed by a research student can have a value beyond and independent of its benefit to the student or to the graduate's ability to use in subsequent employment the specialised skills developed in performing the research. Moreover, a high quality PhD program produces more than specialised knowledge. Many PhD graduates have interesting and useful jobs that make use of their specialised knowledge indirectly at best but which provide challenging opportunities to use the analytical, conceptual and problem solving skills their training developed. This then raises questions about the purpose of a PhD and whether current PhD training is the best way to meet this purpose.

Should the number of PhDs depend more on student, employer or government interest?

While it is not necessary to have a PhD to be a high school teacher, some teachers do have a PhD. The questions are whether this makes them better teachers and if so whether this makes the cost of

69. www.nature.com/naturejobs/science/articles/10.1038/nj7399-535a

70. http://www.ucop.edu/planning/documents/apdx2.pdf

gaining a PhD worthwhile, especially if the remuneration for these jobs does not recognise or provide recompense for this improved performance or for the personal cost of achieving it. (These issues become even more prominent in some other jobs. According to the US Bureau of Labor Statistics, over 8 000 of the 317 000 waiters and waitresses in the USA that have college degrees have doctoral or professional degrees.)

A further question might be whether it is possible to achieve in a more targeted and more cost effective way the benefits that arise from having PhD qualified people as secondary school teachers. This is brought out by another common example. Astronomers and particle physicists with PhDs have the mathematical skills that allow them to move into the financial services sector as quantitative analysts and they will often find rich rewards in making this transition. However, while they may have the necessary mathematical skills, doing a PhD might not be a cost effective way of providing them – and providing targeted courses might have additional advantages, for example in demonstrating that social systems have some characteristics that make them different from physical systems.

Does a PhD add value even when it is unnecessary for a particular job?

However, it is also necessary to consider that aiming for a close linkage between the supply and demand for PhD graduates would have other unintended consequences. There are leakages from the research student and graduate cohort as not all students complete or enter the workforce. Some take up other opportunities or lifestyles before graduation, some go overseas after graduation, and so on. This does not mean that they did not benefit from the training they did complete, or that there are no flow-on benefits to society. Moreover, from the perspective of an employer filling a job for which a PhD is a necessary qualification, there are clearly benefits in having a number of candidates from which to choose. An 'oversupply' can help control salaries, allow employers to select a candidate who will feel comfortable in the firm's corporate culture and can provide a buffer within the labour market that provides for flexibility.

The complexity of the current situation was apparent at the 2012 annual meeting of the US Council of Graduate Schools. According to one report:

> *The good news is that there is broad bipartisan agreement here in Washington and among elite stakeholders that educating people up to the highest level possible is necessary for America to be competitive and prosperous.*

But at the same time (and in the same document):

> *Attendees at the conference said it is unethical to keep admitting students to programs and training them for jobs that don't exist while they are racking up piles of debt only to risk finding university employment as just an adjunct, or obtaining some other low-wage job for which a graduate degree is not necessary, or ending up on food stamps.*[71]

71. http://chronicle.com/article/Some-Say-Its-Time-to-Put-a/136217/?cid=at&utm_source=at&utm_medium=en

The intrinsic value of the work of research students

In discussing the PhD it is important to keep in sight the fact that the work of PhD students has value in itself, independently of what happens to the students after graduation. The work of PhD students contributes a non-trivial proportion of the nation's total research effort and is performed cheaply compared to the same research performed by researchers not undergoing formal training. The table below provides an explicit illustration of this.

Postgraduate students as a proportion of total human resources devoted to Australian higher education research and development (Person Years of Effort)[72]

1992	1994	1996	1998	2000	2002	2004	2006	2008	2010
50.4%	55%	55.7%	57.4%	59.8%	60.4%	58.8%	57.4%	55.9%	56.9%

In 2010 postgraduate students were responsible for around 57 per cent of the total human resources effort going into higher education research. Having more PhD students results in more research and can be a cost effective way of performing research.

As the Russell Group has noted:

> *In many disciplines, particularly STEM subjects, doctoral students are essential to the research endeavour, helping to deliver a department's research programme whilst studying and developing their skills. With proper training and support, doctoral students also play an important role in helping to teach undergraduates, including demonstrating practical skills and techniques. Doctoral students also act as role models and mentors for undergraduate students contemplating postgraduate study or a research career.*[73]

An interesting question that this can raise is the extent to which the desired or most important outcome of PhD research is the research itself or the training of the potential PhD graduates, especially when this professional development relates to attributes that go beyond research. Apart from anything else, there is the potential for conflict, not least because of the requirements of external funding bodies and the drivers set by the performance indicators that different stakeholders might use.

There have been arguments (often seen in blogs discussing this issue) that the present situation places research students as part of a Ponzi scheme that supports the interests of universities by ensuring a continuing supply of creative, well educated, cheap (and easily disposable) labour able to supply a constant stream of new ideas to those tenured academics who were lucky enough to enter the system first. Indeed, in 2012 *Science* named its first ever Science Careers Person of the Year. This was the labour economist Paula Stephan who:

> *In numerous articles and books, and as a member of scholarly bodies and study commissions examining the situation and prospects of young scientists, ... has long expounded the view that the current graduate and postdoctoral training system constitutes, in her words, a "pyramid scheme." This system, she has repeatedly shown, uses young and aspiring scientists as cheap labor for professors' grant-funded research and then fails to provide the career opportunities that have been implicitly or explicitly promised. ... [In her most recent book] She shows why the demand for low-cost graduate students and even lower-cost postdocs is perpetual, insatiable, and out of proportion with subsequent career opportunities.*[74]

72. Calculated from http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8111.02010?OpenDocument

73. http://www.russellgroup.ac.uk/uploads/Russell-Group-submission-to-postgraduate-review-FINAL-2.pdf

74. http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2012_12_21/caredit.a1200140

Whether the professional development of the researcher is of equal or more importance that the progress of the research can then raise another matter – that of the extent to which postgraduate students have some of the characteristics of employees rather than of customers of the university – and the broader implications of this. The European Council of Doctoral Candidates and Junior Researchers (Eurodoc) has argued that doctoral candidates should be considered employees. Some countries such as Germany and Austria already recognise them as employees and some treat them as neither students nor employees.[75] For example, in some countries PhD students have the status of university employees with respect to some areas of industrial and even human rights legislation. This recognises the often substantial contributions that the students make to measurable university outputs.

From a national perspective, what is the balance between the value of the research produced by a PhD candidate and the value of the training the candidate receives?

Recognising the hybrid nature of research students – as customers of the university undergoing training provided by the university in the form of work which makes important contributions to the outputs of these same universities – raises questions about the fees that research students should pay universities and the extent to which estimates of the full cost of research training need to acknowledge this research output.

Another issue associated with the important role research students play in performing a significant proportion of university research is that research students are also an important source of revenue. Individual researchers, schools and institutions can benefit from attracting larger numbers of research students because this has the potential, or even the direct effect, of increasing their funding. This is true both of domestic students (through RTS funding) and international students who may be paying fees (although many universities also offer fee scholarships to cover the fees of international doctoral students).

Qualitative concerns

Concerns about PhD training are not just quantitative, relating to the number of doctoral students in relation to the demand for their services. Closely related to the demand/supply issues there are qualitative concerns that the attributes that doctoral students develop during their PhD training are inadequate because they reduce the employability of PhD graduates or do not match the expectations that potential employers have about the attributes that such graduates should possess. These concerns can relate even to the research expertise of doctoral graduates, reflecting in part the changing nature of research and the different management processes and management expectations of researchers in academia and industry.

Changing nature of research

There is no doubt that research and researchers are playing a growing role in economic development, in improving our health, in managing our environment and across all areas of human activity. However, research is not a static activity and the context in which a growing proportion of global research effort takes place is quite different from that of traditional university research. Research and research processes are themselves changing as a result of technological and other innovation and much university research will reflect this. However, research is also changing because of the changing

75. http://www.nature.com/naturejobs/science/articles/10.1038/nj7401-

demands of society, governments and businesses and because of the new kinds of research outputs and outcomes they are seeking. If PhD training is to be effective it has to respond to these changes as well as to the more general pressures and demands on national education systems, so that PhD graduates have the attributes necessary to operate effectively in the senior positions they should eventually fill.

