Australian Government
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Initiatives to enhance the professional development of research students

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Initiatives to enhance the professional development of research students

Executive Summary

This report presents the findings of a project undertaken by the Australian Government's former Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education ('the Department') from late 2012 to 2013.

This project focused on a range of initiatives that support higher degree by research (HDR) candidates (those undertaking a doctorate or masters by research degree) to develop capabilities and experience extending beyond the advanced disciplinary knowledge, research skills and academic experience that are typically acquired through undertaking a higher degree by research ('research training'). This aligns with a broader agenda of ensuring not only the quality of the research training system in Australia, but also its relevance to labour market requirements.[1] The term 'industry' is used broadly in this report and refers to the private, government and not-for-profit sectors.

The aim of this report is to promote innovative practices in the training and development of HDR candidates, and to assist institutions seeking to develop similiar strategies, by illustrating some of the different approaches that have been implemented which might serve as a 'blueprint'.

The main findings in this report are based on case studies of 15 initiatives administered by a range of organisations, including publicly funded research agencies, cooperative research centres, medical research institutes, business, and universities. The Department also surveyed 249 HDR candidates who have participated in these initiatives to gain feedback on their experiences.

Statements from the university sector and the Australian Government show support for initiatives that seek to enhance the 'work readiness' of HDR graduates:

- In its report A smarter Australia, peak body Universities Australia stated that:

  To develop a powerful research and innovation system that drives economic and social progress, universities will… with input from prospective employers, review how best to train PhD graduates for employment in the broader economy.[2]

- A government report released in 1999, *Knowledge and innovation* that led to the creation of the Research Training Scheme - the current funding mechanism for research training - stated that one of its objectives is to 'ensure the relevance of research degree programmes to labour market requirements.'[3]

- Action 7 of the *National research investment plan* prepared by the Australian Research Committee (ARCom) in 2012 states that:

  Building on work being progressed under the Research Workforce Strategy: Research Skills for an Innovative Future, ARCom will… propose measures to provide research students with the generic skills and

[1] Higher Education Support Act (2003) Other Grants Guidelines - Research Training Scheme Objectives 2.15.1 (4)
[2] Universities Australia (2013) *A smarter Australia: An agenda for Australian higher education 2013-2016* p. 4
[3] Kemp, D (1999) *Knowledge and innovation: A policy statement on research and research training*, p. 18

innovation capabilities needed to be productive in a wide range of employment contexts, including business.[4]

- Priority 4.3 of the *Research workforce strategy* which supports the 'development of new models for research training focussed on the professional employment needs of graduates'.[5]
- Principle 3 in the discussion paper, *Assessing the wider benefits arising from university-based research* released in June 2013, which states that an assessment mechanism should encourage and assist universities to 'develop industry-linked research training and research careers'.[6]

Key findings include**:**

- There are a range of initiatives that enable HDR candidates to develop skills, knowledge and experience that extend beyond the research skills, disciplinary knowledge and academic experience that are the central focus of research training.
- There are a number of ways in which the capabilities and experience of HDR candidates can be enhanced to prepare them for careers in a range of employment sectors. These include through: experience engaging with industry; internships; exposure to interdisciplinary research environments; training courses; and other professional development activities.
- The HDR candidates and program managers who participated in this project considered their respective initiatives to provide a positive experience and support strong graduate outcomes.
- Greater engagement with industry in the development of HDR candidates can benefit students, universities and industry alike. Each of these groups can pursue these opportunities through greater collaboration.
- At a whole of system level, there is no strategic, coordinated approach to the engagement of industry in research training that targets key areas of importance for Australia's future economic development.

It should be noted that the case studies contained within this report are not intended to be comprehensive or representative of all initiatives that fit within this theme. This report simply presents a small sample of initiatives. These are provided at **Appendix A.**

[4] Australian Government (2012) *National research investment plan*. Canberra, Australia. p. 69

[5] DIISR (2011), *Research skills for an innovative future – A research workforce strategy to cover the decade to 2020 and beyond*, Canberra, p.25.

[6] DIISRTE (2013) *Assessing the wider benefits arising from university-based research*, Canberra p. 7.

The changing context for research training

Increasing productivity and economic growth is a key priority of government policy.[7] Universities contribute to this in fundamental ways: in particular, by providing industry with a skilled, educated workforce through the delivery of graduates; the most advanced of which are HDR graduates. HDR graduates serve as mechanisms for knowledge transfer into industry.[8] In addition to their advanced disciplinary knowledge, HDR graduates possess highly developed research and technical skills. As a result of these capabilities, HDR graduates have the potential to make a substantial contribution to the Australian economy through research that drives innovation and supports Australian industries to become stronger, more productive and more internationally competitive.

The connection with industries - as an employer of graduates - in the delivery of higher education is reflected in the design of many Bachelors, Honours and Masters by Coursework degrees, and particularly those that have a direct link to professional practice, such as psychology, engineering, architecture, physiotherapy and business administration. Since these degrees are expected to establish the foundations for a professional career, they are often developed in consultation with industry representatives or professional bodies. These professional bodies may also accredit courses or register graduates to be practitioners and, as a result, industry expectations form an important consideration in the design and delivery of such programs. Industry oriented projects and work placements are also quite common.

Connections with industry tend to be less prevalent in the case of Higher Degrees by Research. The current model of higher degree by research training is derived from what has been referred to as a research 'apprenticeship' model, in which talented students carry out a research project under the guidance of an academic supervisor. The PhD training model in Australia still largely follows this model.[9] The general expectation was that once they graduated, these students would progress onto academia careers.[10] As many HDR graduates now do not progress into academia, it has become more important for HDR candidates to be provided with opportunities to develop broader capabilities and industry experience that are relevant to other career options.

This is in line with one of the objectives of the Research Training Scheme (RTS) which is to 'ensure the relevance of research degree programmes to labour market requirements'. This is in recognition of the fact that whilst the primary purpose of research training is to develop individuals with the capabilities to undertake research, once they graduate they will be required to perform within a work environment; and not necessarily an academic one. To ensure that they are prepared for this, HDR candidates should have a range of broader (that is, non-research or discipline specific) skills, knowledge and experience that are relevant to a variety of professional environments. By developing a workforce that is not only highly skilled, but also able to operate effectively and apply their skills to a variety of professional contexts, this will enhance their utility and promote strong returns on the significant public investment into research training that occurs through the RTS.

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[7] DIISRTE (2012), *Australian innovation system report 2012*, Canberra.

[8] Hughes, A. & Martin, B. (2012) *Enhancing impact: The value of public sector R&D,* report prepared for Centre for Industry and Higher education

[9] Group of Eight (2013) *The changing PhD: A Discussion paper*

[10] Graduate Careers Australia (2011) *Postgraduate research destinations report 2011 Tables and Figures,* (Table 8).

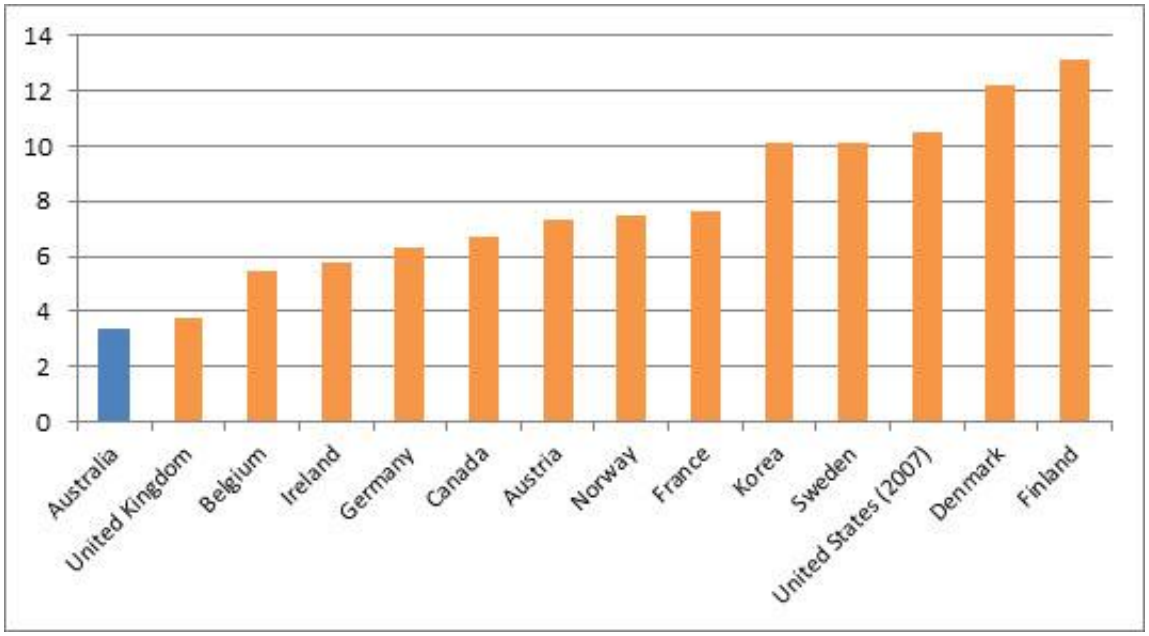
Researchers and innovation

HDR graduates can make a significant contribution to Australian industries, either as highly skilled employees of the R&D workforce or entrepreneurs in their own right. Technological advances and globalisation have increased the need for industries to be innovative in order to maintain a competitive edge. Research and development is an important driver of innovation and requires a highly skilled workforce that is able to carry out effective research and translate discoveries into a new product, process or service.[11]

The Australian Innovation System Report for 2012 noted that the innovation performance of Australian business sector is poor by international standards. Out of 28 OECD countries, Australia ranked 26th in innovation performance for large businesses and 16th for small to medium sized businesses.[12]

Innovation performance is influenced by a complex range of factors, a key element of which is research capacity and skills base. Yet there is a low proportion of researchers in the business sector in Australia compared to many other OECD countries. In 2010 there were three researchers in business for every 1000 workers in Australia; in Austria, Norway and France there were over seven; while Korea, Sweden, the United States, Denmark and Finland had between 10 and 13 (see Figure 1).

Figure 1: Researchers in business enterprises per 1000 workers in industry*, 2010



* Per 1000 total employed in industry FTE

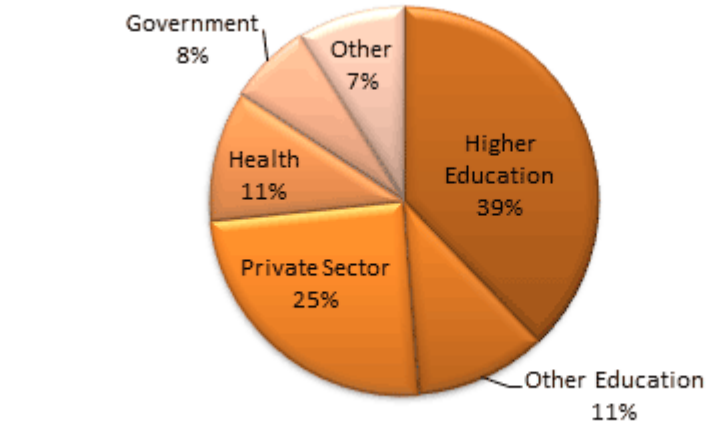
Source: OECD Main Science and Technology Indicators 2012/2

[11] DIISR (2010) *Australian innovation system report 2010*, Canberra.
[12] DIISRTE (2012) *Australian innovation system report 2012*, Canberra, p 52.

Employment of HDR graduates in business

The low proportion of researchers employed in business reflects trends in the early career paths of HDR graduates. Data from Graduate Careers Australia's 2012 report on the postgraduate destinations of recent HDR graduates reveal that only 25 per cent were working in the private sector. The remainder were spread across higher education (39%), the broader education sector (11%), health (11%), government (8%) and other (7%) – see Figure 2.

Figure 2: Employment destinations of research graduates, 2012, working full time



Note - due to rounding percentages will not add up to 100.

To address the low level of researchers in industry, Universities Australia stated in its report*, A smarter Australia: an agenda for higher education 2013–2016:*

> Australia should strive to at least double the number of PhD graduates employed in the broader economy to catch up with the proportion of PhD graduates per 1000 in the strongest innovation-based export economies.[13]

Rethinking the approach to research training

The diverse career trajectories of HDR graduates, and the potential value to be gained from increasing the number of HDR graduates in industry has led to a range of new perspectives on research training. As stated in the Research Workforce Strategy:

> …the occupations and sectors in which research graduates are employed have diversified… Graduates need not only academic skills, but a wide range of generic competencies to operate effectively in these diverse contexts.
>
> Together, these developments demand a contemporary approach to research training which continues to focus first and foremost on the development of the 'scholar' but places increased emphasis on the 'employee' and 'innovator'.[14]

This has prompted some members of the higher education sector to re-evaluate the approach to research training. In March 2013 the Group of Eight released a discussion paper titled, *The Changing PhD*, which states:

[13] Universities Australia (2013) *A smarter Australia: An agenda for Australian higher education 2013-2016*, p.42.
[14] DIISR (2011), *Research skills for an innovative future – A research workforce strategy to cover the decade to 2020 and beyond*, Canberra, p.22.

> …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.[15]

There is evidence to suggest that HDR candidates also value additional opportunities to develop professional capabilities that will help them to be an effective employee. Responses to the National Research Student Survey conducted in 2010 suggest that while most research students considered their HDR to be effective in preparing them for careers in academic research, it was not particularly effective in preparing them for careers in other sectors.[16] Furthermore, in a study undertaken by the Australian Council of Learned Academies on best practice in career support for researchers, HDR candidates stated that they needed potential career pathways to be made clearer, plus better access to professional development and training programs. Postdoctoral researchers from the same study, when asked to identify elements that may contribute towards best practice for universities and research organisations, stated:

> mentoring, training in complementary skills, and an encouragement to collaborate with industry and other researchers should begin earlier in the career pathway, when students are completing their research degree.[17]

Initiatives in which HDR candidates collaborate with industry have been the subject of attention in Europe. In 2009 a project was undertaken for the European University Association, focusing on collaborative doctoral programs. It stated that:

> With over 50% of doctorate holders moving into careers outside the academic sector, the importance of such collaborative programmes is evident. The value of the promotion and dissemination of good practices in such collaborative doctoral programmes, the achievement of inter-sectoral mobility, the development of transferable skill components and the broadening of employment horizons cannot be over-estimated.[18]

The need for research training to prepare students for employment in a range of sectors is also applicable given that research degrees involve gaining knowledge of what is usually highly specialised and discrete subject matter. Employment opportunities directly related to this field of expertise are often relatively limited. It is therefore in the students' best interest to ensure that in addition to the discipline and research specific skills and knowledge that are the core focus of research training, they are also provided with opportunities to develop broader skills, knowledge and experience that are relevant to a variety of employment contexts.

