

Developing a Framework for Work Integrated Research Higher Degree Studies in an Australian Engineering Context

Rodney A. Stewart^{a,1}, Le Chen^b

^aGriffith School of Engineering, Griffith University, Queensland, Australia

^bGriffith Institute for Higher Education, Griffith University, Queensland, Australia

¹Corresponding author. Tel.: +61 7 55528778; Fax: +61 7 55528065; Email: r.stewart@griffith.edu.au

Abstract

Attributed to the changing social, political and economic landscape of the 'knowledge economy', Australian universities are under pressure to produce researchers that have a variety of skills that meet the demands of an increasingly diverse job market. As a consequence, the umbrella of Australian Research Higher Degree (RHD) offerings has broadened from the traditional MPhil/PhD programmes to include a range of professional masters and doctoral degrees. This paper reports on the experiences of three PhD students, engaged in an informally managed industry partnered research programme, described in this paper as the Work Integrated Research Higher Degree (WIRHD). Their learning process shares the attributes from both the traditional PhD programme and professional doctorates. However, because of the blended nature of the learning contexts, candidates engaged in the WIRHD programme must address a wider range of issues than those following the traditional RHD pathway. An exploratory case study approach exploring experiences, benefits, barriers and coping strategies was conducted with the view to develop an integrative framework that attempts to explain the various contexts that influence the learning experience of WIRHD candidates. The exploratory study led to the development a structured approach to guide the WIRHD process, which aims to mitigate the various challenges of this style of partnered research arrangement whilst leveraging its benefits.

Keywords: work integrated learning, doctorate, PhD, research higher degree, engineering

1. Introduction

Both corporate sectors and governments perceive post-secondary education as a strategic tool for the enhancement of the nation's economic health. The doctorate, especially the PhD, is the pinnacle of this large and complex higher education system. Traditionally, doctorate students work within their own units and may hardly seem affected by wider social, economic and cultural considerations (McAlpine and Norton, 2006). Nevertheless, it has been reported that this traditional doctoral training and research mode is facing some challenges in meeting the industry needs in this fast changing economy (Altbach, 2004; Pearson, 2005). To illustrate, there is greater pressure for research to be linked to applied usage, be aligned with private-sector or government objectives and to have shared intellectual property arrangements. In addition, the expanding job market for PhD holders entering entirely new fields (e.g. biotechnology), consulting firms, and government services has put pressure on doctoral training to be more flexible and aimed at a wider array of jobs than the traditional academic profession. Moreover, universities find it hard to compete with the private sector for the best talent. Many of the best young minds are unwilling to undergo the long, poorly paid, and often disorganised road to a doctoral degree. The problems encountered by PhDs in obtaining academic employment are another deterrent. Take the traditional engineering PhD for example (Akay, 2008; Manathunga and Plant, 2006). Many industry employers claimed that PhD students are educated and trained too narrowly and that they lack key professional skills, such as, effective collaboration, working in teams, organisational and managerial skills, and an appreciation of applied problems. The conventional employment avenue for PhD graduates being teaching institutions reported many are ill-prepared to teach and mentor.

In responding to the demands of the knowledge economy that continues to emphasise workers with more flexibility and interdisciplinary skills, in the past fifteen years, there has been a rapid diversification in doctoral degrees to encompass a range of provision (Boud and Tennant, 2006). In addition to the PhDs awarded for original research normally examined by thesis conducted over a duration of 3-3.5 years full time study (Wright and Cochrane, 2000), there is a growing trend toward tailored professional doctorates in such fields as management studies, education, law and engineering. Professional degrees bring together the academy and the workplace with an emphasis on professional practice: PsyD (Psychology), EdD (Education), DBA (Business), JD (Law) and Eng (Engineering). In recent years in Australia there has been a growing shift in source of knowledge, away from the academic genre, as evidenced from the growth in professional doctorate programme (Maxwell, 2003; Pearson, 2005). The focus of attention of these programmes are not designed to produce 'professional researchers' but 'scholar professionals', who are capable of critical reflection upon their professional roles and experiences (Maxwell, 2003). Most of the programmes are featured as a partnership between a university and the employers of the candidates so that doctoral degree experiences are integrated

with the needs of the employers; and the entry requirements include extensive professional experience together with access to workplaces (Maxwell, 2003). Therefore, Lee *et al.* (2000) described the programmes as ‘hybrid curriculum’ where the university, the candidate’s profession and the particular work-site of the research meet in specific and local ways, in the context of a specific organisation.