The problems that governments, business and society need research to address are becoming more difficult. They often take the form of what policy analysts call 'wicked problems'. These are problems for which there is no single, simple or generally agreed solution and for which any intervention is likely to have multiple effects, some unintended, unwanted and even unpredictable. In many cases this will mean that there is no 'solution' to such problems but at best it is possible to manage them. Moreover, these problems do not exist in isolation but are themselves interrelated. Climate change, energy security, population policy, health care issues, education and economics, to name just a few, are not discrete areas of activity but interact with each other, being interdependent and interrelated in many ways.

The characteristics of wicked problems stem from their origin in the complex systems within which we live. While it is true that such systems are intellectual constructs, concepts developed to help understand the world, they nevertheless reflect the reality that many parts of our existence are interconnected, often in surprising and unexpected ways. These systems, and the interconnectedness of the challenges and opportunities they present, are becoming more apparent because the rate of change is itself increasing. This means that the consequences of our interventions make themselves felt sooner. Moreover, on a global scale the growing population and its increasing concentration can mean that the consequences of any intervention are much greater than they might have been in the past.

The flows of money, people, information and other resources within and across systems are growing (in absolute terms and as a proportion of global activity) and are taking place more quickly. While there are many reasons for this, some of the critical factors (themselves interdependent) include the rapid technological advances in information and communications technology and the ways in which we use such technologies, not least in the financial services sector; population growth and migration; changes in the global economic centres of gravity; and significant increases in investment aimed directly at improving the rate of innovation. Such investments include funding for research but they also include, for example, investments in education, technology uptake or to support the creative industries. Nations now use their level of investment in these areas as measures of their potential competitiveness and to stake their place in the world.

How can PhD training respond to the more complex research management environments that today's complex problems demand?

One consequence of the escalating complexity of the modern environment is that the knowledge, skills and expertise we need to tackle major (and even minor) problems need ever higher levels of sophistication. Given the speed of change, learning how to learn has become as important as learning how to do other things; and having the skills necessary to acquire knowledge can be as important as what you know. A further change has been that the nature of current problems and the scale of effort that we need to address them frequently require large teams and multidisciplinary approaches. The idea of a single researcher working in relative isolation and insulated from day to day concerns is becoming an anachronism and PhD training needs to reflect this. The model of an individual researcher, no matter how renowned, working with a student apprentice may no longer be viable.

In the science and engineering disciplines it is already the case that many research students

are working as members of a larger team. However, by itself this may not provide the ability to communicate and work with people across disciplines which is becoming ever more important. Working as part of a team while focussing on just one part of the broader problem the team is addressing is not sufficient. Students also need to be part of the process of placing the particular elements of the research on which they are working into the broader picture of the problem the team as a whole is addressing – and understanding how and why the different research elements fit together into a whole that is bigger and more informative than the sum of its parts.

Specialisation and the boundaries between disciplines can become barriers to achievement but at the same time progress in many areas still requires high degrees of specialisation and a significant depth of knowledge that it takes time to acquire. Research management and research training need to address this paradox head-on. The ability to plan research and to understand how to integrate it into broader research strategies can be as important as the actual performance of the research; and management as important as operation.

The demands of the modern world and its research dependence clearly have particular implications for higher degree by research training. PhD training provides the next generation of researchers. Within the OECD around 70 per cent of all research is performed by business and in 2009 the business enterprise sector within the OECD-area employed more than 2.7 million researchers (about 65 per cent of the total) while the higher education sector employed around 25 per cent of the total.[76] Even in Australia the business sector spends much more on research than the higher education sector. In 2008-09 for example, the Australian business sector spent $16.9 billion on research and development, the higher education sector $6.7 billion.[77]

Firms investing in research and wanting to employ people with research experience will sometimes (but not always) seek out staff with PhDs in the relevant disciplines. Similarly, government and the non-profit sector will seek out the most highly qualified people to conduct their research, often in the social as well as the natural sciences. In Australia universities appear to employ less than 50 per cent of PhD graduates (and a significant proportion of these in temporary and often low paid positions) and while demand from universities will continue to increase, so will demand from other sectors of the economy.[78]

Do business researchers require different skills from academic researchers and how does this play out in PhD training?

That the demand for people with PhD training may be much broader than the market for researchers (or that PhDs take up positions not requiring PhDs because the demand for PhDs is less than the supply) has interesting implications. Some people benefiting from PhD training will often move quickly to senior management and strategic positions that draw upon their demonstrated ability to think clearly, collect and assess evidence, develop and test hypotheses, draw conclusions and make decisions; however, others often find themselves stranded in relatively low level technical positions that may be using only a fraction of their abilities, in part because they find it difficult to move beyond the boundaries of their specialisation.

It is in the national interest that we employ only our most talented people in those senior positions that grapple with the difficult and wicked problems that directly affect our national wellbeing. However, it is also in the national interest that we enable talented people to realise their full potential in ways that

76. OECD Science, Technology and Industry Scoreboard 2011.

77. Data from the ABS 2008-09 Research and Development all sector summary at: www.abs.gov.au/AUSSTATS/abs@.nsf/productsbyCatalogue/07E66F957A46864BCA25695400028C64?OpenDocurrent

78. In the absence of good longitudinal data, it is not possible to know whether Australia is similar to the UK in that PhD graduates gaining initial academic positions later move to other jobs outside universities which might not draw upon their disciplinary expertise.

go beyond their narrow areas of specialisation.

Having research competent people working outside research is important because it helps increase the propensity of an organisation to take up the opportunities that research creates and adds to the innovative capacity of a nation. However, many of the positions that PhD graduates fill require some of the general attributes that PhD training is said to develop but may not require a PhD as a credential or the particular knowledge and research skills that PhD training can provide.

Mismatch between the skills developed during PhD training and needs of employers

Given the traditional view that a PhD is the first step to an academic career, universities might not have the information necessary to understand the wider set of potential employment opportunities and how their programs can better help their graduates to take advantage of them. Universities know what they are seeking in potential employees and may over emphasise these characteristics at the expense of the characteristics that other employers might be seeking. Moreover, business may not see the need to employ people with doctoral qualifications. For example, whilst many employers have graduate recruitment programs, most do not have specific entry routes for postgraduates.

Should a new PhD have all the skills necessary to be employable?

While it is easy to see why industry might have concerns about the capabilities of recent PhD graduates, it is more worrying that even academics have concerns. Universities might know what they need but are not necessarily providing the training that allows PhD graduates to meet this need. The recent UK Higher Education Commission review of postgraduate education noted:

> *... the evidence we have received suggests that it may also be the case that the traditional PhD model is not optimal even for an academic career. One research-active academic giving evidence to the inquiry said of PhDs: "they go too deeply into too narrow an area – and don't have the breadth that I would like to see." A senior university officer contributing to the review recalled that he had seen new postdoctoral researchers struggle to teach introductory undergraduate courses because they no longer had a sufficient understanding of the breadth of their field.*[79]

From an employer perspective, a major issue is the extent to which new PhD graduates have the skills and other attributes the employer is seeking and which would allow their new employees to be fully effective. There can certainly be arguments about the extent to which a PhD program should produce all the attributes that employers seek and the extent to which some of these require on-the-job training that the employer should provide. This raises the issue of what might be an appropriate entry level job for a PhD graduate and the extent to which this should recognise the value of the qualification, whatever the need for further in-house training. (An associated issue is the level of business investment in training and the extent to which businesses prefer to hire at above entry level to save the cost of the training necessary to make new entrants business-ready.)