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[15] The Group of Eight (2013) *The changing PhD: discussion paper*, p. 44.

[16] Edwards, D.Bexley, E. & Richardson, S. (2010) *Regenerating the academic workforce: The careers, intentions and motivations of higher degree by research students in Australia.*

[17] Australian Council of Learned Academies (2012), *Career support for researchers – understanding needs and developing a best practice approach*, p. 34.

[18] Borrell-Damian ,L. (2009) *Collaborative doctoral education: university-industry partnerships for enhancing knowledge exchange*, European University Association, p. 4.

Capabilities of HDR candidates

Within the discourse surrounding these topics is a diverse array of terms to describe the various types of skills needed by HDR graduates. Terms such as 'transferable,' 'soft,' 'generic' and 'employability' skills have become prolific and are often used interchangeably. In some cases a distinction has been made between 'transferable' skills - which are closely linked to the process of research training yet are valuable to a range of other professions (for example, critical thinking, project management and statistical analysis) and the other types of skills which are more general and can be developed through a range of learning experiences (for example, communication and teamwork).

There are also skills, knowledge and experience that are more specific to individual workplace contexts. In a 2010 study of research employers, those from the business sector emphasised the need for greater business acumen, commercialisation, IP and financial management skills.[19] However, these skills may not be as relevant to an academic researcher undertaking fundamental, basic research.

Anecdotally, there appears to be an expectation by some employers that universities should produce graduates who are completely 'work ready'. Whilst higher education providers should certainly strive to provide the best possible conditions for the development of a range of skills, knowledge and experience in their HDR candidates, it should be acknowledged that there are limits to what can be achieved through higher education, and in the end, employers must also accept they too have a responsibility in training and developing their workforce.

The case studies within this report illustrate a range of ways that higher education providers can enhance the skills, knowledge and experience of HDR candidates. These include:

- through experience collaborating with industry;
- internships;
- interacting with researchers from other disciplines;
- training courses; and
- other professional development activities.

Some of these initiatives are well established, and in a few cases, have been running for decades.

[19] The Allen Consulting Group (2010), *Employer demand for researchers in Australia.* Report prepared for DIISR.

Methodology

The Department invited a number of organisations that administered initiatives relevant to the theme of the project to participate. Those who agreed to take part provided the Department with information about their initiative by completing a questionnaire (see Appendix B). In some cases, this was followed by a discussion with representatives from the organisation to clarify certain elements of the initiative and discuss underlying issues so as to gain a deeper understanding.

An online student survey was developed to obtain feedback from current and (where applicable) graduated students of those programs. A complete set of the student survey questions is at Appendix C. Topics covered in the survey included:

- the benefits and challenges associated with undertaking the program;
- the perceived impact of the program on their capability development; and
- whether they thought participating in the initiative would be advantageous in helping them to achieve employment in their preferred career path.

The survey was completed by 249 participants. Whilst almost half of these were from CSIRO, their responses were generally consistent with students from programs offered by other research organisations. However, the sample size for some programs was also quite low. As a result, the aggregated results cannot be considered representative of all initiatives included in the project.

Some organisations submitted profiles of individual students who are presently undertaking or have completed their program.

The Department engaged in discussions with a small number of industry representatives who have either worked closely with HDR candidates involved in the programs, or have employed graduates from one of the programs. The purpose of these discussions was to gain a clearer understanding of the motivations for industry to engage in research training, the benefits of this engagement, and their perspectives on the capabilities of HDR graduates.

Through the Australian Council of Deans and Directors of Graduate Studies, the Department extended an invitation for universities to nominate initiatives they considered appropriate for inclusion. From the submissions, the Department selected those whose design was considered to complement or add diversity to the project. Based on information provided, the Department prepared written case studies of these initiatives for inclusion in the report.

It should be noted that the Department selected initiatives on the basis of their design rather than their scale. Some of the programs presented in this report have small student cohorts and the focus is on the features of these models.

Initiatives to enhance the capabilities of HDR candidates

There are a number of ways in which institutions can enhance the skills, knowledge and experience of HDR candidates. These include providing HDR candidates with:

- opportunities to collaborate with industry stakeholders;
- embedding them in an interdisciplinary research environment;
- formal training courses; and
- other professional development activities.

Feedback from HDR candidates obtained through the online survey and the information provided through the case studies suggest that incorporating some of these elements can add value to the research training process in three main ways:

- Expanding the experience of HDR candidates
- Supporting the development of transferable skills and knowledge
- Providing access to a network of contacts outside academia

Over two-thirds (68%) of respondents perceived the initiative that they were undertaking as 'very different' or 'moderately different' compared to more traditional university-based research training.

The following table shows the extent to which these programs were considered by students to offer specific opportunities. It should be noted that not all initiatives are seeking to provide these opportunities.

Table 1: Opportunities provided by the programs as rated by students

	Very strong feature	Strong feature	To a moderate extent	To a small extent	Not applicable
Expansion of skills beyond the purely academic	27%	39%	22%	11%	1%
Opening up a broader range of career options	20%	48%	18%	14%	1%
Experience in a non-university research environment	29%	34%	21%	7%	9%
Getting a 'head start' on a research career outside academia	17%	31%	31%	15%	6%
Insight into the commercial world	11%	23%	30%	25%	10%
Establishing a network of contacts	18%	34%	30%	16%	2%
Opportunity to work on finding solutions to 'real world' problems	35%	30%	21%	12%	2%

Note - due to rounding not all rows will add up to 100 per cent

Some key findings from the student survey are:

- The majority of respondents (66%) rated the 'expansion of skills and knowledge beyond the purely academic' as a very strong or strong feature of the program.
- Over two-thirds (68%) of students believed the initiative was opening up a broader range of career options, rating it as a very strong or strong feature.
- Almost half (48%) believed the initiative was giving them a 'head start' on a research career outside academia, rating it as a very strong or strong feature.
- Over half (52%) of students reported that 'establishing a network of contacts,' was a very strong or strong feature of the program.

Interestingly, the percentage of respondents that rated these as 'very strong' or 'strong' features was higher for those undertaking initiatives that involved engaging directly with industry.

The majority of respondents believed the initiative they were undertaking would give them a competitive edge over other HDR graduates in securing employment in their preferred field. Commonly cited reasons included: access to opportunities for networking and collaborating with a range of stakeholders; industry exposure; and, being associated with an organisation that has a strong reputation. For example:

> I believe the experience in working in an organisation with commercial and industrial links will increase my appeal to future employers.
>
> Better experience in the commercial world. Greater contact with other people, including other academics and people from the commercial world, permitting a better view of where I fit in within the research community.
>
> I have not spent my entire PhD hunkered in a university lab and have more transferable skills for future research.
>
> This program has set me apart others because it has given me a comprehensive training that I would need as post-doctoral fellow researcher. The knowledge of new techniques, dealing with a broader community and how research knowledge is transferred for economic outcomes.

Some respondents were not sure whether it would give them an advantage, which is understandable considering that many were still in the early stages of the program. A small proportion did not think it would be advantageous.

The following section explores some of the common themes identified throughout these initiatives, supported by brief snapshots of programs or student profiles. The full case studies and student profiles are provided at **Appendix 1**.

Engagement with industry

Feedback from HDR candidates and consultation with program managers indicates that enabling HDR candidates to undertake their project in a research environment where collaboration with industry is a strong focus can contribute to the development of broad skills, knowledge and enhance the overall research training experience.

This is demonstrated in postgraduate programs offered by research organisations such as CSIRO, the National Measurement Institute, cooperative research centres (CRCs) and medical research institutes (MRIs). These organisations host HDR candidates who undertake research projects that align with the organisation's objectives. This often involves collaborating with industry partners and end users, including business, government agencies, representative bodies and other research organisations. HDR candidates embedded in these organisations may have the opportunity to collaborate with industry, enabling them to develop experience and skills that may be beneficial in their career. As one respondent stated:

> Solving industry based problems is key to CSIRO research and that difference has allowed a very different skill set. I met with industry representatives and partners in a very short time frame and I doubt this would be the case if I was in a purely academic role. This is a big advantage for me in my field.

Responses from students indicate that regardless of the extent of direct interaction, being immersed in a research environment that is directed toward the needs of an industry or end user helps them to develop a stronger appreciation of the application of their research to the industry. As one respondent stated:

> The specific skills, knowledge and experience gained in this [research organisation] as opposed to a traditional university setting are all to do with your work supporting larger goals. This work environment teaches you to always keep in mind the applications of your research to industry.

Snapshot: Defence Materials Technology Centre's Postgraduate Program

The Defence Materials Technology Centre (DMTC) is a collaborative venture that seeks to develop new materials and manufacturing technologies to enhance Australia's defence capability. DMTC's postgraduate program aims to improve the knowledge and capability of the Australian defence sector through industry focused postgraduate research projects.

The DMTC works with government research agencies, universities and suppliers to the defence industry. The Australian Defence Force is engaged in all research projects and all projects have at least one industry partner to ensure the research has the potential to be translated into a new material or technology. Being embedded within this environment enables students to gain an understanding of the defence industry and the processes involved in bringing technology to the market.

The DMTC places a strong emphasis on providing students with a well-rounded postgraduate experience. For this reason, students are involved in the centre's project management activities, which may include participating in project monitoring and reviews, financial reporting and stakeholder management. Furthermore, students are also required to participate in an Annual Student Conference and various professional development workshops throughout the year.

Each student has an academic supervisor, and preferably an industry supervisor, who helps candidates to understand the challenges and sensitivities that can be associated with conducting research in a defence context.

Exposure to industry on a more immediate level can be particularly beneficial to those considering a research career in industry. This can be achieved through initiatives where HDR candidates conduct a research project focusing on the needs of a particular industry organisation, often a business. In some cases these are also open to government agencies and not-for-profit organisations.

Snapshot: ATN Industry Doctoral Training Centre in Mathematics and Statistics

The Australian Technology Network of Universities (ATN) Industry Doctoral Training Centre in Mathematics and Statistics (IDTC) is a four year industrial PhD trial program administered by the ATN across its five member universities.[20]

The IDTC commenced in 2012, with seed funding from the (then) Department of Innovation, Industry, Science and Research and is based on a UK model which has 80 Centres and £390m ($641m) of government funding in the Engineering and Physical Sciences alone. The IDTC has a current cohort of 25 students and a planned steady-state intake of 25 commencing places each year.

The IDTC operates a model in which the ATN cooperates with an industry partner to identify real R&D problems requiring mathematical or statistical research. These may include, for example; a scheduling or supply chain problem; the physical modelling of a new plant process; or the statistical analysis of huge data sets or time series. The IDTC then works with the industry partner to identify either an existing employee or an outside recruit to solve the problem as a PhD student in the IDTC. In all cases the student has an academic supervisor from the ATN and an industry supervisor to ensure that both the rigorous academic and industry requirements are satisfied.

Organisations currently partnering with the program include Rio Tinto, NAB, Ausgrid, CSIRO, DSTO and the Australian Bureau of Meteorology.

Exposure to industry can occur over a period of several years in cases where the research project forms the basis of a candidate's thesis (as is the case with the ATN's IDTC) or over a shorter period of time in the case of internships.

Snapshot: AMSI Industry Internships

The Australian Mathematical Sciences Institute's Industry Internship program (AMSI Intern) is a national program where postgraduate students across all disciplines undertake short term research projects for industry.

Large companies, small-to-medium enterprises and government agencies can access a research student registered with AMSI Intern to address a specific research challenge or problem their organisation is facing. The student spends approximately 4-5 months working on this research project under the guidance of an academic supervisor. For PhD candidates, this internship commonly occurs during the time lag between thesis submission and ratification, which enables them to make effective use of an often frustrating period.

The program enables students to put theory into practice and gain first-hand experience in an industry environment. All 26 students who responded to the online survey reported that the program gave them some level of insight into the commercial world, with approximately 77 per cent rating it as a 'strong' or 'very strong' feature.' It also enables them to build contacts in the industry that may prove beneficial in their career.

[20] The Australian Technology Network of Universities (ATN) are Curtin University (Perth), University of Technology Sydney (Sydney), RMIT University (Melbourne), University of South Australia (Adelaide) & Queensland University of Technology (Brisbane).

Direct exposure to industry enables HDR candidates to gain skills, knowledge and experience that are particularly beneficial to those seeking a career in industry:

- Knowledge about how to conduct research in a commercial context;
- Skills relevant to working in an industry environment; and
- Practical industry experience.

As stated in a study of European doctoral programs[21] that involve industry collaboration:

> The advantage of a collaborative doctoral experience is that, in addition to sound research skills, they will gain an understanding of the business world which can facilitate communication with industry and ultimately broaden their employability perspectives, outside academic environments.

These assertions are supported by survey results of the students from initiatives that involved working directly with an industry organisation. The majority of the 37 respondents rated the following as either 'very strong' or 'strong' features:

- Insight into the commercial world (71%)
- Getting a 'head start' on a research career outside academia (64%)
- Opening up a broader range of career options (72%)
- Expansion of skills beyond the purely academic (87%)

When asked to describe the capabilities and experience they had gained through these programs, those commonly identified include: consulting experience; networking skills; the ability to communicate with non-expert audiences; and to meet tight deadlines. For example:

> Insight into corporate world including corporate politics, interests, and priorities
>
> Consulting experience: meeting new people to discuss ideas with and how this research relates to real world applications.
>
> Explaining my research very concisely to people in the commercial world.

Student snapshot: G'deona Soeharyo – University of South Australia

Industry Partner: Defence Science and Technology Organisation (DSTO)
Project: Robust decision making in counter-terrorism risk.

The IDTC Program has been a great opportunity for me to be able to work on a project that has direct applications in industry. The idea of beginning a PhD and finding an area to research was daunting to me, so having an industry problem focussed my research and appealed to my problem-solving side. It is also a privilege to be able to collaborate with my industry partner and get some experience in the workplace, which I will be doing more of later in my project. I believe the network of people I establish both in the industry and within the IDTC program will be invaluable for my future career.