Nevertheless, if organisations – whether business, government or non-profit – seeking to employ PhD graduates believe that these graduates lack some of the characteristics the organisations consider to be necessary to be fully effective in the work environment they offer, there are at least some questions to ask. One is whether graduates with bachelor degrees have these skills ready to apply in their first appointment (and if not, how they gain them); another relates to the experience of students and employers where the research student is already in full time employment and is seeking the qualification to help progress within their current career.

79. http://www.policyconnect.org.uk/hec/sites/pol1-006/files/he_commission_-_postgraduate_education_2012.pdf

The government's Research Workforce Strategy acknowledged that there is a perception that a knowledge and skills gap exists for PhD graduates and stated:

> *A growing body of evidence suggests that our researchers and recent higher degree by research graduates lack core competencies required in the modern workplace. A 2010 study of researcher employers conducted for DIISR by The Allen Consulting Group, for example, indicates that communication, teamwork and planning and organisational skills are key 'soft-skill' areas in need of improvement. The study also points to researcher knowledge gaps in areas important to the utility and effectiveness of research staff in a business context, including business and financial management skills, commercial acumen, commercialisation skills and intellectual property management, among others.*[80]

Similarly, the authors of a 2008 Australian review found that:

> *Non-academic employers involved in the consultation phase of this research indicated that they found those with higher degrees in science and mathematics had a 'narrow focus' of expertise, lacked both verbal and written communication skills, and had been in the 'cloistered' environment of a university too long to possess any business knowledge or commercial nous. ... those with the higher qualifications were more likely to display some of the traits that employers were not impressed with – such as lack of commercial acumen and a narrow focus – and ... tended to expect wages that were unrealistic.*[81]

Work done in this area tends to identify a number of generic skills that employers feel PhD graduates either lack or in which they exhibit a poorer performance than the employers would like or expect. In at least some cases these reflect the nature of the PhD experience as training rather than work. This training environment may allow PhD candidates to operate in a more focussed way than is possible, for example, in a business environment. The leadership, management and even communication demands on a research student can be very different from those faced even by a junior researcher in business. The latter has to communicate and explain to non-specialists and non-academics; will often be working on several projects at the same time; will be working within stricter timeframes and often non-negotiable deadlines; experience a very different research management regime in which factors other than academic excellence play a predominant role; and so on. These differences mean that a typical set of attributes that employers believe need greater emphasis in PhD training includes more effective communication skills, ability to work as a team member, project management, and other attributes that might vary according to the particular employment opportunities under consideration.

Attachment 1 provides a set of general attributes that an employer might expect or aspire to have a PhD recruit exhibit. It includes those specific to the research that formed part of the program but also those that go beyond the disciplinary and research focus – some of which bachelor graduates of the same age will have developed through their experience in the workforce.

Does it make sense to incorporate the development of generic skills into a PhD program?

Implications for PhD training

Students undertaking PhD training now are operating in a more demanding and more competitive environment than similar students even 20 years ago. Their potential career paths are more diverse but at the same time the expectations that potential employers have about the skill sets PhD graduates

80. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/ResearchSkillsforanInnovativeFuture.pdf

81. Daniel Edwards and T. Fred Smith 2008, *Supply, demand and approaches to employment by people with postgraduate research qualifications in science and mathematics: Final Report*, Report to the Australian Government, Department of Education, Employment and Workplace Relations.

should possess have changed, expanded and become more demanding. Not least this is because the educational attainment of the general population has also grown as the proportion of the population having undergraduate and other postgraduate qualifications has increased significantly, raising expectations about what additional attributes a PhD graduate should bring to the job.

In many cases the PhD learning experience has also changed, in part because of our improved understanding of how research can contribute to national wellbeing. A growing proportion of government funding views research as a direct means to an explicit end – whether this is improved productivity, new economic opportunities, environment sustainability, social wellbeing or a combination of these. As a result, in many areas of research there is now a much greater focus on how the research can make life better for people who are not themselves researchers.

Should PhD students work in groups and teams, rather than by themselves?

While paths to impact are many and diverse, ranging from informing policy development to commercialisation, or from public education to the creation of new business opportunities, they all have one thing in common. This is the need for researchers to work productively with other players in the innovation system. There are many aspects to this including the need to work and communicate effectively in multidisciplinary teams; accepting the need for top down rather than bottom up (investigator-led) research management that goes beyond research excellence to output (and outcome) focussed criteria; and factoring in cost and practicality, not just intellectual advancement, in research assessment processes. Some of these factors are different between the research performed in universities and, for example, that performed in business or even some government research agencies. Nonetheless, it may be important that researchers trained in universities are aware of and can respect the need for these different approaches.

Working to achieve (non-academic) impact requires an understanding and appreciation of the important roles played by these other (non-research) players and respect for their different but complementary contributions. Research is more and more operating in a trans-disciplinary environment that requires close working links with the non-research community. This extends way beyond the traditional multidisciplinary approach in which researchers from different disciplines work together.

Other more direct factors have also changed the learning environment – for example, the growing proportion of students spending at least part of their course working part-time and the fact that many students are starting their PhD courses at a later age. While this allows them to bring to their study and research a broader range of experience, it can also mean greater non-university work and personal commitments that the universities have to acknowledge in the support they provide. A student with family and non-university work commitments will find it more difficult to become part of a broader academic community and this can have implications for the kind and level of academic support they will seek from the university. Some research students find that far from conducting research as part of a broader peer community, they feel isolated, lacking the support of an environment that promotes creativity through the continual free exchange and testing of ideas, methods and experimental techniques. Most of their day to day interactions may be with people who do not really understand what the research student is trying to achieve, why, or the personal sacrifices this can involve.

All this means that there are growing concerns about whether the traditional approach to PhD training in Australia may need to change. At present the core activity of PhD education remains a research project that will make a significant contribution to new knowledge. However, given the increased numbers of students undertaking such training, the uncertain career paths that they face and the changing demands placed on researchers, it is important to ask whether this should always continue to

be the case and whether there is a need to go beyond this traditional model to incorporate additional or different approaches and curriculum material.

PhD training has always supported the development of a set of generic capabilities that complement the specific specialisations and research skills that directly flow from the research project, although the development of these capabilities has been a by-product of the training – implicit rather than a clearly defined and intended outcome. However, given the changing expectations of employers and the ever more diverse range of employment that PhD graduates take up, it has become important to ask whether there should be a more explicit approach to developing – or at least to recognising, acknowledging and perhaps even assessing – these skills.[82]

The changing and more diverse nature of the research workforce and the increasingly competitive environment within which research takes place also raise other questions about what PhD training should include. Project management and planning skills are becoming more important as are the attributes necessary to develop and manage collaboration between institutions and across disciplines. Legislative restrictions on international collaboration at any level are becoming more complex as sanctions and defence trade controls start to impinge on services as well as goods. Research administration is becoming more complex and accountability is increasing as funding sources are becoming more diverse. Occupational health, safety and environmental concerns are becoming more explicit and the responsibilities for meeting them becoming more devolved. In addition, high profile, international examples of plagiarism and the falsification of data have raised questions relating to research ethics which universities could previously take as given. For this reason Australia's *National Code for the Responsible Conduct of Research* states that:

> *All research trainees must receive training on research ethics, this Code and the research policies of the institution concerned. This should have high priority for completion early in their careers.*[83]

Commercial links between universities and business raise another set of complex issues and the need to protect IP requires record keeping and other procedures that in at least some cases may be more stringent than those employed in the past.

Taken together, these and other factors are requiring universities to examine their PhD programs with a view to making them more relevant and responsive to society's needs. At the same time, they need to do this without in any way moving from the commitment to excellence and the focus on research that have always formed the foundation principles of such training. Among other things this debate has led to questions about the need for PhD training to include formal coursework to cover broader issues that extend beyond individual disciplines. This then raises issues about the diversity of entry paths to PhD training (and the need for flexibility to respond to this); and the length of a PhD course if it is necessary to add to existing programs.