[21] Borrell-Damian, L. (2009) *Collaborative doctoral education: university-Industry partnerships for enhancing knowledge exchange*, European University Association, p. 27

Experience working with industry helps HDR candidates to become aware of the demands and expectations associated with working in a business environment. For example, when describing the skills, knowledge and experience they had gained, one survey respondent noted:

> Working with industry and government on projects exposes one to the requirements these institutions have which are not always present in traditional university programs. This means students acquire skills and knowledge that is highly regarded when gaining employment.

Candidates may also develop an awareness of the different factors that need to be considered when carrying out research in a commercial context - for example, market potential, budget constraints, trade regulations, licensing and intellectual property laws. As one respondent stated, 'I gained lot of insight into industrial process and planning.'

Snapshot: BlueScope Steel Research Staff Development Program

BlueScope Steel Pty Ltd offers suitable employees the opportunity to undertake a PhD at the University of Wollongong whilst embedded in its research division. The program aims to build the capacity of BlueScope's research workforce by developing skills and knowledge that are not currently available in the company.

The company and the employee come up with a potential research topic which may involve a fundamental industry problem or an aspect of the design of a new product or process. This is discussed with university staff and amended if necessary to ensure that it meets academic requirements. The PhD candidate then divides their research time between the university and the company (typically a 60:40 split).

The PhD candidate is supported with a stipend and a salary provided by BlueScope that reflects the amount of time spent at university as a student and onsite where they are regarded as an employee. The PhD candidate has both an academic supervisor and a supervisor from the company.

This initiative gives employees the opportunity to build their technical expertise and formal qualifications so as to help them advance their career in the industry, whilst promoting innovation and bringing cutting edge research ideas into the company.

Students undertaking programs that involve direct industry collaboration still have access to the support and resources available through the university, but with the added benefit of direct exposure to industry. Through this, these programs support the development of research graduates who are capable of operating in both academic and industry environments[22]. As a result, not only are they prepared for employment within either sector, they are also prepared for collaborative partnerships between the two sectors. As stated by one survey respondent:

> When I graduate, I would have the understanding to not only be both industry and academia ready, but also to be capable of developing strong collaborative research between both settings.

Evidence of the employment outcomes of students who have undertaken these types of programs in Australia is scarce. However an analysis of the Danish Industrial PhD program released in December 2012 showed that approximately 80 per cent of industrial PhD graduates were employed in the

[22] Borrell-Damian, L. (2009) *Collaborative doctoral education: university-industry partnerships for enhancing knowledge exchange*, European University Association.

private sector, compared with 50 per cent of 'conventional PhDs.' In addition, their salaries were on average 6.5 per cent higher.[23]

Interaction between disciplines

Many research organisations are directed towards addressing major challenges or 'wicked problems' of national or global significance. These types of complex challenges usually cannot be addressed through one research discipline alone, and as a result, research projects typically consist of researchers from a range of disciplines. The degree of interaction between researchers from different disciplines varies depending on the nature of the research environment and the organisational structure. To ensure that there are adequate opportunities for knowledge sharing amongst researchers, the majority of the organisations included in this report host regular cross disciplinary meetings. In many cases, researchers from various disciplines also work in close proximity to each other and so interaction occurs naturally. As a consequence, HDR candidates are exposed to theories and perspectives outside their immediate field of research.

Feedback from students suggests that this expands their knowledge base, broadens their overall perspective and enriches the research training experience:

> Being a part of multiple research groups has given me a broad perspective on the way research is undertaken and has allowed for a diverse range of input into my research plan.
>
> Collaboration gives a great opportunity to learn different sciences from the people around.
>
> Wider focus than purely my own research- i.e. I get to see what other researchers are working on.

Student snapshot: Andrew Bowerman

Andrew Bowerman is a PhD student with the Food Futures Flagship, attached to CSIRO Plant Industry in Canberra.

This project brings together techniques from molecular biology, biochemistry and plant physiology, along with microscopy and more specialised techniques. We have contact with people in multiple sections of CSIRO Plant Industry to discuss the different sections of work being performed, and with people within the other sections of the Flagship. I am also co-supervised with members of The Australian National University.

CSIRO is a unique environment for a PhD student. The combination of pure research so close to application-driven science provides a view across all areas of R&D. Projects are very much related to or driven by a product or return goal, yet there are still open research ideas being developed, often in the same area and with the same people. Our projects are performed in collaboration with universities, Research Councils and often major international companies. I think this has given me an excellent view of all of the science in my particular field and let me focus on where and how I want to work in future. It has also been an example for how we should interact and collaborate with internal and external partners.

[23] Danish Agency for Science, Technology and Innovation (2012) *The effects of the industrial PhD program on employment and income*.

Across all initiatives examined, the opportunity to work on finding solutions to 'real world' problems was rated as a 'very strong' or 'strong' feature by 65 per cent of the students who completed the survey. One survey respondent stated that:

> University research sometimes does not focus on solving real-world problems and lacks networking with industries and other partners. [Research agency] was the perfect link between academic-based research and applications to real-world scenarios.

Young and Well CRC postgraduate program

The Young and Well CRC's Young and Early Career Researcher Program aims to build the capacity of PhD students to conduct research which helps to better understand how young people use technologies and how these technologies can be leveraged to improve wellbeing. It has 75 partner organisations from the university, government, non-for-profit and private sectors. At 30 June 2013 there were 25 students enrolled in the program.

PhD students in the Young and Well CRC are embedded within a diverse research team which typically includes researchers, practitioners, policymakers, technologists and the primary end users - young people. Many of the projects involve a range of disciplines, such as psychology, psychiatry, sociology, communication studies, education, technology and social work. This exposure to individuals from various industry sectors and research disciplines helps the students to gain an understanding of the industries involved, and supports the development of communication and stakeholder management skills. It also provides opportunities to explore creative ways to translate research into outputs.

Training courses and other professional development activities

The skills, knowledge and experience of HDR candidates can also be enhanced through targeted training courses and other professional development activities.

Of the 297 candidates who responded to the survey, the majority reported having undertaken additional training courses - writing, presentation and communication skills were the most common. This training was reported to be 'worthwhile' or 'very worthwhile' by 84 per cent of respondents. When asked how challenging it was to complete this additional training within the required timeframe, the vast majority rated it as either 'fairly easy' (40%) or 'sometimes challenging' (39%). Only 15 per cent rated it as 'difficult' and 6 per cent rated it as 'extremely difficult'.

Some institutions offer a variety of individual training courses or workshops which students can undertake at their discretion. For example, the ATN's e-Grad School has developed online programs for research students including the Learning Employment Aptitudes Program, designed for research students to improve their employment skills and innovation capabilities. This is complemented by the Modules on Research program which is focused on core research skills and practices.[24]

There are a number of institutions, such as the University of Melbourne and Monash University, delivering training courses and professional development activities as a 'package' or program. In some cases, students who complete the program are formally recognized through the award of an institutionally recognized 'Graduate Certificate.'

[24] Further information can be accessed from the website <http://www.egradschool.edu.au/>

Some programs explicitly recognise that different career paths will require a different set of capabilities. For example, in 2013 the University of Queensland launched its Career Advantage PhD Program. HDR candidates approximately one year into their degree may elect to undertake the program and select from one of three streams, depending on their career goals:

- Higher Education Practice and Leadership
- Research Innovation, Translation and commercialisation
- Global Collaborations

Each stream involves a three day workshop plus a cluster of training and professional development activities selected by the student. These are intended to help them develop core competencies as well as skills, knowledge and experience that are relevant to their preferred career path.

THE SOAR Centre (Support – Opportunities – Advice – Resources)

The SOAR Centre is a peer-to-peer support service for HDR and honours students launched in 2009 by Edith Cowen University.

Each year ten HDR students who have research and professional skills that can benefit their peers are employed as SOAR ambassadors. The ambassadors are provided with extensive training in career guidance tools, cultural awareness and research skills. Once fully trained, the ambassadors provide support and advice to their peers who can book one-on-one appointments or participate in group workshops. They also arrange for industry representatives to come and speak with the HDR cohort about employment in their sector.

Whilst HDR students benefit from the support and information provided through the ambassadors, the ambassadors themselves benefit from the opportunity to practice leadership and build their communication and interpersonal skills.

Since 2009, 42 SOAR Ambassadors have been employed and trained.

Some initiatives take a structured and well considered approach to the capability development of their HDR cohort. For example, the Invasive Animals CRC's Balanced Researcher Program is underpinned by a series of guidelines which were developed in consultation with stakeholders. Candidates participating in this program are required to complete, in connection with their supervisor, a Personal Development Plan. This prompts them to think early on in their candidature about their career aspirations and identify the skills, knowledge and experiences that will help them to achieve this. A training plan is then devised to help them develop the core competencies that are relevant to virtually any employment context as well as those that are relevant to their preferred career path. These training and development activities are expected to comprise at least 80 days over the duration of their candidature.[25]

[25] Dimond, W. & Sarre, S. (2011) *Guidelines for the balanced scientist program,* Invasive Animals Cooperative Research Centre, Canberra.

Snapshot: Research Oriented School Engaged Teacher-researcher Education

The Research Oriented School Engaged Teacher-researcher Education (ROSETE) Partnership provides PhD and Masters by Research students from China with the opportunity to combine academic work with practical teaching experience putting them in a strong position for a successful career in the education industry.

This is a collaborative research program administered through a partnership agreement between the University of Western Sydney, the NSW Department of Education and Communities and the Ningbo Municipal Education Bureau in China.

Under the ROSETE program, ten HDR students from China come to Australia each year to support the teaching of Chinese to primary and secondary school students whilst undertaking their research projects at the University of Western Sydney. They invest approximately 10 hours per week supporting teaching at these schools and this experience not only contributes to their research projects and theses, but also enables them to gain experience in a school learning environment (the 'industry') where they interact with teachers, principals and parents, and work closely with the students (who are the 'end users'). This builds their professionalism, improves their bilingual skills in English and Chinese, and enriches their Australian cultural literacy.

To prepare them for their roles as language teachers-researchers, the partner organisations provide the students with formal structured training in generic and professional skills. To do so, they undertake a four hour workshop plus tutorials each week, as well as regular seminars, conference presentations and a partnership-driven induction program.

Since the first intake in 2008, 40 HDR students have completed the program. Most of these have successfully gained employment in China in senior high schools, universities and international education enterprises. Several of the Masters candidates have continued their studies undertaking PhDs in Australia.

Training in research commercialisation and translation is also being offered by some institutions. For example, the University of New South Wales delivers training in entrepreneurship and innovation through its technology transfer office, NewSouth Innovations. The development activities offered include not only training courses, but also internships and mentoring.

More detailed information about individual initiatives and show they support the professional development of candidates is provided in the case studies at **Appendix A.**

Australia in the international context

In 2011, there were over 58,000 Higher Degree by Research candidates enrolled in Australia.[26] Whilst consolidated data on the total number of students hosted by research organisations is not readily accessible, there is evidence to suggest that they make a reasonable contribution to research training in Australia. For example:

- CSIRO has an average student load of 800 PhD students per year.
- In 2010, CRCs hosted 1,027 FTE HDR students.[27]

Opportunities for HDR candidates to undertake a research project directly with an industry organisation appear more limited. Whilst there are several structured initiatives currently in Australia included as case studies, these are relatively small in scale and scope compared to some initiatives that have been implemented overseas. As the Chief Scientist stated in early 2013:

> Such opportunities are currently in place in a few organisations and universities around Australia, but the scale is small… if we are to provide students with a taste of working in business and industry; if we are to encourage education providers to design programs that enable graduates to work easily and willingly in many different sectors of the economy; and, if we are to change the prevailing cultures, we need scale.[28]

The Australian Research Council's (ARC) Industrial Transformation Training Centres scheme provides a unique training environment for early-career researchers, allowing them to develop their research skills in an industry setting that is targeted at end-user focused research industries vital to Australia's future. Funding of up to $1 million per year for three years is provided to training centres to support at least 10 HDR candidates and three postdoctoral researchers.

There are a number of initiatives that have been implemented in other countries, and in some cases, on a large scale:

- **Mitacs Accelerate** is a Canadian research internship program that began in 2003 and has placed more than 5,500 PhD students in work placements. It is open to all disciplines and in just under 40 per cent of cases the student is retained as an employee.[29]
- The **Danish Industrial PhD program** commenced in 1988 (although its roots date back to the Industrial Researcher Program that commenced in 1971). Between 1988 and 2009, 1,200 PhD candidates have participated in the program. As at 2011, one in four applications were from the fields of social sciences and humanities with the remainder in science, technology, engineering and mathematics disciplines (STEM). About 40 per cent of all approved projects involve small-medium sized enterprises.[30]

[26] DIICCSRTE (2013) 2011 Student full year summary, Selected higher education statistics, Canberra.
[27] Palmer, N. (2012) *The CRC contribution to research training*. Canberra, Australia: Cooperative Research Centres Association.
[ar] Speech by Chief Scientist, Professor Ian Chubb (2013) at AMSI Productivity, Industry Engagement and the PhD Workforce event, Canberra.
[29] Further information can be accessed at < http://www.mitacs.ca/accelerate>
[30] Further information can be accessed at <http://fivu.dk/en/research-and-innovation/funding-programmes-for-research-and-innovation/find-danish-funding-programmes/postgraduates-in-the-private-sector/industrial-phd >

- In France, since 1981 over 12,000 PhD students and 6,000 companies have participated in industrial PhD projects under the Industrial Arrangements for Training through Research scheme (the CIFRE scheme).[31]
- The UK funds industrial CASE studentships and industrial doctorate centres. The doctoral centres commenced in 2009 and enable PhD students to be immersed in a research environment that has a strong industrial focus. The program is funding 26 centres, each of which will take in approximately 10 PhD students per year for five years.[32]

The success of these programs suggests that there is scope for Australia to implement this concept on a larger scale and to a wide range of disciplines.

[31] Further information available at < http://www.anrt.asso.fr/fr/pdf/plaquette_cifre_complete_avril2009_GB.pdf >
[32] Further information available at < http://www.epsrc.ac.uk/skills/students/coll/Pages/training.aspx>

Benefits for the business sector

There has been strong growth in business expenditure on research and development (BERD). As a proportion of GDP, BERD has grown by 12 per cent from 2006-07 to 2009-10 which has brought Australia up to 12th place in the OECD.[33]

A relatively low cost way for industry to access research expertise is by engaging the services of a research student. This can occur for a short period of time in the case of an internship or over a period of several years where the focus of research forms the basis of the student's PhD project. Through the student, a business can also gain access to the expertise of their academic supervisor and the institution.