Knowing what we want

Unless there is agreement on the purpose there is no way to determine whether existing system is serving that purpose or needs changing. At a broad level PhD training is about building national capabilities, although building capabilities without providing a means of using them can seem short-sighted. As noted earlier, the funding for research training has in general no direct quantitative or

82. The Office of Learning and Teaching has awarded a grant to the Australian National University in partnership with the Australian Council of Deans and Directors of Graduate Studies into: *Coursework in Australian doctoral education: what's happening, why, and future directions?* See: http://www.olt.gov.au/system/files/2012_Grants_Fellowships_0.pdf

83. http://www.nhmrc.gov.au/publications/synopses/r39syn.htm

qualitative links to the career opportunities available to PhD graduates. (There are exceptions, of course, for example through the provision of scholarships by business or other potential employers.) The PhD itself is a temporary training stage – not a continuing employment opportunity – and the level and type of remuneration available to PhD students reflects the fact that PhD research is about training rather than production – even though good research students should and do make a significant contribution to the national research effort.

Because the production of PhD graduates is an educational and training process, its main purpose must be to help students develop high level knowledge, skills and capabilities that will enable them to realise their full potential and contribute in a significant way to national prosperity and well being when they move on to formal employment. While this might be true, it is too general to be useful. Without more specific agreement on what student outcomes or attributes we are trying to achieve through providing PhD training it will be impossible to know whether the existing system is achieving them or what changes we must make to existing programs to ensure we do achieve them. The preceding discussion (and see Attachment 1) suggest that while there may be differences between disciplines and even between different universities, the outcomes PhD training seeks to achieve go beyond the contribution to new knowledge and the more general disciplinary, research and technical skills and knowledge that have always been explicit, to cover more generic skills such as communication and team work.

While there is no doubt that society can benefit from having PhD graduates available for employment and contributing to society more generally, it is also important to ask what the candidates are looking for and whether the PhD serves their purpose as well. There is no point in providing world class training if potential students do not want to take advantage of it.

Can we agree on what a PhD program should achieve?

For this reason it is worth considering the purpose of PhD programs from some different perspectives.

Candidate perspective

While the AQF sets out what the provider of a PhD education has to provide and achieve, and what the candidate has to achieve for the award of a PhD, this can provide too narrow a focus for those considering whether to devote the time and effort necessary to work for a PhD. Deciding to spend three or four years working for a PhD involves a huge personal commitment with significant opportunity costs. Moreover, there is no certainty that successful candidates receiving a PhD will recover the financial position they gave up by delaying their entry to the paid workforce. It is not unknown for postgraduate students to refer to (or even complain about) their low pay (although in Australia they are not employees), their uncertain prospects and even refer to themselves as slave labour. Anyone interested in this subject should look at the blog *100 reasons NOT to go to graduate school.*[84]

By definition, potential PhD candidates are the high performers. If they move to a full time PhD on completing their honours year, they will be missing out on the employment opportunities immediately available to them. This commits them to spending several years as poorly paid students unable to access many of the benefits of their already high accomplishments that their often less well-performing peers are already using to their advantage. Even if a person decides to work for a PhD after having spent time in the workforce, and while retaining a part time job, no matter how senior, they will still need to make financial and other personal sacrifices, given the stringent demands of PhD training.

84. http://100rsns.blogspot.com.au/2012/11/87-financial-rewards-are-decreasing_8738.html

From a university perspective, of course, the greater the number of bright students that stay on, and the brighter they are, the better for the university. They can provide a source of cheap, motivated, highly talented labour, increase the publication output of the university, help improve its status and contribute in a positive way to performance measures of academics and their ability to bring in funding. In addition, PhD students are readily disposable because they are not employees. Moreover, if a university were to cut back its intake of students because of a perceived lack of appropriate opportunities for its graduates, lesser universities might step in and the benefit to students would decrease even further.

One problem with the current situation may be that because only the best and most able students are suitable for PhD training, and they know this, their selection may create unreasonable personal expectations about the prospects that such training can create. Potential candidates need to know more than the costs involved in working for a PhD – in particular they need realistic information about the career pathways that may be open to them, the benefits that these careers can provide and how having a PhD can help them progress in these careers . This may be less of an issue when students are already in the workforce but only if their current work goes beyond that needed to provide the funding necessary for them to complete their PhD.

Do PhD candidates receive realistic information about the opportunity costs of doing a PhD and the employment opportunities it will or will not create?

Perhaps the most important (and certainly amongst the most common) reason for working for a PhD is that it provides an unrivalled opportunity to spend a period of time exploring a problem, largely free from other distractions, in a way that extends personal understanding and advances knowledge. A PhD dissertation presents information, knowledge or understanding that go beyond what existed before the candidate wrote the dissertation. This ability to spend time going where no one has gone before has an appeal such that many people are willing to make personal sacrifices to achieve it. Completing the work and receiving the doctorate can be a reward enough in themselves for those who see working for a PhD as a privilege, a means of supporting personal development, rather than as a credential providing the pathway to better pay or a particular kind of job. While this might be a reasonable perspective for an individual, it does raise questions of affordability and why tax payers should subsidise what (at least in some cases) might well be seen as a piece of self indulgence.

Personal interest and a vital need to study further and perform research are absolutely essential to anyone intending to take on PhD study. In the absence of such a sense of feeling, the effort required may well seem too high a price to pay. Nevertheless, it is certainly true that combined with a strong personal commitment to learn more, there can be other, more pedestrian, reasons for moving on to a PhD – for example to delay entering the workforce, to occupy time (perhaps while a partner or spouse is on a secondment) or otherwise to keep the mind active. Spending three or four years on a PhD provides candidates with the time (and a variety of experiences) to consider and explore what employment options they might consider long-term.

An online survey in 2010 of 4 500 current postgraduate researchers undertaking doctoral degrees in the UK explored their career intentions and aspirations, their career decision-making to date and what influenced those decisions.[85] One conclusion of the report was that for many postgraduates, undertaking a doctorate is an exploratory career stage, not a definite first step to a research career. Even for those in later years of their doctoral program, only a minority had definite ideas about their future. Their choice to undertake doctoral research had been overwhelmingly for intellectual curiosity and interest, desiring to develop more specialised knowledge and expertise, with few citing distinct

85. http://www.vitae.ac.uk/CMS/files/upload/WDRWTD-The-career-intentions-of-doctoral-graduates-Feb12.pdf

career-related motivations. Not surprisingly, those who entered a doctoral research program some time after their prior first degrees (i.e. after periods in employment) were somewhat more focused on the relevance of their PhD for a particular career.

A survey of over 4 000 graduate students at 39 tier-one US institutions similarly found that:

> *... the attractiveness of academic careers decreases significantly over the course of the PhD program, despite the fact that advisors strongly encourage academic careers over non-academic careers.*[86]

The University of Queensland Social Research Centre study (referred to earlier) that examined PhD Graduates 5 to 7 years out asked graduates about the extent to which they had developed certain skills or attributes during their training and the importance of these to their current employment. In reporting (on a five point scale) graduates reported that generic characteristics such as problem solving (4.52), critical thinking (4.50) and oral communication (4.35) were of highest importance to post graduation employment and that:

> *... general knowledge about designing and undertaking research (mean value of 3.93), and about analysing information or data (3.96) played a significantly larger role than did knowledge of their PhD disciplinary area (3.61), or knowledge of their PhD topic (3.12) .... Skills or knowledge in using tools and instruments that were acquired during the PhD (3.35) were of greater relevance than the PhD thesis topic.*[87]

The broader generic skills that promote flexibility and an ability to respond to new situations and context were more important outcomes of the training – at least in employment terms – than the specific disciplinary knowledge and contribution to new knowledge made during the training. However, 79 percent of respondents stated that overall their PhD training was either very useful or useful for their current or most recent work. Only eight percent reported that it was either not useful or minimally so.

86. http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0036307

87. http://researchsuper.chelt.anu.edu.au/sites/researchsuper.chelt.anu.edu.au/files/797summaryresultsgrad(2).pdf

Moving ahead

There are clearly many and varied views about the role, purpose and usefulness of PhD programs and about the need for people with a PhD qualification. It is also clear that much of the debate builds on anecdote and personal experience. Certainly in Australia, there is a paucity of useful data, for example of the kind that would come from detailed longitudinal studies of the experience of PhD graduates and the ways in which they assess the value of their PhD training as they move through their various careers. However, it is also apparent that in the nature of things it is not possible to provide unambiguous or rigorous data on issues such as the likely future demand for PhD qualified people in particular disciplines. Given the time it takes for someone to complete a PhD such forecasts need to be looking 4 to 10 years ahead and, as Niels Bohr once remarked, prediction is very difficult, especially about the future. We live in a rapidly changing and unpredictable world so that action taken to respond to current specialised shortages of skills may be redundant by the time newly qualified people become available for employment. Moreover, at this level Australia operates within a global employment pool, drawing from the best from around the world. This makes it all the more important to consider the generic skills that PhD training can produce in responding to aspirational statements about the likely increases in Australia's demand for PhDs and the nature of this demand.

It would be possible to suggest many responses to the complex issues issues raised in this paper. For example, if one were to accept that we produce too many PhDs an extreme position might be to reduce the number of PhD students but to increase the level of technical assistance available to university researchers;[88] another might be to try and better match the supply of PhD students with the demand that exists. However, given the uncertainty that exists about demand and opportunities, and the concerns that exist about the quality of the training PhD programs provide, a more realistic response is to reform the PhD and develop PhD programs to produce graduates who have a better understanding of the opportunities available to them and who possess a broader range of skills that fit them for a wider range of employment opportunities. This response is already underway and making significant progress.

Change is taking place but do all PhD programs need to change in the same direction?

Within Australia, the Australian Council of Deans and Directors of Graduate Studies[89] and the Go8 Deans and Directors of Graduate Studies are both putting considerable effort into improving the PhD experience and its outcomes, while the Department of Industry, Innovation, Science, Research and Tertiary Education is also examining issues such as research training quality as well as broader research workforce issues.[90] One of the common themes for much of this work is the need to go beyond the research produced by the PhD candidates to consider the students themselves – and the value they gain from undertaking a PhD program and how modifications to such programs can help increase the value add to the student and consequently to society as a whole.

88. A recent survey of Australian researchers identified concerns that Australian universities accept too many PhD students given the work opportunities available and participants suggested that universities might concentrate their existing resources on fewer students to increase the quality of their learning experience. See: http://www.tossgascoigne.com.au/docs/CareerSupportForResearchers.pdf

89. http://www.ddogs.edu.au/

90. http://www.innovation.gov.au/RESEARCH/RESEARCHWORKFORCEISSUES/Pages/default.aspx

Coursework

One important response to the issues raised in this paper has been to promote the introduction of coursework into PhD training. The UK recognised the importance of this as early as 2002 when the Roberts' report recommended early career researchers receive professional development training over a broad area and the government provided specific funding to make this happen. In particular, the report recommended that:

> *... major funders of PhD students, should make all funding related to PhD students conditional upon students' training meeting stringent minimum standards. These minimum standards should include the provision of at least two weeks of dedicated training a year, principally in transferable skills, for which additional funding should be provided and over which the student should be given some control.*[91]

Introducing formal coursework can have advantages beyond increasing the employability skills of graduates. A review of the UK experience on the introduction of research training and codes of research practice in the arts, humanities and social sciences found that it led to increased submission rates. Indeed, a combination of: requiring the candidate to submit a project approval form outlining the research objectives and plan; completion of a training program; and assessment and being supervised by a team together increased the probability of a candidate submitting a thesis within four years from 15 to 70 per cent.[92]

A set of best practice principles identified by a *Workshop to Explore Approaches to Quality Doctoral Research Training in Our Region* run in Malaysia by the Australian Council Deans and Directors of Graduate Studies had as its second principle the development of generic/transferable skills and concluded:

> *The development of generic/transferable skills is fundamental to best practice doctoral training. Candidates undertake doctorates as preparation for a wide range of careers that require diverse skills in addition to the capacity to undertake independent research. Modern research higher degree candidates commence doctoral programs at a wide range of ages and with diverse skills developed through prior experiences.*[93]

In December 2012 the OECD published a book which compares a number of countries in terms of their development of transferable skills for researchers.[94] The report identified:

> *a significant amount of transferable skills training activity, undertaken predominantly by individual institutions, for the most part without any overall national strategy or direction from governments or other entities.*

The report also noted that:

> *Formal approaches to transferable skills training for PhD students are not uniformly welcomed, with some concerns about implications for core research, degree lengths and costs if more training is incorporated into PhD studies. There is also debate over the skills to be taught at different stages and the best way to learn them – interaction with supervisors and peers, formal courses, or workplace-based learning (e.g. during an internship). There are also questions about the amount and method of*

91. http://www.hm-treasury.gov.uk/d/robertsreview_introch1.pdf

92. Robin Humphrey et al 2012, 'The impact of research training and research codes of practice on submission of doctoral degrees: an exploratory cohort study', *Higher Education Quarterly*, volume 66, January 2012, pp 47-64.

93. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/DoctoralResearchTraininginOurRegion.pdf

94. OECD (2012), 'Transferable Skills Training for Researchers: Supporting Career Development and Research', OECD Publishing, http://dx.doi.org/10.1787/9789264179721-en

training for transferable skills and the roles of various stakeholders, such as governments and research institutions.

At the national level in Australia, in 2012 the Office for Learning and Teaching made a $150 000 grant to the ANU Centre for Higher Education, Learning and Teaching to examine how to introduce coursework into PhDs. The purpose of the project is to "provide an understanding of the pedagogical, curriculum, organisational and funding issues related to the introduction of coursework within the Australian PhD."[95]

Australia's Physics decadal plan 2012-2021 contains a recommendation to broker:

> *... agreements between Australian higher education providers to ensure that the Australian physics PhD is comparable in the breadth, depth and duration of training to those in the USA and the EU, particularly by providing the resources for the inclusion of postgraduate coursework as a key component for higher degree by research training.*[96]

In this context it is interesting that the 2012 Australian Council of Learned Academies report on career support for researchers stated that:

> *Programs which trained research students in complementary skills important for a career in research (project management, managing IP, communication skills, etc.) also enjoyed support as an aspect where the Australian system performs well.*[97]

As an example of what is already happening in Australia, the University of Queensland has introduced its *UQ Career Advantage PhD Program*. The aim of the program is to stimulate greater interactions between students, industry and alumni by enhancing cross disciplinary dialogue and collaboration to increase employability among one of three pathways: higher education practice and leadership; research, innovation, translation and commercialisation; and global collaborations.[98] Similarly, the Monash PhD will now require at least three months of professional development coursework and/or training in addition to a thesis.[99] This coursework will encompass generic topics such as communication skills, personal effectiveness, teamwork and networking, career management, and financial management to enhance employability; and discipline-specific topics to cover technical, research and academic skills. At the University of Sydney all new PhD students are to complete a Training Needs analysis that they will repeat at every annual progress report date and each of which represents a formal contract between the student and university.[100] The University of Western Australia is adopting a different approach based on named Graduate Research Programs which can develop specific curricula specific to particular disciplines and to fit the expectations that external stakeholders – including potential employers – might have about the program.[101]

Introducing coursework is part of a more global response to ensuring that PhD programs reflect the reality of employment pathways and of ensuring that PhD graduates have skills and attributes that go beyond those of specialised technicians. There are even suggestions that the nature of the PhD program should change so that rather than the students performing all the research

Does coursework provide a sensible means of differentiating the PhD programs offered by different universities?