Under the guidance of the academic supervisor, the student can directly assist a business in a variety of ways. These include:

- investigating ways to address a specific problem currently being experienced by the business;
- developing models for the design of a new product or process;
- the enhancement of an existing product; or
- even reviewing the structure of the organisation itself.

An impact analysis[34] of the Danish Industrial PhD program showed that for businesses that hosted industrial PhD projects:

- The number of patent applications per year in the years after initiating the first project doubled in comparison to other businesses.
- Gross profit grew by DKK2 million a year (approximately AUD 375K) for a cumulative effect of DKK30 million (approximately AUD 5.6M) in the first five years after initiating the first project, compared to companies not hosting industrial PhD projects.

Senior personnel from various European companies who were interviewed for a study of collaborative doctoral programs described a range of benefits:

- 'Bringing highly qualified work force and scientific know-how
- Bringing cutting-edge research, enabling exploitation of results
- Developing innovative concepts at early stages
- Performing work and addressing technical problems difficult to do in-house
- Exploring new areas of research for exploitation in the future
- Access to sophisticated instruments and large scale facilities'.[35]

[33] DIISRTE (2012) *Australian innovation system report 2012*, Canberra, p. 51.

[34] Danish Agency for Science, Technology and Innovation (2011) *Analysis of the industrial PhD program*. Report prepared by the Centre for Economics and Business Research

[35] Danish Agency for Science, Technology and Innovation (2011) *Analysis of the industrial PhD program*. Report prepared by the Centre for Economics and Business Research

Whilst there is no formal expectation that the business will continue to employ the student once the project has been completed, this does appear to occur quite often in the case of large scale initiatives in other countries. In this way, hosting a research student can also serve as a useful recruitment tool.

There are also a range of Government initiatives to support businesses with undertaking research. Small to medium sized businesses wishing to gain access to the expertise of a fully qualified academic researcher may be eligible for financial support under the Researchers in Business program, administered by Enterprise Connect.[36] The R&D Tax Incentive can help businesses offset some of the costs of doing R&D.[37] The Cooperative Research Centres is another program that supports collaborative research projects.

[36] For further information please go to <http://www.enterpriseconnect.gov.au/ecservices/rib/Pages/default.aspx>
[37] For more information see <http://www.ausindustry.gov.au/programs/innovation-rd/RD-TaxIncentive/Pages/default.aspx>

Challenges

Feedback from HDR candidates through the survey confirms that there can be challenges associated with collaborative or innovative research training initiatives, particularly those that involve engaging with industry. The main issues cited relate to the complexities associated with working across multiple institutions, in terms of administration and the differences between industry and academia.

In terms of administration, the most commonly cited difficulties were laborious clearance processes, additional paperwork, multiple reporting processes and templates. Approximately 30 per cent of survey respondents rated it as either a 'very significant' or 'significant' challenge.

The other key issue was dealing with the different dynamics and expectations between industry and academia. These differences expressed themselves mainly through their relationship with supervisors. Just over one quarter (26 per cent) of students rated this as a 'very significant' or 'significant' challenge. It should however be noted that the majority of students did not consider these to be significant challenges.

Several students referred to challenges associated with being based off campus. These were mainly related to feeling isolated from the university community and not being closely surrounded by other students, which meant a lack of peer support.

There are also issues related to the development and implementation of programs:

- establishing partnerships between universities and industry;
- finding suitable HDR candidates;
- identifying suitable research projects; and
- reaching an agreement on financial and intellectual property matters.

These issues can usually be overcome through careful planning and good practice.[38]

[38] Borrell-Damian, L. (2009) *Collaborative doctoral education: university-industry partnerships for enhancing knowledge exchange*, European University Association.

Conclusion

Engaging industry in the research training and development of HDR candidates can support the development of research graduates with capabilities that are relevant to the needs of the labour market in a variety of employment sectors.

The case studies presented in this report demonstrate a number of ways in which the capabilities of HDR candidates can be enhanced beyond the advanced research skills, disciplinary knowledge and academic experience that are the hallmarks of traditional research training. These initiatives recognize that whilst the purpose of research training is for students to learn how to undertake research, eventually they will have to do so within a professional context, and not necessarily an academic context. To ensure that HDR candidates are equipped to perform effectively wherever they end up, it makes sense to ensure that they are provided with opportunities to develop broad skills and experience that are valuable to virtually any employment context, as well as those that are more specific to their preferred career path.

Across all of these initiatives, the basic research training 'model' itself remains the same; characterised as mostly self-directed learning of a discrete topic under the guidance of at least one supervisor. What can vary is the context in which this takes place (including whether any industry supervisors are involved) and the focus of the research project; and these factors can have a significant effect on the experience and outcomes for the HDR candidate. For example, candidates participating in initiatives that involve interacting with industry stakeholders and researchers from other disciplines report that this experience has widened their understanding of how the industry operates; improved their ability to communicate to non-expert audiences; and expanded their perspective; providing for a rich and rewarding research training experience. The contacts that they develop throughout this process can also lead to future employment or partnership opportunities.

The skills, knowledge and experience of HDR candidates can also be enhanced through professional development activities that are additional to the research training process. These include internships, formal training courses and leadership opportunities; to name but a few. It seems that these are increasingly being delivered as a comprehensive professional development 'package' and some are underpinned by a development plan that is tailored to the needs of individual students.

Initiatives in which HDR candidates carry out research oriented toward the needs of a specific organisation can help the organisation to become more innovative. Whilst this concept is being implemented to a small extent in Australia, the success of large initiatives in other countries shows that there are benefits to be gained from implementing it on a larger scale and to a wider range of disciplines. Students, universities and industry all have a role to play in achieving this, and can actively pursue these opportunities by approach each other to develop a partnership.

Similar to the approach that has been taken to undergraduate education, greater industry engagement in research training will help to ensure that it is relevant to the needs of various labour markets. Doing so will increase the capacity of research graduates to make a significant contribution to innovation and economy; the effects of which flow through to the wider community.

For a more detailed description of the initiatives that were used as case studies for the purposes of this report, please see the full case studies at **Appendix A.**

Appendix A: Case studies

The ATN Industry Doctoral Training Centre in Mathematics and Statistics

The Australian Technology Network of Universities (ATN) Industry Doctoral Training Centre in Mathematics and Statistics (IDTC) is a four year industrial PhD trial program administered by the ATN across its five member universities.[39] Mathematics and statistics have been selected as the focus of the IDTC trial due to the overarching and enabling nature of mathematics and statistics, industry skills shortage in these areas and the collective ATN research capacity in these disciplines.

The IDTC commenced in 2012, with seed funding from the (then) Department of Innovation, Industry, Science and Research and is based on a UK model which has 80 Centres and £390m ($641m) of government funding in the Engineering and Physical Sciences alone. The IDTC has a current cohort of 25 students and a planned steady-state intake of 25 commencing places each year.

The IDTC operates a model in which the ATN cooperates with an industry partner to identify real R&D problems requiring mathematical or statistical research. These may include, for example; a scheduling or supply chain problem; the physical modelling of a new plant process; or the statistical analysis of huge data sets or time series. The IDTC then works with the industry partner to identify either an existing employee or an outside recruit to solve the problem as a PhD student in the IDTC. In all cases the student has an appropriate academic supervisor from the ATN and an industry supervisor to ensure that both the rigorous academic and industry requirements are satisfied.

Organisations currently partnering with the program include Rio Tinto, NAB, Ausgrid, CSIRO, DSTO and the Australian Bureau of Meteorology.

The student spends as much time as possible on site with the industry partner to gain practical industry experience. Valuable networks are established both through the student industry partnership and within the IDTC student cohort.

Of the 14 students who responded to the student survey, 70 per cent rated 'helping them establish a network of contacts' as a 'very strong feature' of the program and 69 per cent considered that 'opening up a broader range of career options' was either a very strong or strong feature.

During their candidature they undertake the equivalent of one year's development coursework and activities, both in technical subjects and in professional areas such as Leadership and Communication, Research Commercialisation, Entrepreneurship, Project Management, and Sustainability. One way in which students undertake these courses is through the ATN's e-Grad School[40] which is hosted by the Queensland University of Technology.

All the students who completed the online survey agreed that 'expansion of skills beyond the purely academic' was a very strong (85%) or strong (15%) feature of the program.

For further information please visit the IDTC website at <http://www.atn.edu.au/IDTC/index.htm>

[39] The Australian Technology Network of Universities (ATN) are Curtin University (Perth), University of Technology Sydney (Sydney), RMIT University (Melbourne), University of South Australia (Adelaide) & Queensland University of Technology (Brisbane)

[40] See http://www.egradschool.edu.au/

Student Profile: G'deona Soeharyo – University of South Australia, student

Industry Partner: Defence Science and Technology Organisation (DSTO) - the Australian Government's lead agency charged with applying science and technology to protect and defend Australia and its national interests.

Project: Robust decision making in counter-terrorism risk.
This project explores the mathematical methods that can be applied to decision making for rare and dynamic events, where the consequences are difficult to predict, for example terrorist events.

The IDTC Program has been a great opportunity for me to be able to work on a project that has direct applications in industry. The idea of beginning a PhD and finding an area to research was daunting to me, so having an industry problem focussed my research and appealed to my problem-solving side. It is also a privilege to be able to collaborate with my industry partner and get some experience in the workplace, which I will be doing more of later in my project. I believe the network of people I establish both in the industry and within the IDTC program will be invaluable for my future career.

Student Profile: Oliver Czibula – University of Technology Sydney, industry employee

Industry Partner: Ausgrid - Australia's largest electricity distributor, servicing more than 1.6 million customers across over 22,000 square kilometres.

Project: Optimisation algorithms for planning and scheduling dedicated resources.
This project will optimise Ausgrid's training & safety course timetabling system from a variety of perspectives. The scheduling of courses is most often a very large and difficult problem and, as such, specialised approximation algorithms will be developed in order to reach a good quality solution in a practically acceptable time frame.

I believe that by researching real-world problems that are relevant to several industries, I am not only gaining a depth of knowledge and experience but also a breadth that employers will find invaluable. I have already come across many industry-specific challenges to which a purely academic student may not have been exposed.

Student Profile: Chun Yin (Joey) Fung – University of Technology Sydney, student

Industry Partner: CSIRO - the Commonwealth Scientific and Industrial Research Organisation, is Australia's national science agency and one of the largest and most diverse research agencies in the world.

Project: Deterministic scheduling models with machine cost and buffers.
This project will tackle one of the most difficult problems in planning and scheduling arising in the minerals resource industry: long-term capacity planning to determine cost-effective capacity expansion with the aim of meeting forecasted demand involving highly complex supply chains.

The IDTC PhD program has given me a great chance to be exposed to the vibrant and stimulating environment of a world leading research organisation. Furthermore, it gives me immense satisfaction that my work has immediate practical relevance, which is a great stimulus to further develop my research and mathematical skills. The program has also been a great way to gain the skills that I need to work both inside and outside of academia after the completion of my PhD.

AMSI Industry Internship Program

The Australian Mathematical Sciences Institute's Industry Internship program (AMSI Intern) is a national program where postgraduate students across all disciplines undertake short term research projects for industry.

AMSI Intern is modelled on the highly successful Canadian research internship program known as Mitacs Accelerate.[41] Since its inception in 2003, Mitacs has placed more than 5,500 PhD students in industry internships. In just under 40 per cent of cases, the industry partner has retained the PhD student as an employee.

The AMSI Intern program got underway in 2009 with a Collaborative and Structural Reform grant from the Commonwealth to place 30 mathematics and statistics PhD students into private and public enterprise. This grant was succeeded by a Commonwealth discretionary grant to place interns from all disciplines into the SME sector in conjunction with Enterprise Connect. AMSI concluded the relationship with Enterprise Connect in March 2013. During the life of the program AMSI Intern has placed 77 HDR students into industry.

Large companies, small-to-medium enterprises and government agencies can access a research student registered with AMSI Intern to address a specific challenge or problem their organisation is facing. The student spends approximately 4-5 months working on this research project under the guidance of an academic supervisor. For PhD candidates, this internship commonly occurs during the timeframe between thesis submission and ratification, which enables them to make effective use of an often frustrating period.

The program enables students to put theory into practice and gain first-hand experience in an industry environment. All 26 students who responded to the online survey reported that the program gave them some level of insight into the commercial world, with 77 per cent rating it as a 'very strong' or 'strong feature.'

> Overall I found the AMSI internship program to be of benefit in seeing first-hand the types of problems industry is facing and using my knowledge and research of these problems to suggest solutions.

It also enables students to build a network of contacts in the industry that may prove beneficial in their career. Approximately 74 per cent of respondents believed that 'opening up a broader range of career options' was either a very strong or strong feature. It also provides a link for the academic supervisor to build new partnerships with industry.

Students are provided with training prior to undertaking the internship through online courses and coaching to prepare them for situations they might not be familiar with, such as communicating to non-expert audiences or dealing with tight deadlines. All respondents to the survey agreed that the expansion of skills beyond the purely academic was a benefit of the program.

> This program has set me apart from others because it has given me a comprehensive training that I would need as post-doctoral fellow researcher; the knowledge of new techniques; dealing with a broader community and how research knowledge is transferred for economic outcomes.

For further information please visit the AMSI Intern website at <http://amsiintern.org.au/>

[41] http://www.mitacs.ca/accelerate

Student Profile: Gauri Laud

Institution: RMIT University
Industry Partner: Show Works
Academic Mentor: Dr Raju Mulye

Gauri Laud is undertaking a PhD in the School of Economics, Finance and Marketing and has completed an internship with Show Works Creative Solutions - a leader in theatrical set construction.

The company has a unique product called sprung floor, which is directed to the dance market in Australia. The problem was determining the market potential for sprung floors across Australia, whether it was applicable to different market segments within Australia and whether there is potential for this product internationally. Gauri used her knowledge of market research and marketing determine the reactions of the fitness industry, architects and dance schools to this unique sprung floor product.

This internship has exposed me to the manufacturing industry, which was a highlight. Secondly I learnt the Australian corporate culture, how people work in the industry, and thirdly it gave me employable skills.

Student Profile: Selvaraaju Murugesan

Institution: La Trobe University
Industry Partner: Biarri Networks
Academic Mentor: Dr David Tay

Selvaraaju Murugesan is studying a PhD in electrical engineering and has completed an internship with Biarri Networks - a commercial mathematics company that delivers optimisation to the Telecommunications industry.

The research involved in this internship was to inform strategic business direction decisions within Biarri Networks regarding how a wireless/4G network optimisation product should be developed. Selvaraaju used his knowledge of mathematics and background in electrical engineering to assist Biarri Networks regarding small wireless product development.

Working with Biarri, they are such an amazing group of people teaching me and developing my skills from a technical view point in the areas of Python and C++. A highlight was seeing how an industrial setting operates given the pressing deadlines of clients. I was able to make industry connections by working with Biarri and having made these connections will hopefully assist me later in life for future career prospects.

BlueScope Steel Research Staff Development program

BlueScope Steel is a large steel manufacturing company that offers existing employees the opportunity to undertake a PhD at the University of Wollongong whilst embedded within the company's research division. While the scale of this program is very small at an average of one new opportunity offered per year, the fact that it is primarily driven by a private company rather than a university or other administering organisation makes it an interesting case study for exploration.

The aim of the program is to build the capacity of BlueScope's research workforce by developing skills and knowledge that are not currently available in the company or that require regeneration due to ageing of staff or the emergence of new technology. This strategic and ongoing approach to research staff development is intended to place it in a strong position to be innovative and respond effectively to technological advances and challenges affecting the global market for steel products.

This program enables a selected employee to build their technical expertise and formal qualifications so as to help them advance their career in the industry. It also provides them with the opportunity to directly contribute to innovation within the company by acting as a source of knowledge transfer from the university to the company, thereby providing a fresh supply of cutting edge research concepts.

Prior to the commencement of a new place, researchers and the selected employee identify a potential research topic relevant to the needs of the company, such as a fundamental industry problem or an aspect of the design of new products or processes. The topic is then discussed with university staff and modified if necessary to ensure that it meets academic requirements.

The selected employee has an academic supervisor as well as a supervisor from the company and divides their research time between the university and the company (typically a 60:40 split). Whilst onsite at the company they work alongside researchers in a range of disciplines and may also occasionally spend time at another university or a materials supplier. This means that not only do they deepen their understanding of industrial processes relevant to their particular area of focus, but also across the sector.

The employee is supported with a stipend and a salary to reflect the amount of time at university as a research student and onsite where they are treated as an employee. The vested interests of the company in the project results in a strong emphasis on supporting the student in developing their project management capabilities to ensure that the project stays on track and milestones are met.

Since the research topics selected are those which can be translated into or support commercial outcomes, if successful, the employee has the satisfaction of seeing the outcomes of their research implemented in new industrial products and processes.

Once the employee has completed their PhD program they can return to BlueScope as an employed researcher or alternatively, they are assisted with finding a postdoctoral position elsewhere if they wish to develop further skills and experience.

For further information please contact Evan.Evans@bluescopesteel.com.

Student Profile: Dr Troy Lowe

Dr Trow Lowe worked at BlueScope Steel in their cadet program from 2000 to 2007 focussing on industrial tinplating and polymer additives at BlueScope steel while obtaining a BSc (chemistry) at the University of Wollongong (UoW). In 2007, he commenced a joint PhD project between UoW and BlueScope Steel in corrosion electrochemistry as part of the BlueScope Steel Research Staff Development Program.

I consider having an industrial sponsor an ideal way to complete a scientific research PhD as I had the advantages of industrial work experience, extra mentors in industry, financial support for travel and instrument access, as well as part time work. The industrial environment also provides a good framework for developing other important skills such as project & time management, supervising and mentoring. While the University provided access to a range of specialised scientific equipment and exposure to many research projects, collaborators, conferences and international academics which I would not have had access to by working solely at BlueScope Steel.

Following my PhD (2010), I took an academic postdoc at KTH in Stockholm for 18 months. The postdoc gave me the opportunity to learn more fundamentals, to be a principle researcher in a project and to collaborate with European scientists. Upon completion, I was offered a position back at BlueScope Steel.

By being in the BlueScope Steel Research Staff Development Program, the employment outcome was excellent; I received job offers for postdoc positions as well as a position at BlueScope Steel as a research scientist. Overall, I see a lot of advantages and no disadvantages to an industrial PhD project for anyone who is interested in applied research.

The Invasive Animals CRC's postgraduate program

The Invasive Animals CRC (IA CRC) aims to produce 'multi skilled, industry ready graduates with the professional, strategic and vocational skills, knowledge, networks and contacts that go far beyond those gained in a traditional university based PhD program.' To date, 28 PhD students have completed the IA CRC's Balanced Scientist Program and a further 12 are currently enrolled.

The program gives postgraduate students the opportunity to conduct a research project that contributes to the organisation's mission which is about finding ways to reduce the impact of invasive pests on Australia's economy, environment and people. To help achieve this, the IA CRC works with various partner organisations, including government departments, industry bodies, businesses, universities and research agencies. PhD students embedded within this collaborative research environment develop an understanding of the industry sector and gain experience interacting with stakeholders.

One of the core elements of the IA CRC's Balanced Researcher Program is a comprehensive training and professional development initiative consisting of both formal training and experiential activities. Students are expected to complete 80 days of additional training during their candidature which includes a period of placement within industry. To ensure that this additional training does not impact on student's ability to complete a quality research thesis, the IA CRC funds them for up to an additional six months beyond the maximum 3.5 year term of an Australian Postgraduate Award stipend.

A key element of the Balanced Researcher program is the Personal Development Plan (PDP). This plan requires students to think about their career aspirations and the capabilities they will need to achieve them from an early stage in their candidature. Of course, this is an active document and is expected to evolve over the course of the PhD. A training program is then devised to help them develop core competencies relevant to practically any employment context as well as other capabilities and professional experiences tailored to their career aspirations. This program includes:

- Week long annual student camps involving short courses on core subjects such as: communication and media skills, leadership, negotiation, presentation, grant application workshops, commercialisation and ethical decision making.
- An industry work placement of at least 20 days duration. Interestingly, it is preferred (although not always possible) that it's in an area not directly related to their research, in order to broaden their perspective and expand their experience.
- Other training opportunities such as, for example, attending or presenting at conferences, teaching, participating in committees and mentoring.

All respondents to the online survey reported that this additional training was 'very worthwhile or 'worthwhile'. One respondent, who has completed the program stated:

> My experience with the Invasive Animals CRC's Balanced Scientist Program enabled me to hit the ground running in my first 12 month contract after completing my PhD, and produce a greater quality and quantity of output than if I had undertaken a traditional university-based program. The Program and my first year of work out of the Program have provided a strong foundation for the rest of my career.

The program coordinator noted that whilst delivering such a comprehensive training program is relatively expensive; their completion rate is very high at 93 per cent.

For further information please visit the Invasive Animals CRC's website at:
<http://www.invasiveanimals.com/education/balanced-researcher-program/>

Student Profile: Dr Amanda Elledge

Dr Amanda Elledge joined the Invasive Animal CRC's Balanced Scientist Program in 2006 whilst undertaking her PhD in Ecology. Her research project involved conducting extensive ecological based fieldwork which can be a very costly exercise.

The IACRC supported my research project with operating funds necessary to carry out this work and also provided me personally with a top-up scholarship to my Australian Postgraduate Award which helped ease the financial burden of being a student.

Another benefit of being a student with the IA CRC is its Balanced Scientist Program. The program supported my attendance at various conferences, workshops, and training courses.

Amanda graduated from the program in 2011 and is now working as a Catchment Scientist at the QLD Department of Natural Resources and Mines. She believes that one of the key benefits this program is that it enables 'students to develop strong relationships with industry networks which facilitates project collaboration and the transfer of industry knowledge.

Student Profile: Dr Andrew Bengsen

Dr Andrew Bengsen participated in the IA CRC's Balanced Scientist Program between 2006 and 2010, whilst undertaking a PhD in Ecology.

Through the formal training program, I gained a diverse range of skills and knowledge fundamental to a career in applied science, directly from experts in the field. I gained experience working with industry and also with government management agencies.

Andrew completed the program in 2010 and now works as a Research Scientist in the Vertebrate Pest Research Unit at the NSW Department of Primary Industries.

The skills, knowledge and contacts gained through this work enabled me to move seamlessly into a career in applied vertebrate pest research. Had I not participated in the Balanced Scientist Program, I would have found it much more difficult to find relevant work after my PhD.

Young and Well CRC postgraduate program

The Young and Well CRC's Young and Early Career Researcher Program aims to build the capacity of PhD students to conduct research which helps to better understand how young people use technologies and how these technologies can be leveraged to improve wellbeing. The CRC has 75 partner organisations from the university, government, non-for-profit and private sectors. At 30 June 2013 there were 25 students enrolled in the program.

All PhD students work on a research project that contributes to the CRC's broader agenda which is to conduct research to improve the wellbeing of young people aged 12 to 25. This fosters in the students a strong sense that their research is 'making a difference'.

PhD students in this CRC are embedded within a diverse research team which typically includes researchers, practitioners, policymakers, technologists and the primary end users - young people. Many of the projects involve a range of disciplines, such as psychology, psychiatry, sociology, communication studies, education, technology and social work. This collaborative and multidisciplinary research context is supported through regular, usually weekly, team meetings. This exposure to individuals from various sectors and research disciplines helps the students to gain an understanding of the industries involved and facilitates the development of communication and stakeholder management skills. Having direct access to individuals from a range of backgrounds also provides opportunities to explore creative ways to translate research into outputs.

PhD students engaged in the Young and Well CRC have at least two supervisors; typically one from the university and one from an industry partner. Depending on the nature of the project, some students spend some of their research time onsite with the industry partner. For some students, this may consist of two days per week, whilst for others it may be less often. This broadens their professional experience and helps them to establish networks which may prove beneficial in their future career.

In some cases the students are existing employees of an industry partner that provides financial support for them to undertake a PhD through the program. Because these research projects align to some extent with the interests of the partner organisation, supporting an employee through this process means that the organisation benefits not only from the knowledge generated through the research itself, but also from the growing expertise of their employee.

Students may have the opportunity to participate in an international research training institute held in partnership with Johns Hopkins University in Baltimore, USA.

The students also have access to an online support platform delivered by the CRC which enables them to build relationships with others doing similar work. Through this online platform they can receive peer support from other young or early career researchers.

For further information please visit the Young and Well CRC's opportunities webpage at <http://www.youngandwellcrc.org.au/get-involved>

Student Profile: Samantha Ewart

Samantha Ewart is undertaking a PhD at the University of Western Sydney and is working on a research project through the Young and Well CRC. Samantha's research project looks at youth engagement in vulnerable populations utilising music and technology, in particular, providing age appropriate recreational activities for hospitalised young people aged 12-18+ within the Children's Hospital, Westmead.

The Young and Well CRC has benefited my research immensely by providing a supportive network to grow as an early career researcher. This includes being accepted into the Young and Well CRC Research Training Institute at Johns Hopkins University where I was able to expand on existing connections, knowledge and skill sets. This experience has made me to realise that my future is limitless and has many different avenues all of which are supported by the rich research culture and supportive network that is the Young and Well CRC.

Student Profile: Rebecca Randall

Rebecca Randall is undertaking a PhD in Psychology through the Australian National University and is working on a research project through the Young and Well CRC. Her research topic looks at ways that young people are engaged in mental health work, and compares the perspectives of organisations who involve young people with the young people who are involved.

Rather than working in isolation, I value being an equal member of a research group, and the broader network of Young and Well CRC projects. This allows me to connect with other early career researchers through an online workspace, and engage with researchers from across Australia to seek feedback and advice. Working on a project that has directly foreseeable benefits to university students helps me to see the value of my work. This research sits at the intersection of many different fields which can be challenging but I know that it is also great experience for my career.

Student Profile: Sally Bradford

Sally Bradford is undertaking a Clinical PhD in Psychology through the University of Canberra, and is working on a research project through the Young and Well CRC. Sally's research is looking at how technology can be incorporated into face-to-face mental health care for young people aged 12-25 years, and whether this can improve engagement, disclosure, and service delivery.

Conducting my research through the Young and Well CRC has provided fantastic professional networking and research opportunities. The biggest benefit is the strong connection to a community of likeminded researchers. Many of my PhD student colleagues have spoken about how isolating a PhD can be; however my involvement with the Young and Well CRC has provided the opposite experience. The financial support has also enabled me to attend workshops and conferences, enriching my experience.

I feel that the overall experience of working on a project within the Young and Well CRC will help me in my future career as I have learnt how to work well in multidisciplinary research teams, been able to extend my professional network, and has learnt how to present, and conduct myself, in professional research environments.

The Lowitja Institute's Education and Training program

The Lowitja Institute is Australia's national institute for Aboriginal and Torres Strait Islander Health. They provide opportunities for HDR candidates to carry out research projects that align with the Institute's objectives. The program was originally restricted to Indigenous students but is now open to all students; although Indigenous students are given preference. To date, 33 postgraduate students (including PhDs and Masters by Research) have completed the program and 11 are currently enrolled.

A distinctive feature of the Institute's program is the emphasis on conducting research training in a way that caters to the needs of its Indigenous HDR candidates. This is largely based on the principles of mutual respect, trust and the need to feel part of a community - which apply to all candidates - but are particularly important when supervising Indigenous students.

Typically up to 40 per cent of the candidates' research time is spent consulting with local Indigenous communities, although this does vary depending on the project. The ability to successfully engage with these communities depends on building their trust and respect. This takes significant time and patience coupled with strong interpersonal skills and cultural sensitivity. To guide them, each candidate has an Indigenous supervisor who has a strong knowledge of Indigenous affairs and culture.

Most of the candidates engaged through the Institute will spend some time working with researchers from other disciplines, such as education, psychology, sociology, social work and cultural studies. This is due to the complex nature of Indigenous health which usually requires a multidimensional approach to achieve effective outcomes. As one student survey respondent stated:

> It provides experience in a cross disciplinary environment…This develops valuable negotiation, cross cultural, and cross disciplinary skills.

The need to feel part of a community is important to most Indigenous students not only because it is an integral part of their traditional culture, but also due to the fact that many of them have had to relocate away from their families and local community in order to pursue their tertiary education. Since the Institute's head office is physically separated from the university where each student is based, staff members from the Institute cultivate this sense of belonging through regular contact with the students and by providing opportunities for them to get together through meetings and events. Program managers and leaders introduce the students to other researchers and research students and make an effort to include them in all relevant activities.