95. http://chelt.anu.edu.au/doctoral-coursework
96. http://www.science.org.au/natcoms/nc-physics/documents/nc-physics-DecadalPlan.pdf
97. http://www.tossgascoigne.com.au/docs/CareerSupportForResearchers.pdf
98. http://www.uq.edu.au/grad-school/career-advantage-phd/
99. http://www.monash.edu/migr/why-monash/phd/index.html
100. http://chelt.anu.edu.au/sites/default/files/Maire_Carroll.pdf
101. http://chelt.anu.edu.au/sites/default/files/Alan_Dench_1.pdf

themselves, they should instead be put in a position where they have responsibility for the project and have to manage the job.[102]

As discussed earlier, however, one of the difficulties in introducing course work relates to the varied background and existing competencies of any cohort of PhD candidates. There is also a need to consider how formal coursework has to be – for example whether it should involve formal assessments, marks and boards of examiners. This is a particular issue in a country such as Australia in which the PhD examination process relates only to the dissertation and the examiners do not need to have had any direct contact with the student.

Pathway to a PhD

One issue related to the introduction of coursework is the nature of the path that research students take to become PhD candidates and the extent to which this equips them with the transferable and generic skills that they need. In many countries students take a two year masters degree before they start a three year PhD and this provides an opportunity for them to pick up transferrable skills, not least those directly related to research methodologies. In Australia a typical domestic research student has completed a three year bachelors degree and followed this by an honours degree that typically involves around 9 months study. The PhD generally provides 3 to 3.5 years of scholarship support, so the total study time is less than the 8 years implied by the Bologna protocol. This pathway has implications, not only for the preparedness of PhD candidates in Australia but also for the acceptance of Australia honours graduates for the PhD programs of overseas universities.

Within Australia, Macquarie University has already decided to replace its honours degrees with a two year masters by research. Professor Max King, formerly Pro Vice-Chancellor (Research and Research Training) at Monash University has initiated a process to examine the adoption of a masters pathway to an Australian PhD. This would align Australia with what is increasingly the international practice; it would also provide an opportunity to include some necessary coursework in this pre-PhD degree.

Improving the quality of research training

While there is no doubt that the expanding number of doctoral graduates can create problems in them finding employment as researchers or in jobs that make use of their disciplinary knowledge, there is no argument that quality matters. High quality training has an increased probability of producing excellent graduates with broad career opportunities.

Employers of all kinds are competing to attract the very best and most talented candidates. Those who find it most difficult to find employment will often lack some of the attributes that the best candidates are able to demonstrate or, if they possess these attributes, are less able to demonstrate them. In a very competitive environment, it may also be true that the status and reputation of the institution that provided the qualification may also play a role in the initial process of culling the applicants for a position – but status and reputation flow at least in part from the quality of the programs on offer.

Excellence is at a premium but it is important to recognise that excellence is a relative, not an absolute measure. If excellence is better than normal performance, at least 50 per cent of all graduates must be less than excellent – but this is against a selection process that has already chosen the best for PhD training. Moreover, the criteria used to measure excellence depend on context. Measuring the excellence of the research produced by a researcher in a university can quite properly (and effectively)

102. http://www.universityworldnews.com/article.php?story=20120903152518738

use a set of criteria different from that used to measure the excellence of the research produced by a researcher in a particular business. Nevertheless, it is important – for both providers and students – to have a clear view about what contributes to an excellent or high quality PhD program. Such criteria will need to build on what attributes such programs aim to develop in those taking them.

The UK Higher Education Commission independent inquiry into postgraduate education noted that quality is difficult to define in the context of research degrees but that it needs to encompass a measure of the academic quality of the research produced by the student as well as a measure of the extent to which the program met the needs and expectation of the students and the academy. Moreover, any consideration of quality has to take place through an international prism, given that there is a global market for research training and those receiving such training operate in a worldwide employment market.[103]

In Australia the government's Research Workforce Strategy stated that:

> *... research training standards would need to take into account, among other issues, the quality of the physical and intellectual environments in which training is conducted, institutional arrangements for student selection, admission and award of a HDR degree, and the integration of opportunities for transferable and professional skills development in training programs. They would further need to take into account HDR graduate attribute and knowledge expectations established under the new AQF.*[104]

In October 2011 the Australian Department of Innovation, Industry, Science, Research and Tertiary Education released a consultation paper on defining quality for research training.[105] This attracted 63 submissions from higher education institutions, research agencies, peak bodies and individuals.[106] The areas the consultation paper identified as forming a possible framework for quality criteria were:

- Research training environment
  - Physical resources
  - Student opportunities
  - Supervision
  - Research environment
- Research training program
  - Subject specific knowledge
  - Broader skills
- Other quality considerations
  - Length of support
  - Support for part-time students
  - Top-ups to Australian Postgraduate Awards (to attract students in areas of high demand where the starting salaries for bachelor degree graduates might deter further study)

In its submission responding to the consultation paper the Group of Eight noted that:

> *... one of the most important areas that requires agreed standards in order to maintain the integrity of Australian degrees is that of examinations and examination processes. Any suggestion that examination processes lack the rigor applied in other countries would have the potential to devalue the worth of an Australian degree to the disadvantage of both students and institutions.*[107]

103. http://www.policyconnect.org.uk/hec/sites/pol1-006/files/he_commission_-_postgraduate_education_2012.pdf

104. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/ResearchSkillsforanInnovativeFuture.pdf

105. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/DefiningQualityforResearchTraininginAustralia.pdf

106. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Pages/ResearchTrainingQualityPaperSubmissions.aspx

107. http://www.innovation.gov.au/Research/ResearchWorkforceIssues/Documents/RTQSubmissions/GroupofEightSubmission.pdf

The department is currently working on advice to the minister that will take into account these submissions as well as work by the National Standards Panel that will feed into the standards used by the Tertiary Education Quality and Standards Agency (TEQSA).

External placements

One way of broadening the experience that a PhD program provides is to enable PhD candidates to gain experience in different environments. For this reason there is increasing interest in students having placements in industry, government research laboratories or other non-academic programs, whether domestically or overseas, through the course of their program. As discussed earlier, the context within which research takes place in business can be very different from that experienced while in an academic environment. A good example of the use of business placements is that provided by the Accelerate program operated by the Canadian organisation Mitacs.[108] Each year this places around 2 000 research students and post doctoral researchers into four month internships in business. The program encompasses over 50 universities and 1 300 firms. It is interesting that while around one third of the placements involve engineering students, the next highest category is that of the social sciences, arts and humanities. Within Australia the AMSI intern program (funded through the Commonwealth government's Enterprise Connect program) offers a similar service which provides:

> *...postgraduate students with the opportunity to take part in paid, research-based internships, guided by an academic mentor at their home institution. Small-to-medium enterprises seeking high-end analytical expertise can take on an intern to address a specific research challenge or problem facing their business. Projects can cover any research area – not just mathematics and statistics – and typically last 4-5 months.*[109]

As discussed below, the Cooperative Research Centre program can also offer a broader experience to research students by linking the research closely to end-user needs and a number of universities have their own programs to facilitate external placements. For example, the "Research Innovation, Translation & Commercialisation" component of the University of Queensland's Career Advantage PhD program includes an industry internship.[110] A move to a doctoral training centre model, as discussed below, can also provide a broader range of research experience.

Teaching and learning environment

There is a huge variation between countries in the design, development and organisation of PhD education that extends even between institutions and disciplines within a single country. However, some common trends are emerging.

Providing an environment that both facilitates and encourages learning is an essential precondition for effective PhD training. At best this will promote the open exchange and testing of ideas, support argument and discussion across disciplines and cultures and help broaden the perspectives of students beyond the immediate focus of their personal project. The March 2010 report of the League of European Research Universities entitled Doctoral degrees beyond 2010 concluded:

> *Doctoral education must be embedded in a strong research environment and culture to ensure that the opportunities for cross-fertilisation between disciplines can foster the necessary breadth and*

108. http://www.mitacs.ca/accelerate

109. http://amsiintern.org.au/about-amsi-intern/

110. http://www.uq.edu.au/grad-school/career-advantage-phd/research-innovation-translation-commercialisation

interdisciplinarity. For this reason we believe that doctoral education is best undertaken in research-intensive institutions or in partnerships where the benefits of a wide range of research activities can be exploited.[111]

A primary requirement has to be that the institution providing the training is producing excellent and innovative research, so that the training takes place within an environment that itself demonstrates high standards. In Australia the results of the Excellence in Research for Australia (ERA) exercise can be useful in identifying where excellence resides. However, excellence in a particular field is not enough. The institution also requires scale, such that it can demonstrate excellence across a range of disciplines. This is becoming more important as multi- and inter-disciplinary research becomes more important but it has further advantages in providing the potential to broaden the outlook of students, not least by creating opportunities and the need for trans-disciplinary networking, communication and learning.