Since the role of the supervisor is instrumental to the delivery of research training, the Institute encourages candidates and their supervisors to attend the Melbourne University Summer School Program for Indigenous Postgraduate Students. Together with the CRC for Aboriginal Health, the Institute has also produced a handbook titled, 'Supporting Indigenous Researchers: a practical guide for supervisors.'

The Institute recognises that many Indigenous students face additional challenges which can hinder them from reaching advanced stages of tertiary education. Unless they are supported and nurtured from early stages of the educational pipeline, they may never reach the pinnacle of doctoral education. For this reason, the Institute assists students in VET, undergraduate and honours degrees. Several of these students have progressed through to and completed the PhD program.

For further information please see the Lowitja Institute's website at <http://www.lowitja.org.au/student-pages>

Student Profile: Megan Williams

Megan Williams is undertaking a PhD in public health and criminal justice at the University of New South Wales. Her project, 'The experience of social support post-prison release in an urban Aboriginal population', is contributed to the Lowitja Institute as in In-kind project and has been supported for two periods by a research scholarship and also with direct research funds.

Building on work experience in the health and human services sectors, Megan's research takes a strengths-based approach to examine social support, which is an important determinant of health among Aboriginal and Torres Strait Islander people. Support is provided in many instrumental, practical, emotional and cultural ways by Elders and family members for their loved ones post-release. This research provides a rare insight into multi-layered, principled and holistic leadership available within an urban Aboriginal community. Data collected through 36 in-depth interviews have been analysed in terms of implications and strategies health and community services may use to bolster Aboriginal and Torres Strait Islander support processes.

Given Megan was already an experienced health service provider and contributed to undergraduate and postgraduate university teaching, it was important that Megan had some flexibility during her PhD scholarship to undertake a small number of related projects. These were opportunities to provide feedback from the PhD research to communities, produce community publications and keep up professional networks. Periods of full time study with a stipend were vital "where the rubber to the road" in producing a PhD thesis, as well as the collegiality of the Lowitja Institute.

The Defence Materials Technology Centre's Postgraduate Program

The Defence Materials Technology Centre (DMTC) is a collaborative venture that seeks to develop new materials and manufacturing technologies to enhance Australia's defence capability through industry-led research programs. DMTC's postgraduate program aims to improve the knowledge and capability of the Australian defence sector through industry focused post graduate research projects. There are 33 HDR students currently enrolled in the program and DMTC continue to recruit new candidates as project needs arise.

The DMTC works with Defence agencies, government research agencies, universities and the defence industry. The Australian Defence Force is engaged in all research projects and all projects have at least one industry partner to ensure a pathway to market exists to enhance Australia's defence capability. This operating model enables students to gain an understanding of the defence industry and the processes involved in bringing technology to market. As one survey respondent stated:

> Working with industry and government on projects exposes one to the requirements these institutions have which are not always present in traditional university programs. This means students acquire skills and knowledge that is highly regarded when making gaining employment.

Collaboration with industry stakeholders also helps students to 'establish a network of contacts' which was rated by eight out of the twelve students who completed the survey as a 'strong feature' (50 per cent) or 'very strong feature' (16.7%) of the program.

The DMTC places a strong emphasis on providing students with a well-rounded postgraduate experience. For this reason, students are involved in the centre's project management activities, which may include participating in project reviews and stakeholder management. This enables them to gain valuable workplace skills, such as organisational management, project administration and stakeholder management. Three quarters of respondents to the student survey reported that 'giving them a head start on a research career outside academia' was a very strong, strong or moderate feature (25 per cent each).

Each student has an academic supervisor, and preferably an industry supervisor, who helps candidates to understand the differences between conducting research in an academic setting with a defence industry context. This is particularly crucial in terms of the restrictions associated with managing commercially sensitive information. When asked to describe the skills, knowledge and experience they had gained, one student commented:

> Awareness of Defence-related IP, where not everything may be publishable in an academic context. Potential to work in Defence fields, and awareness of security and other sensitive information handling and disclosure.

The DMTC organises an annual student conference where students have the opportunity to present their work to their peers. They also have access to an online student forum and professional development courses offered through the centre.

For further information please see the DMTC's website at <http://dmtc.com.au/education/>

Student Profile: Michael Wang

Michael Wang completed a Bachelor of Mechanical Engineering and Bachelor of Laws at the University of Melbourne before starting a PhD programme funded by the DMTC in 2010. His thesis focuses on the use of computer simulations to predict thermal properties of aerospace ceramics and composite materials. A key milestone to date has been the development of a completely in-house computer algorithm that harnesses the power of computer graphics hardware to accelerate thermal conduction simulations by more than 100 times.

With the support and training of the DMTC PhD programme, as well as having close collaborations with the Australian Defence industry partners such as BAE Australia, ANSTO and DSTO, this project has enabled the development of a local simulation capability that is cutting edge.

It was the cross-disciplinary collaboration and industry outreach that made the difference when it came to deciding to do a PhD with the DMTC over finding a graduate engineering job. During the PhD, I essentially learned how to write project proposals, and see them through to completion by managing resources and deadlines. This has been good training for my career. One of the greatest benefits I found early on was the opportunity to collaborate and travel. Research is never done in isolation, and I am very happy to have been part of several successful collaborations and to have made some lasting connections.

Student Profile: Cameron Barr

My name is Cameron Barr and I am a DMTC sponsored PhD Candidate currently completing my research at the University of Melbourne under the supervision of Prof. Kenong Xia. My research topic is 'Equal Channel Angular Processing of Aluminium Bronze Alloys for Marine Applications'.

Nickel Aluminium Bronze (NAB) is widely used for marine applications thanks to its high strength and longevity when exposed to seawater. However, due to its complex microstructure, NAB suffers from selective corrosion and requires regular replacements of corroded components. In this PhD study, equal channel angular pressing (ECAP) has been used to improve corrosion resistance; thereby reducing the large cost burden of replacing NAB components. The ECAP process has also contributed to impressive increases in strength, allowing NAB to compete with stainless steels that can suffer from galvanic corrosion issues.

As part of my work with the DMTC, I have been privileged to be a part of a wider community of researchers, defence personnel, business leaders and enthusiasts; all with the same ambition of improving the capability of our nation's armed services. It is always a great feeling to be approached by industry members who remark, "That's really fascinating", or "we've got a component that could really benefit from your research". I find this collaborative effort to be most satisfying as your day to day research is kept relevant by placing it firmly within a business framework, with each step aiming to adapt the newest methods to industry requirements.

Commonwealth Scientific Industrial Research Organisation

The Commonwealth Scientific Industrial Research Organisation (CSIRO) is Australia's largest publicly funded research organisation. CSIRO offers PhD candidates the opportunity to work within the organisation on a research project that aligns with CSIRO's mission to deliver scientific and innovative solutions for industry, society and the environment.

Approximately 800 PhD candidates per year undertake these 'studentships' and are spread throughout CSIRO's 55 sites across Australia. Most of these candidates are embedded within multidisciplinary teams, consisting of scientists, project leaders, research assistants and support staff including business development specialists. Several candidates who responded to the online survey identified one of the benefits of working in this collaborative scientific community is direct access to support and advice from other researchers working nearby. Another benefit cited by several respondents was the ability to connect with leading experts not only in their field, but other fields as well.

Collaboration with industry, government organisations and end users is instrumental to many of the projects. These partnerships provide PhD candidates with exposure to a variety of stakeholders, although the nature and extent of the interaction varies from project to project: some may not interact directly but will be aware of the link between their project and industry needs, whilst others may gain experience interacting directly with these stakeholders. For example, a candidate based in a research program focused on sustainable agricultural practices may talk to farmers during their fieldwork.

In addition to building research capabilities, being embedded within this collaborative research environment enables candidates to gain a broad range of capabilities and expand their employment opportunities. One survey respondent commented:

> Solving industry based problems is key to CSIRO research and that difference has allowed a very different skill set. I met with industry representatives and partners in a very short time frame and I doubt this would be the case if I was in a purely academic role. This is a big advantage for me in my field.

Another benefit mentioned by one respondent was the possibility of 'future employment opportunities with the partner organisation.'

One of CSIRO's largest initiatives is the National Research Flagships, which covers a broad range of research areas including biosecurity, mineral resources, manufacturing technologies and sustainable agriculture. One of the projects within the Food Futures Flagship seeks to improve the export value of Australian wheat flour for the purposes of bread manufacturing, where North American wheat flours are considered the 'gold standard'. The focus is on understanding the differences in pore structures between these breads and how those differences can be mitigated through processing. PhD students involved in the flagship have the opportunity to contribute to a project, which if successful, would bring significant value to Australia's wheat industry.

The majority of candidates who responded to the student survey reported that one of the main features of the program is the 'opportunity to gain experience in non-university research environment.' This was rated as a 'very strong' or 'strong feature' of the program by 68 per cent of respondents.

For more information please see the CSIRO's website at <http://www.csiro.au/en/Portals/Careers/Work-experience-and-scholarships/Postgraduate-scholarships.aspx>

Student Profile: Andrew Bowerman

Andrew Bowerman is a PhD student with the Food Futures Flagship, attached to CSIRO Plant Industry in Canberra. Andrew's interaction with the Flagship is in the cereal section, specifically working on the starchy endosperm of grains. The results of this study may have importance with respect to potential yield, biomass and early growth changes, as well as providing clues as to how these areas are interrelated in plants. It may also be important with respect to food security and agricultural efficiency.

This project brings together techniques from molecular biology, biochemistry and plant physiology, along with microscopy and more specialised techniques. We have contact with people in multiple sections of CSIRO Plant Industry to discuss the different sections of work being performed, and with people within the other sections of the Flagship. I am also co-supervised with members of The Australian National University.

CSIRO is a unique environment for a PhD student. The combination of pure research so close to application-driven science provides a view across all areas of R&D. Projects are very much related to or driven by a product or return goal, yet there is still open research ideas being developed, often in the same area and with the same people. Our projects are performed in collaboration with universities, Research Councils and often major international companies. I think this has given me an excellent view of the science in my particular field and lets me focus on where and how I want to work in future. It has also been an example of how to interact and collaborate with internal and external partners.

CSIRO is also particularly well equipped in terms of resources and experience to help in any way that a student needs. If a member of our team couldn't help me with a question or concern, they knew of someone in the organisation that could help. This is extremely valuable to a new, developing scientist.

Murdoch Children's Research Institute's PhD Program

The Murdoch Children's Research Institute (MCRI) is the largest child health research organisation in Australia. Based at the Royal Children's Hospital in Melbourne, PhD candidates at MCRI have the opportunity to carry out research that contributes towards improving the health of children in Australia and the world. The types of research conducted at the institute span laboratory, clinical and public health research.[42]

MCRI has been hosting PhD candidates since its inception over twenty years ago and there are approximately 30 commencing places each year. Most of the candidates are enrolled at the University of Melbourne which has its Department of Paediatrics based at the hospital. This provides the candidates with immediate access to both the resources available through the university as well as those provided by the MCRI.

Being located on a Hospital Campus provides a couple of key benefits for the candidates:

- It enables them to interact with patients and their families on a regular basis; and
- It provides direct access to medical or allied health professionals, including doctors, nurses, physiotherapists, occupational health therapists and psychologists.

Researchers within the Institute come from a wide range of disciplines, encompassing not only medical and health sciences (e.g. genetics, oncology, pathology, biology, paediatrics, physiotherapy, etc.), but also psychology and cognitive sciences, language and cultural studies. The majority of PhD candidates do, at some point, work with researchers from other disciplines. This helps to expand their knowledge and broaden their network of contacts. Of the 22 candidates who responded to the online survey, 55 per cent rated 'establishing a network of contacts' as a 'very strong' or 'strong' feature of the program.

In addition, the candidates assist with leading tours of the Institute for members of parliament, financial supporters and other guests. They also help with organising events and participate in fundraising activities. Being involved in these types of activities helps them to develop transferable skills such as interpersonal, communication and organisational skills. The 'expansion of skills beyond the purely academic' was rated as a 'strong' or 'very strong' feature by 65 per cent of respondents to the online survey.

The Institute seeks to produce research that has a real impact on the lives of children. Translation and commercialisation of research does therefore occur - the development of an oral rotavirus vaccine is a well-known example. PhD candidates connected to research areas that are ultimately commercialised may have the opportunity to participate in some of these activities. Through this they may interact with industry partners and learn about the processes involved in translating research into outcomes for the medical industry and ultimately patients.

For further information please visit MCRI's website at <http://www.mcri.edu.au/careers-students/students/>

[42] McKeon, S. et al (2013) Strategic Review of Health and Medical Research

Student Profile: Elena Tucker

Elena Tucker completed her PhD in 2011 at MCRI under the supervision of Professor David Thorburn and Dr Alison Compton. While undertaking her PhD, Elena investigated the molecular basis of mitochondrial disease, a devastating disorder that results in a range of debilitating symptoms and sometimes death. Not only did the study achieve a number of diagnoses, it also identified three novel disease genes. The study provided new insight into mitochondrial disease and highlighted the huge potential of the new technology.

While studying for her PhD, Elena won a number of awards including the New Investigator Award from the Human Genetics Society of Australasia, an Australian Postgraduate Award, a Melbourne Abroad Travelling Scholarship and the Murdoch Childrens David Danks Scholarship, which she won in the first year of her PhD. Since completing her PhD Elena has been awarded an Early Career Fellowship and become a post-doctoral fellow in the Molecular Development Research Group at the Institute.

I loved doing my PhD through MCRI's program. I have always been interested in genetics but was keen for my research to have a direct application to human health. The fact that MCRI is based within the Royal Children's Hospital enabled close connection to clinicians and patients. This meant that I was always aware of the clinical impact of my work, which I found motivating and rewarding. Through MCRI's program, I was also able to access and attend courses and seminars offered through the University of Melbourne. I was exposed to the best of all worlds – the clinical, research and academic.

Student Profile: Jean Paul

PhD student, Jean Paul is investigating how doctors who specialise in genetics communicate with parents in consultations for children who have developmental delay. She hopes findings from her research will inform health professionals about best practice in medical communication and will contribute to training the medical profession in effectively communicating genetic testing results.

In 2012, Jean was awarded the Harold Mitchell Travelling Fellowship, for her research. The fellowship enabled her to attend and present at two international conferences in Europe in human genetics and medical communication research. Jean also undertook an intensive summer course at the Health Communication Research Centre at Cardiff University to enhance her analytical techniques for her PhD.

Studying at MCRI has given me the opportunity to learn about cutting-edge local and international research through various seminars and events. MCRI financially supports and encourages students to attend the Postgraduate Students' Association (PSA) annual retreat where we socialise and share experiences while also hearing from experts in particular topics of relevance for graduate research (e.g. career development, stress management, media training). The PSA provides events throughout the year including a student symposium held during Campus Research Week. I believe MCRI is committed to fostering young researchers as they develop their skills particularly through providing opportunities to receive travel funding. As a student at MCRI for over four years now, I feel part of a supportive community, committed to improving child health.

Walter and Eliza Hall Institute's PhD Program

The Walter and Eliza Hall (WEHI) Institute is the oldest medical research institute in Australia. Affiliated with the University of Melbourne, they have been hosting PhD candidates for many decades. Since 1966 (when formal reporting of student numbers began) they have hosted over 380 PhD candidates and approximately 130 are currently participating.

PhD candidates work on research projects that align with the institutions mission that is the mastery of disease through discovery. WEHI collaborates with universities, hospitals and research institutes, and through this, candidates are exposed to various disciplines including clinical and allied health fields, biomedical research, chemistry, mathematics and physics. WEHI also actively encourages and facilitates internal collaborations between its laboratories and divisions through weekly seminars and divisional meetings. This collaborative environment provides PhD candidates with the opportunity to engage with other scientists, many of whom are leading experts in their field.

WEHI also works with clinical trials organisations, commercial partners and cooperative research centres to translate and commercialise its research. For the PhD candidates who are involved in projects that have reached this stage, this may provide an opportunity to gain some insight into commercialisation processes and the medical industry more broadly.

Additional training is delivered during an annual two day retreat organised by the WEHI's student association on themes such as commercialisation, ethics and alternative career pathways.

WEHI actively encourages candidates to develop their research capabilities by pursuing opportunities overseas before returning to Australia at a later stage of their career. It provides fifty per cent of funding for those in the final stages of their PhD to travel overseas to attend an international conference and visit laboratories to explore potential postdoctoral positions.

Due to several internal data collection exercises occurring at the time the student survey for this project was conducted, WEHI did not participate in the student survey.

For further information visit WEHI's website at <http://www.wehi.edu.au/education/graduate_education/>

Student Profile: Sarah Best

Sarah Best began her PhD with WEHI in March 2011. Her project involves manipulation of gene expression to better understand the role of particular proteins in mammary gland development.

Once we can better understand how proteins are involved in normal development, we can then truly understand how they can be deregulated in cancers, and subsequently how we can intervene.

The institute is a department of Melbourne Uni, so you get all the important benefits and help on that front, but it's also an institute that produces research that aims to either be quickly translated, or is highly relevant to disease. There are plenty of seminars to go to, which gives you a well-rounded knowledge of your field and many others. I think, most importantly, you work with scientists who are the top in their field, so there is always someone who you can talk to about the various technical issues that will crop up in any project.

The National Measurement Institute – several initiatives

The National Measurement Institute (NMI) is Australia's peak measurement body responsible for biological, chemical, legal, and physical measurement. NMI is a division within the Department of Industry.

NMI provides high-level measurement expertise and policy input into questions of national and international significance for human health, the economy and the environment. This involves engaging in activities such as analysis of illicit drug seizures for law enforcement agencies, analysis of athletes' samples to detect banned performance enhancing substances, detection and measurement of contamination in food and environmental samples (for example, pesticide residues in export beef), development of new measuring instruments to meet industrial and scientific needs such as measurement of nanoparticle size and shape, and improvement of the accuracy of current methods for DNA analysis.

NMI has several types of initiatives available to research students:

- Internships - NMI has been hosting interns for several years including a number of students from international universities. Internships involve students undertaking a short term (usually 6 month) research project.
- Each year NMI offers a limited number of postgraduate student research projects in which all or most of the research work is performed at NMI with guidance and supervision from NMI staff, in collaboration with a university co-supervisor.
- Some postgraduate students carry out parts of their research at NMI to access specialised equipment and professional expertise. This may be for a specified period of time or can occur intermittently throughout the course of the degree.
- Existing NMI employees may undertake a research degree part time whilst continuing with their current work duties; in these cases the research project will usually be closely related to their field of work and thus these activities tend to complement each other.

These initiatives provide research students with the opportunity to build their scientific skills and knowledge whilst gaining experience in a research environment that is government operated and focussed on meeting the needs of industry and end-users.

NMI works closely with partner organisations in Australia and overseas. These include local and international universities, scientific research organisations such as CSIRO, ANSTO and our counterpart national measurement institutes around the world. These partnerships contribute to a collaborative research environment that helps students extend their network of contacts. This was reported to be a strong or very strong feature by 72 per cent of the seven survey respondents.

All students who completed the survey rated the 'expansion of skills beyond the purely academic' as a strong feature of NMI's initiatives. In terms of whether this experience would give them a competitive edge over other research graduates in pursuing their preferred career path – one respondent cited 'Yes, (my intended) employers prefer real-life 'industrial' experience, particularly in relation to quality assurance management.'

For further information please see the NMI's 2014 student projects at <http://www.measurement.gov.au/Documents/StudentProjects.pdf> or contact Dr Cheryl Lim on Ph. 02 8467 3845 or email cheryl.lim@measurement.gov.au

Student Profile: Dr Catrin Goebel

Catrin first became involved with NMI when she joined one of its forerunner organisations, the Australian Government Analytical Laboratories (AGAL), as the successful recipient of a scholarship offered to UNSW Industrial Chemistry Honours students.

Catrin undertook a project on detection and measurement of veterinary antibiotics in food, under the supervision of Dr Lindsey Mackay (presently General Manager of Chemical and Biological Metrology at NMI). Upon completion of her honours project, Catrin was offered a PhD scholarship, with Lindsey continuing to act as her primary supervisor. The topic for her project was decided through a fortuitously timed visit by staff from Sydney's Royal North Shore Hospital who wanted to study the chemical analysis of saliva in relation to pain management.

During this time, Catrin also began working with the Australian Sports Drugs Testing Laboratory (ASDTL) within NMI (then still AGAL), initially as part of her PhD, and then as an employee. She left ASDTL for a short period to work in the Horse Racing laboratory at Royal Randwick Racecourse, and during this time finished writing up her thesis. She returned to NMI to try her hand at environmental measurements in NMI's Dioxin Laboratory, but was soon back again at ASDTL as a research scientist. In 2010, Catrin was appointed head of ASDTL, a role that she currently occupies. In this role she has continued to contribute to sports drug analysis and research in Australia and overseas, including leading a team of NMI analysts to work with international counterparts on the testing of banned performance enhancing drugs at the 2012 London Olympics.

My time as a student at AGAL/NMI gave me the funding, supervision and opportunity to obtain my Honours and PhD qualifications. Furthermore I had the chance to work on a number of 'real world' problems such as food quality/safety, environmental testing, and the area which finally became my career – sports drugs testing and research. Exposure to and engagement with a range of end-users was also a direct consequence of the applied nature of these topics.

The benefits that were available to Catrin are typical of those offered to all students who have access to NMI's highly specialised and, in many cases, unique laboratory facilities and expertise. The experience of working in a professional research environment that is focussed on meeting the (measurement-related) needs of industry and other stakeholders, the exposure to industry and the opportunity to observe and experience scientific work in a professional setting first-hand epitomise the kind of research/working environment that students will find themselves in at NMI.

University of Queensland's Career Advantage PhD Program

The Career Advantage PhD Program is a training initiative launched by the University of QLD (UQ) in 2013. It exposes PhD students to a range of theoretical and practical professional development activities throughout their candidature so that upon graduation candidates are better prepared to enter the job market.

PhD students at UQ may opt to participate in the Program approximately 12 months into their PhD candidature. They select from one of three career pathways (with an opportunity to switch programs if they change their mind):

- *Higher Education Practice and Leadership* – for those wishing to pursue academic careers.
- *Research Innovation, Translation and Commercialisation* – for those interested in careers in industry or government.
- *Global Collaborations* – for students interested in a research-related career emphasising international collaboration.

Each pathway involves a three day workshop plus a cluster of primary and secondary training activities selected by the student:

- Primary activities are those with a practical or experiential component and are undertaken over an extended period of time. These may include, for example: an industry internship; international exchange or joint PhD; participation as members of associations or committees; tutoring; presenting at an international conference and mentoring.
- Secondary activities are more theoretical and may be undertaken over a shorter period of time. These could include: attending a grant writing workshop; an industry engagement event; or seminar series.

The length of time each PhD student spends on these activities must be at least 15 days over the course of their candidature, but may be more depending on the types of activities selected by the student. It should be noted that this program it is not intended to be the only career preparation the students will undertake. It is intended to prompt students to think about what direction they would like to take in their career and provide them with opportunities to help them progress in that direction.

Despite the fact that the program had only begun a few months before the student survey was conducted, over 95 per cent of the 22 students who completed the survey reported that they believed that it was helping them to develop a wider range of skills and was opening up a broader range of career options.

For further information please see UQ's Career Advantage webpage at <http://www.uq.edu.au/grad-school/career-advantage-phd/>

University of Canberra's 'redesigned' PhD Program

The University of Canberra (UC) has redesigned its PhD program to meet the needs of industry by providing a pathway for existing industry professionals to enter a PhD and by encouraging students to gain industry experience during their candidature.

Historically, UC has often received applications from professionals who are well established in the workforce (including senior industry leaders) who wished to undertake a doctoral degree in order to further develop their disciplinary expertise and research capabilities. Since these individuals had often been in the workforce for many years they usually did not meet the required level of knowledge (Honours degree or equivalent) and thus the university was unable to offer them a place.

To overcome this, UC has introduced a new pathway into the PhD that consists of six months of coursework covering the fundamental research skills and disciplinary knowledge necessary to commence a PhD. This supports industry to build its research workforce capacity by providing a mechanism by which industry professionals can enter a research degree. Students who do have the requisite level of knowledge can bypass this and go straight into the PhD.

PhD Candidates are encouraged to gain experience in industry during their candidature by undertaking a six month work placement. This enables those with industry experience to gain experience in a research specific role or in another work context, whilst those with minimal professional experience have the opportunity to become more 'work ready' in preparation for when they complete their PhD.

The work placement can be undertaken at various stages of candidature:

- It can be undertaken prior to data collection where a better understanding of a specific industry or organisational context is required to ensure the research design is appropriate;
- May occur toward the end of candidature where a student wishes to apply their research in a non-academic setting and be better prepared for the job market;
- A particular company may choose to sponsor a student who will be able to work them during the PhD in developing an application for them.

For further information please see UC's Graduate Research Office webpage at <http://www.canberra.edu.au/graduate-research/home>

Research Oriented School Engaged Teacher-researcher Education (ROSETE)

The Research Oriented School Engaged Teacher-researcher Education (ROSETE) provides PhD and Masters by Research students from China with the opportunity to combine academic work with practical teaching experience putting them in a strong position for a successful career in the education industry.

This is a collaborative research program administered through a partnership agreement between the University of Western Sydney, the NSW Department of Education and Communities and the Ningbo Municipal Education Bureau in China.

Under the ROSETE program, ten HDR students from China come to Australia each year to teach Chinese to primary and secondary school students whilst undertaking their research projects at the University of Western Sydney. They invest approximately 10 hours per week supporting teaching at these schools and this experience contributes to their research projects and theses. Typically, these projects engage in the joint construction of Australia-China knowledge for making Chinese learnable for largely monolingual English speaking school students. By enhancing their skills in these areas this research program aims to improve the teaching and learning of Chinese in Australian schools and to produce highly skilled language teacher-researchers.

The ROSETE program prepares HDR students for careers in the education industry by enabling them to gain experience in a school learning environment (the 'industry') where they can interact with teachers, principals and parents, and work closely with the students (who are the 'end users'). This builds their professionalism and improves their bilingual skills in English and Chinese, and enriches their Australian cultural literacy. These work-integrated teaching/research experiences forms their international mindedness of how the outcomes of their research makes practical contributions to improving the teaching and learning of Chinese in Australia and furthering Australia-China knowledge exchange.

To prepare them for their roles as language teachers-researchers, the partner organisations provide the students with formal structured training in generic and professional skills. This includes a four hour workshop plus tutorials each week, as well as regular seminars, conference presentations and a partnership-driven induction program. These events cover a range of topics including evidence-driven teacher research methodologies, Chinese as a local sociolinguistic practice, intercultural language teaching and learning, and Australia-China collaboration in internationalising education and research.

Since the first intake in 2008, 40 HDR students have completed the program. Most of these have successfully gained employment in China in senior high schools, universities and international education enterprises. Several of the Masters candidates have continued their studies undertaking PhDs in Australia.

Between 2008 and 2012 the program has contributed to the teaching of Chinese to 4,271 primary school students and 1,454 high school students in Sydney.

For further information please contact Professor Michael Singh at m.j.singh@uws.edu.au

The SOAR Centre

The SOAR Centre (Support – Opportunities – Advice – Resources) is a peer-to-peer training and support service for Higher Degree by Research (HDR) and Honours students launched in 2009 by Edith Cowan University. It helps build social and academic networks amongst the HDR and Honours cohort, to enrich the research training experience and provide support on dealing with life as a research student.

Each year ten HDR students who are regarded as having research and professional skills that can benefit their peers are employed as SOAR ambassadors. The ambassadors are provided with extensive training in career guidance tools, cultural awareness and research skills. Since 2009, 42 SOAR Ambassadors have been employed and trained.

Once fully trained, the ambassadors provide support and advice to their peers who can book one-on-one appointments or participate in group workshops. The ambassadors provide advice on a variety of topics related to life as a research student – ranging from those directly related to research (for example, research methodologies, ethics applications, data collection and analysis, using research software, academic writing and presentation skills) through to dealing with personal challenges (for example, developing work-life balance, juggling family commitments, adjusting to cultural life in Australia) and career planning (using a career guidance tool and e-portfolio system). Between 2009 and 2012, 1,431 HDR and Honours candidates have received support and training through the SOAR centre.