The UK Research Excellence Framework (REF) which comes into force from 2014, awards 15 per cent of its score following an assessment of the research environment and this covers provision for doctoral education.

An interesting trend internationally has been to teach PhD students in groups rather than having them work with individual supervisors. This has involved the establishment of doctoral training centres which bring together students in cohorts to work on specific areas such as chemical synthesis or chemical biology.[112] Britain's Engineering and Physical Sciences Research Council has opened more than 50 of these centres which provide a four year program and other funding bodies are following this trend.[113]

The European University Association has noted a rise of the doctoral school (30 per cent of institutions in 2007 to 65 per cent in 2010).[114] The German Research Foundation (DFG), which is Germany's largest funding organisation for university researchers (with a 2012 budget of €2.5 bn) makes the distinction between Graduate Schools and Research training Groups. The former (of which there are 45) cover the research fields and priorities of the university and each would have 25 or more principal investigators and 40 to 300 doctoral researchers. The 225 Research Training Groups can be modules within the Graduate Schools and each has a coherent research program designed by its 5 to 10 principal investigators.[115]

In Australia the new Industrial Transformation Training Centres scheme:

will foster close partnerships between university-based researchers and other research end-users to provide innovative Higher Degree by Research (HDR) and postdoctoral training for the end-user focused research industries vital to Australia's future. Over a five-year period the ARC will award funding for up to 50 Training Centres with funding for at least ten (10) Higher Degree by Research candidates and three (3) postdoctoral fellows in each Training Centre.

The Industrial Transformation Training Priorities are research areas identified by the ARC which will be updated from round to round. The Industrial Transformation Training Centres for funding commencing in 2013 will seek applications addressing the Industrial Transformation Training Priorities which focus on research that underpins future food storage; food processing; manufacturing capabilities; product

111. http://www.leru.org/files/publications/LERU_Doctoral_degrees_beyond_2010.pdf

112. The League of European Research Universities makes the distinction between Graduate schools, organised across the whole of a university to provide strategy, regulation, financial support, generic skills courses, and often admission processes for doctoral education; and doctoral schools (or centres), usually organised along thematic lines crossing disciplines but focused on specific broad topics. They may bring together researchers in the field from a number of different disciplines. They may also bring together a number of institutions creating stronger critical mass in the field. See: http://www.leru.org/files/publications/LERU_Doctoral_degrees_beyond_2010.pdf

113. www.nature.com/news/phds-leave-the-ivory-tower-1.10383

114. http://www.eua.be/Libraries/Doctoral_week_2012/Thomas_Jorgensen_Plenary_II.sflb.ashx

115. http://www.eua.be/Libraries/Doctoral_week_2012/Sebastian_Granderath.sflb.ashx

opportunities and other food related research.

The objectives of the Industrial Transformation Training Centres scheme are to:

1. *foster opportunities for Higher Degree by Research candidates and postdoctoral fellows to pursue industrial training and to enhance competitive research in collaboration between universities and organisations outside the Australian higher education sector; and*
2. *strengthen Australia's Industrial Transformation Priorities to supplement the needs of industries and other research end-users.*[116]

Under the provisions of the government's 2013 *Industry and Innovation Statement*, The Industrial Transformation Research Program, of which the training centres form a part, will direct its activities at areas identified for ten Industry Innovation Precincts which will be led by industry and have a strong focus on economic development and the generation of new jobs.[117]

Also in Australia the Australian Technology Network's doctoral training centre in maths is to support 20 to 25 new HDR students each year. The PhD program will be for up to 4 years and the contributing industry partners will play a role in developing the research project. Students will spend a significant amount of time working at the site of the industry partner and the program will incorporate coursework.[118]

PhDs involving co-mentoring and co-funding with industry have been common in the US for around 60 years and they are now becoming more common in Europe. The Engineering and Physical Sciences Research Council in the UK funds 26 industrial doctorate centres. France has had an Industrial Arrangements for Training Through Research (CIFRE) scheme since 1981 which has produced around 10 000 PhD graduates. The Danish Industrial PhD program (established in the 1970s) approved 116 industrial PhD projects in 2011 and in that year the European Commission launched a 20 million euro industrial PhD initiative as part of its Marie Curie Actions funding program.[119]

Does the relatively low performance of research by Australian business limit the options for changes to PhD training?

In Australia the Cooperative Research Centres have played an important role in providing doctoral education in a research user context and over the period 2002 to 2012 were together the twelfth largest provider of research training in Australia.[120] The CRC Association is currently exploring what it means to provide "good" postgraduate training in an industry-focussed setting. CRCs are partnerships involving universities and as Nigel Palmer noted in his report for the Association:

A general view on the nature and extent of the CRC contribution to research training may depend on who you ask. From a university perspective, CRCs may be regarded as an additional add-on for some of their research students. From a CRC perspective however, it often seems that CRC engaged research candidates are regarded as the CRC's research students, with the university contribution being more administrative than practical in nature. In truth of course the nature and extent of the CRC contribution to research training will vary on a case-by-case basis, with research students typically seeking out the resources and support that best suit them and the needs of their project. The challenge for CRCs however is in demonstrating the contribution they make to research training, as part of their broader

116. http://www.arc.gov.au/ncgp/itrp/centres_default.htm

117. http://aussiejobs.innovation.gov.au/documents/IS%20Full%20Statement.pdf

118. http://www.atn.edu.au/IDTC/index.htm

119. http://www.nature.com/naturejobs/science/articles/10.1038/nj7386-557a

120. http://crca.asn.au/the-crc-contribution-to-research-training/

education and research activities.[121]

However, Australia has a small number of PhD qualified researchers working in industry compared to most other OECD countries (and its proportion of researchers in the business sector workforce is also significantly smaller). One consequence of this is the difficulty of finding appropriate industrial partners for PhD training. Partnership with industry can also create tensions if the initial agreements do not address matters such as the right (and need) to publish, the need to complete even if the research does not go as expected and IP matters. Nevertheless, providing opportunities to work outside an academic environment and in other research centres, including those in other countries can be an important means of increasing the richness of a PhD program and adding to the value of its outcomes. Such experience not only broadens the experience of the student, it also adds to the national research infrastructure by creating and strengthening domestic and international linkages and networks.

121. http://crca.asn.au/wp-content/uploads/2012/12/The_CRC_Contribution_to_RT_Final_Report.pdf

Conclusion

Australia provides effective PhD programs and has an international reputation for doing so. Countries around the globe recognise that Australia's PhD programs are world class, Australia attracts PhD students from many different nations, and the number of international students seeking PhD education in Australia continues to increase. A recent report from the Australian Council of Learned Academies on career support for researchers, based on data from a survey and focus groups, noted that respondents regarded Australia's PhD program "as a powerful factor in launching people on a career in research" and concluded that:

> *The PhD program is recognised as the best feature of the Australian research landscape by the study group.*[122]

While this report did identify some concerns these were much more about the opportunities available at the end of PhD training and the need to increase the number of research positions available for new entrants, rather than about the quality of the PhD programs. The main issues raised with respect to the PhD programs were:

> *an increase in the time to complete a PhD, enabling the student to build up a publishing record and (perhaps) gain teaching experience [and] the provision of training in complementary skills.*

Despite the strength of PhD education in Australia there is an ongoing debate here as right around the world about the need for PhD programs, their purpose and effectiveness. Some of this debate reflects the views of disillusioned graduates who are finding that their employment opportunities do not meet their expectations; some reflects the views of employers that PhD graduates lack some of the attributes they would expect (and require) them to exhibit; some reflects the concerns of governments that there may be an insufficient supply of PhDs to meet the demands resulting from their policies to restructure their economies and make them more competitive, as well as their unease about the increasing costs of PhD education and its effectiveness.