The ambassadors also arrange for industry representatives to come and speak with the HDR cohort about employment in industry. Career development experts also conduct training sessions on self-marketing, interviews, and career networking, as well as providing support on the use of a career guidance system to build a professional career portfolio.

The SOAR Centre represents a mutually beneficial system – the HDR candidates benefit from the support and information provided through the ambassadors, whilst the ambassadors benefit from the opportunity to practice leadership, and build their confidence, communication and interpersonal skills. Meanwhile, both groups benefit from a better understanding of their career options across employment sectors.

For further information please visit the SOAR centre webpage at <http://intranet.ecu.edu.au/research/for-research-students/soar-centre>

Australian Government

Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education

Appendix B: Program Details Questionnaire

[Insert Organisation Name]

This qualitative questionnaire is intended to gather information about programs for higher degree by research candidates (those completing a Doctorate or Masters by Research) for the purposes of a project being conducted by the Department of Industry, Innovation, Science, Research and Tertiary Education. The aim of the project is to enhance awareness of a variety of programs for postgraduate research students which give them the opportunity to expand their experience beyond the traditional academic environment or develop professional and generic skills to prepare them for a range of research career paths, particularly those in industry.

Please note that the term ‘candidate’ is used to refer to individuals undertaking a Higher Degree by Research.

We recommend this survey be completed by a member of your organisation who has a thorough understanding of your program and is familiar with common experiences of candidates. It can be completed either electronically or in hard copy.

This survey is designed to obtain information about a broad range of programs and therefore some sections may not be relevant to your program. In these instances, please indicate ‘NA’.

We understand that the answers to some questions may vary depending on the candidate. In these cases, please provide a range, average or ‘typical’ response, indicating where this is done.

Information provided in the survey will be used to develop a summary of your program for inclusion in a report to be published on the department’s website. This summary will be submitted to you for verification and approval before publishing. We will not publish any information about your program without your written consent.

We are also seeking short case studies or ‘success stories’ about candidates who have undertaken your program. Please ensure that before submitting these, you obtain consent from any individuals that may be identified. These are not due until 22 March 2013.

If you have any questions please contact Sophie Hardman on (02) 6213 6544 or Sophie.Hardman@innovation.gov.au.

1 PROGRAM DETAILS

1.1 Name of program:

1.2 Please briefly describe the aim of your program:

1.3 In what year did the program commence?

1.4 How many candidates have completed the program since its inception?

1.5 How many candidates are currently enrolled in your program?

1.6 How many commencing places are usually offered each year?

1.7 How long (on average) does it take to complete the program?

1.8 In what regional or city locations do the majority of current candidates undertake your program?

1.9 Does your organisation provide financial support directly to candidates undertaking this program? If Yes, what type of expenses does this cover? (E.g. salary or stipend, other living expenses, books, tuition fees, domestic or overseas travel to attend conferences/seminars, etc.)

2 SUPERVISION AND THE RESEARCH TRAINING ENVIRONMENT

2.1 How many supervisors is each candidate typically assigned, where are they from (e.g. university, industry, organisation) and what are their roles?

2.2 Are they assigned a mentor separate from supervisory arrangements? If Yes, how is this organised?

2.3 What percentage of the candidate's research time is typically spent located at the following:
Your organisation: University faculty or academic school: Other (e.g. onsite with industry partners):

2.4 Does your research training environment differ from a traditional academic environment? If yes, how?

2.5 How would you describe the role and significance of the candidate's university in the research training process?

2.5 How would you describe the role and significance of the candidate's university in the research training process?

3 RESEARCH TOPICS AND INTELLECTUAL PROPERTY

3.1 How is the candidate's research topic determined?

3.2 Please briefly explain what the ownership arrangements are for intellectual property generated as a result of research undertaken by the candidate. (Note that if you consider it necessary to provide a more detailed response, you can also insert a link or attach relevant documents).

3.3 Do candidates become familiar with working alongside other disciplines outside of their immediate research area during the program?

4 STAKEHOLDER ENGAGEMENT

4.1 Does your organisation work closely with other organisations, industry partners or end users? If Yes, what type of organisations and how many? Do they have any direct involvement with the delivery of your HDR program?

4.1 Does your organisation work closely with other organisations, industry partners or end users? If Yes, what type of organisations and how many? Do they have any direct involvement with the delivery of your HDR program?

4.2 Do the candidates themselves have regular contact with any of these stakeholders during the program? If Yes, which stakeholders and how does this usually occur?

5 PROFESSIONAL AND GENERIC SKILLS DEVELOPMENT

5.1 Do the candidates undertake professional development or generic skills training (e.g. communication, teamwork, presentation skills, etc.)? If so, in what skills and how is this training delivered?

5.2 Do they spend any time undertaking non-research roles (e.g. admin, teaching) within your organisation?

5.3 Do opportunities to gain professional or research experience with other organisations feature as part of your HDR program?

6 FUTURE CAREER PATHWAYS

6.1 Are candidates assisted with developing a future career development plan as part of your program?

6.2 Does your program have a specific career path in mind for the candidates? (e.g. higher education, industry, publicly funded research organisations)

6.3 Once the candidates have completed the program, do you provide any assistance in finding employment in their field of research? If so, please summarise below.

6.4 Have you employed graduates from your HDR program? If so, does this often occur?

7 SUMMARY

7.1 What do you consider to be the key benefits for candidates in your program?

7.2 Do you intend to submit any case studies or 'success stories' of candidates who have undertaken your program? (Note these will not be required until 15 March 2013)
□Yes □No

7.3 Please provide any additional information you would like to include about your HDR program…

Appendix C: HDR Candidate Survey

Introduction

Purpose of this survey

This survey is intended to gather information on the views of Higher Degree by Research (HDR) candidates in selected programs (see list below), for the purposes of a project being conducted by the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education ('The department').

About the Project

The department is carrying out a small research project focusing on programs for HDR candidates (Doctorate and Masters by Research) which aim to prepare candidates for careers in a range of sectors, particularly industry. These include programs that expand the candidate's experience beyond academia (e.g. through collaborative programs and internships), and/or provide formal, structured training in generic and professional skills.

The aim of the project is to highlight a range of approaches to research training outside the traditional university-based model, and to highlight the benefits of these approaches in enhancing the skills, knowledge and experience of HDR candidates.

The following organisations are taking part in this project:

- ATN Industry Doctoral Training Centre in Mathematics and Statistics
- Aust. Mathematical Sciences Institute (AMSI) – Industry Internship program
- Bluescope steel – Research Staff Development program
- CSIRO – Masters/PhD program
- Defence Materials Technology Centre (DMTC) – Postgraduate program
- Invasive Animals CRC Balanced Researcher program
- Lowitja Institute Education and Training program
- Murdoch Childrens MRI – PhD program
- National Measurement Institute – various programs
- University of Queensland Career Advantage PhD program
- Walter and Eliza Hall Institute PhD program
- Young and Well CRC Early Career Researcher Program

Definitions

Please note the intended meaning of the following terms used in this survey:

Generic skills: These are broader (non-research specific) skills that can be easily transferred from one employment context to another. Some examples include: communication, team work, leadership, presentation, organisational and project management skills.

Traditional university-based research training: This is the most conventional approach to research training in which students undertake their research project within a university faculty under the guidance of one or more academic supervisors (sometimes described as a

'master-apprentice' model). There is generally minimal interaction with stakeholders outside of the university (e.g. end users, government or industry) and the emphasis tends to be on the acquisition of research skills and discipline specific knowledge.

How to complete the Survey

This survey is intended to gather information from HDR candidates who are either currently undertaking, or have recently completed (within the past five years), one of the programs identified in the list above.

Please ensure that when completing this survey, your responses relate only to this particular program (i.e. that run by the organisation who sent you this link).

As this survey is designed to cover a range of different types of programs, please note that some questions may not apply. In these instances, please skip the question.

Questions marked with an asterisk are compulsory.

The survey should take between 10 and 15 minutes to complete.

Confidentiality

All survey responses will remain anonymous; information will not be disclosed, published or disseminated in a manner that is likely to reveal the identity of the respondent. Results from structured questions will be aggregated with those of other respondents and may be published. Written comments may be published, but the name of the respondent will not be identified.

If you have any questions about completing the survey, please contact the Research Training and Workforce Analysis team at RWS@innovation.gov.au

1. Which program are/were you participating in?

- ○ ATN Industry Doctoral Training Centre in Mathematics and Statistics
- ○ Aust. Mathematical Sciences Institute (AMSI) – Industry internship program
- ○ Bluescope steel – Research Staff Development program
- ○ CSIRO – Masters/PhD program
- ○ Defence Materials Technology Centre (DMTC) – Postgraduate program
- ○ Invasive Animals CRC - Balanced Researcher program
- ○ Lowitja Institute - Education and Training program
- ○ Murdoch Childrens MRI – PhD program
- ○ National Measurement Institute – various programs
- ○ University of Queensland - Career Advantage PhD program
- ○ Walter and Eliza Hall Institute - PhD program
- ○ Young and Well CRC - Early Career Researcher Program

2. For how long have you been enrolled in this program?

- ○ Less than 1 year
- ○ 1-2 years
- ○ 3-4 years
- ○ Over 4 years
- ○ Already completed

3. Are/were you a domestic or international student?

- ○ Domestic (includes New Zealand)
- ○ International

4. What type of research degree are/were you undertaking?

- ○ Doctorate by Research
- ○ Masters by Research

5. How many years of experience did you have in the general workforce (excluding casual work) prior to undertaking this degree?

- ○ None
- ○ Up to one year
- ○ 2-5 years
- ○ 6-10 years
- ○ 11+ years

6. Within what broad classification does/did your area of research best fit?
Note - these are derived from the Australian New Zealand Standard Research Classifications (ANZSRC)

- ○ Mathematical Sciences
- ○ Physical Sciences
- ○ Chemical Sciences

- ○ Earth Sciences
- ○ Environmental Sciences
- ○ Biological Sciences
- ○ Agricultural and Veterinary Sciences
- ○ Information and Computing Sciences
- ○ Engineering
- ○ Technology
- ○ Medical and Health Sciences
- ○ Built Environment and Design
- ○ Education
- ○ Economics
- ○ Commerce, Management, Tourism and Services
- ○ Studies in Human Society
- ○ Psychology and Cognitive Sciences
- ○ Law and Legal Studies
- ○ Studies in Creative Arts and Writing
- ○ Language, Communication and Culture
- ○ History and Archaeology
- ○ Philosophy and Religious Studies

Benefits and challenges

7. Please rate the extent to which the program offers/offered the following opportunities

	Very strong feature	Strong feature	To a moderate extent	To a small extent	N/A
Expansion of skills and knowledge beyond the purely academic	❒	❒	❒	❒	❒
Experience in a non-university research environment	❒	❒	❒	❒	❒
Opening up a broader range of career options	❒	❒	❒	❒	❒
Insight into commercial world	❒	❒	❒	❒	❒
Getting a 'head start' on a research career outside academia	❒	❒	❒	❒	❒
Establishing a network of contacts	❒	❒	❒	❒	❒
Opportunity to work on finding solutions to 'real world' problems	❒	❒	❒	❒	❒

8. Please rate the extent to which this program presents/presented the following challenges

	Very significant challenge	Significant challenge	Often challenging	Occasionally challenging	N/A
Completing the program within required timeframe	❒	❒	❒	❒	❒
Differences between academic and industry priorities	❒	❒	❒	❒	❒
Access to adequate supervision	❒	❒	❒	❒	❒
Dealing with joint or multiple supervisors	❒	❒	❒	❒	❒
Having to present research outcomes using multiple report templates	❒	❒	❒	❒	❒
Complex administration associated with working across institutions					

9. Are there any other significant benefits you can identify?

10. Are there any other significant challenges you can identify?

Research training programs

Note: Respondents in internship (e.g. AMSI intern) or generic skills programs (e.g. UQ career Advantage PhD) do not need to complete this section. Please go to Q16.

11. Do/did you spend any of your time carrying out research in a non-university environment (e.g. onsite with industry partners)? If so, approximately what percentage?

12. Do/did you receive guidance from anyone other than the academic supervisor?

- ○ Yes
- ○ No

13. If yes, please broadly identify what type of supervisor performed this role –

- ○ Industrial R&D manager
- ○ Industry based researcher
- ○ CSIRO Scientist
- ○ Research organisation scientist

Other (please specify)

14. Please rate the degree to which you think this program differs from more traditional university-based research training.

Very different	Moderately different	Slightly different	No difference
❒	❒	❒	❒

15. Do you think you are developing a broader range of skills, knowledge and experience than if you had undertaken more traditional university-based research training?

- ○ Yes
- ○ No
- ○ Not sure

16. Please briefly describe these skills, knowledge or experience

Generic and professional skills development

Have you been given formal training (e.g. workshops, training courses or coaching) in any of these skills? (tick all that apply)

- ○ Career development
- ○ Communication
- ○ Entrepreneurship
- ○ Financial management
- ○ Grant application writing
- ○ Interview and resume/application writing
- ○ Leadership
- ○ Managing time and workloads
- ○ People management
- ○ Presentation
- ○ Project management
- ○ Research commercialisation, knowledge transfer and IP
- ○ Team work
- ○ Writing skills

17. Do you feel you have/had sufficient opportunity to develop, practice and apply these skills?

- ○ Y
- ○ N

18. How challenging is/was it to complete this training in addition to your research project within the nominated timeframe?

Extremely difficult	Difficult	Sometimes challenging	Fairly easy
❒	❒	❒	❒

19. Overall, how worthwhile do you think this training is?

Not worthwhile	Occasionally worthwhile	Worthwhile	Very worthwhile
❒	❒	❒	❒

20. Please provide any suggestions on how the training could be improved –

Career paths

21. In what sector would/did you prefer to be employed after finishing your degree?

- ○ University – research focused
- ○ University – teaching focused
- ○ University – teaching and research
- ○ Business/private
- ○ Medical Research Institute
- ○ Publicly Funded Research Organisations (e.g. CSIRO)
- ○ Cooperative Research Centres
- ○ Government agency
- ○ Not-for-profit
- ○ Not sure – still deciding

Other (please specify)

22. In what type of role? (e.g. medical researcher, R&D manager, technical research officer, science journalist)

23. Do you think this program is helping/helped to prepare you for this? (please briefly explain)

24. Do you think that this program will give/gave you a competitive edge over other research graduates in securing employment within your preferred field? If so, in what way?

25. Would you like to make any other comments?