Pressures for change are coming from the growth in the number of PhD students, the increasing diversity of the student cohort and the problems of supporting part-time students who are often working off campus and in non-academic environments. An increased diversity in the employment trajectory of PhD graduates is raising issues about the kinds and the breadth of non-research skills that PhD graduates need or can reasonably acquire to make them more competitive in the job market against bachelor qualified people with work experience. Changes in the research environment with greater emphasis on large scale interdisciplinary research managed to achieve outcomes identified in advance, as distinct from research whose major aim is to advance knowledge, are also creating the need for broader and different skill sets.

Despite this ongoing debate, the PhD remains and will remain the pinnacle of formal academic achievement. Australia and other countries will continue to need people who can contribute to national wellbeing by drawing upon the specialised knowledge and research capabilities that PhD education provides. The reforms underway and the continuing debate will help keep Australian PhD education necessary, relevant and world class.

An overriding concern of the current changes is to ensure that the programs provided go beyond a focus on producing high quality research to better serve the needs of the student. One of the explicit objects of the ongoing reform is to ensure a system that extends beyond a narrow emphasis on training for a particular career to one which creates well-rounded, research-capable people able to

122. http://www.tossgascoigne.com.au/docs/CareerSupportForResearchers.pdf

market and apply their knowledge, skills and undoubted intelligence in a wide variety of contexts. As these changes take place it is likely that a more diverse array of PhD programs will become available, broadening the choice available to students and providing a range of different pathways – but all operating within an agreed accountability system and against a set of minimum standards that ensure quality and comparability.

By unleashing the potential of some of Australia's brightest and most talented people, PhD education will continue to play a role not only in meeting current national needs and priorities but also in creating the capacity to extend beyond these by creating new and better opportunities and a continuing stream of innovation across all sectors of national activity.

Attachment 1

Potential attributes of PhD graduates

Student learning outcomes are difficult to measure but arguably provide the most fundamental information about the success of PhD training, given its purpose. Graduates, potential employers and the universities themselves all have an interest in the skills and attributes that the graduates develop and in particular on their ability to contribute to the further development of the discipline in which they have been working. This contribution may take place through further research, teaching or the application of their skills, knowledge and experience in the broader economy and society.

Having a focus on student outcomes and their attainment makes it possible to identify the areas in which PhD training may not be fully effective and can lead to changes in the content and approaches to the training which can lead to greater benefits for graduates and society.

While at some level there will be differences between disciplines and in some cases a requirement for very specific skills at a level necessary to meet requirements of professional practice, the following list suggests a set of high-level generic outcomes and attributes as a basis for further discussion. At the same time it is important to recognise that employers in different sectors may place very different weights on the relative importance of different attributes and there are always questions as to whether PhD training is the best way to gain them (as distinct from on the job training, for example).

Disciplinary knowledge

- A high level of specialised disciplinary knowledge centred on the research project but not restricted by it.
- An understanding of how the discipline draws upon and contributes to related disciplines.
- An appreciation of the importance of the discipline to society.
- An understanding of the various ways in which the discipline can have direct or indirect impact on national wellbeing.
- An understanding of the major research opportunities existing across the discipline and of current debates within the discipline.
- A capacity to contribute to the development of professional practice.
- A network of domestic and international research contacts active and prominent in the broader disciplinary area.

Research skills

- An ability to formulate and present a problem in a form suitable for research – developing a hypothesis for testing.
- An ability to develop a research strategy that will address the identified problem and test the hypothesis.
- An understanding of research techniques at a general level.
- An ability to work and communicate across disciplines.
- An appreciation of the range of research management techniques that is available and of how and

in what circumstances to apply them.

- An understanding of the quantitative and qualitative analysis techniques (including different approaches to data visualisation) used within the discipline and an ability to use them properly.
- Experience in conducting critical literature reviews.
- A knowledge, understanding and acceptance of research ethics and practices – including the *National Code for the Responsible Conduct of Research* – with a strong commitment to probity and an ability to identify and respond appropriately to any ethical issues that might arise.
- An understanding of the need to obtain any necessary formal approvals for research and how to go about doing this.
- A general appreciation of funding sources, how to access them and the accountability and reporting responsibilities this entails; how to write effective grant applications and tenders and the resulting reports.
- An ability to work in an interdisciplinary context.
- An understanding of how and where to publish research findings.

Technical skills and knowledge

- An ability to identify, understand and apply the technical skills associated with the discipline.
- An ability to use and apply the technical equipment associated with research within the discipline and in different contexts.
- An ability to adapt and extend technical approaches in novel ways to address new problems.
- Knowledge of how to locate specialised infrastructure and equipment used within the discipline and how to access it.
- An awareness and understanding of technical issues such as occupational health and safety, environmental regulations, bio-safety, animal welfare, privacy and other issues as appropriate.

Contribution to knowledge

- A significant contribution to new knowledge tested through peer review processes or through the normal evaluative processes typical for the discipline.
- An ability to assess evidence critically and to comment on and make use of the findings of other research in a way that adds value to them.
- An understanding of all the appropriate ways of disseminating new knowledge, of the necessary protocols in using them and demonstrated experience in doing so.
- An understanding of teaching skills and experience in using them.

Generic skills

- Effective communication skills – written and verbal, including listening, responding and an ability to present a well structured argument, tailored to the needs of different audiences, which will have impact.
- A broad understanding of financial management issues.
- Teamwork skills – including an ability to recognise the need for complementary expertise / skills sets, to value them and to identify and work productively with people possessing them.

- Leadership and assertiveness skills.
- Problem solving skills with good judgement and common sense.
- Initiative and a preparedness to take action to achieve results.
- An ability to think ahead, recognise risk and plan accordingly with good project management skills.
- An ability to cope with ambiguity and uncertainty and to manage accordingly.
- Resilience and an ability to respond effectively to the unexpected in a way that does not lose sight of the intended strategic outcomes.
- An ability to manage one's own career.
- General IT skills.

Attachment 2

Numbers of PhDs in Australia by State and Discipline

QALFP - 2 Digit Level	Natural and Physical Sciences	Information Technology	Engineering and Related Technologies	Architecture and Building	Agriculture, Environmental and Related Studies	Health	Education	Management and Commerce	Society and Culture	Creative Arts	Food, Hospitality and Personal Services	Mixed Field Programmes	Field of study inadequately described	Field of study not stated
Main Statistical Area Structure (Main ASGS) (POW)														
New South Wales	7611	759	2660	153	579	6803	1105	1010	5736	545	0	3	223	121
Victoria	8176	743	2427	145	354	5395	1045	890	5339	477	0	0	243	355
Queensland	4417	424	1547	82	476	4088	765	618	2822	312	0	0	130	149
South Australia	2374	155	584	41	213	1875	259	201	1212	94	0	0	62	77
Western Australia	2998	166	1022	40	345	2055	374	298	1615	143	0	0	56	35
Tasmania	853	47	105	10	117	452	95	40	395	52	0	0	14	47
Northern Territory	213	0	25	4	32	196	45	21	148	8	0	0	12	0
Australian Capital Territory	2375	219	337	20	186	510	94	153	1714	96	0	0	90	18
Other Territories	8	0	0	0	0	3	0	0	0	0	0	0	0	0
POW not stated	247	20	91	0	21	187	47	48	175	16	0	0	12	34
POW not applicable	7542	380	1836	123	588	4046	1490	656	5976	463	0	0	301	322
Total	36814	2913	10634	618	2911	25610	5319	3935	25132	2206	0	3	1143	1158

Data Source: Australian Bureau of Statistics 2011 Census of Population and Housing

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