From an engineering education perspective, it has been suggested that today’s climate of rapid-fire change requires ‘innovative engineers’, that can go beyond one technical specialty to understand the broader implications of the technology he or she develops (Akay, 2008). In view of this, engineering doctorates in business or government must understand both specialised technical content and its broader context, in order to realise their potential as technology leaders (Akay, 2008). At present, the professional engineering doctorate (EngD) has been the most reported doctoral training and research mode to satisfy such a demand. The EngD fully integrates the technical requirements of a doctorate study with the needs and market drivers of the respective industrial sector, and offers a unique learning opportunity for experienced research engineers to develop subsequent careers in industry at a management level (Kerr and Ivey, 2003). For example, the consultant/ researcher/ innovator/ entrepreneur (CRIE) model developed by the Gas Turbine Instrumentation Group at Cranfield University (the UK), combines management course work and a technical research component, which acts as an effective vehicle for conducting market-focused research at a doctorate level together whilst concurrently offering a fresh perspective to product development (Kerr and Ivey, 2003). The DTech at Deakin University serves as a good example in Australia that made strong use of links with industry, to create a technology-based professional award in the fields of science, architecture and engineering that is embedded in a particular professional situational context (Maxwell, 2003).

The WIRHD has appeared just recently in the landscape of Australian engineering education in responding to the mounting needs of linking high quality research studies with issues that need urgent attention, such as the globalised economy (Abanteriba, 2008) and sustainable engineering innovation (Schäfer and Richards, 2007). Similar to the traditional PhD and Master of Philosophy (MPhil) programme, described often by Australian Universities as Research Higher Degree (RHD) programmes, the dissertation is the central element of WIRHD, and is intended to be a significant piece of original research which makes a new contribution to science and the discipline (Altbach, 2004). Readers should note that from this point forward the paper mainly refers to the higher level PhD degree; however the discussions and findings presented are equally relevant to the MPhil degree. Albeit WIRHD candidates’ research studies are carried out partly within the context of an industrial partners’ organisation, they are full-time research students, with no direct employment relationship with these organisations, which is contrary to the usual case for professional doctorates (Wellington and Sikes, 2006). Sharing the contextual environment of both the traditional PhD as well as work-based professional doctorates, it is expected that WIRHD candidates face the challenges associated

with both forms of research learning provision. The closest resemblance to the programme described herein is the industry-based PhD programme offered in Denmark. This type of innovative PhD programme is well advanced in this country, having commenced in 2001, and from the evidence presented in a recent study, is proving to be functioning effectively (Kolmos et al. 2008).

In general, the individualised nature of doctoral study and the need for greater responsibility and creativity on the part of the student are factors that may lead to much of the frustration involved in the doctoral process (Gardner, 2008). It has been reported that a lack of supervision, isolation and financial stress are the three primary challenges that are normally encountered by full-time Ph.D. candidates (Gardner, 2008; Haksever and Manisali, 2000; Wright and Cochrane, 2000). Whilst, work-based professional doctorate candidates might find difficulties in mastering knowledge and reconciling conflicting methodologies, locating an intellectual community, gaining sufficient supervision, and balancing roles and responsibilities (Walker, 2008; Wellington and Sikes, 2006). Moreover, student workplace transfer and high workloads affect study continuity (Maxwell, 2003). In addition to these challenges, WIRHD candidates need to satisfy the requirements and be emotive to the value systems of the two different types of agencies that they interact with on a daily basis, namely, the university and the industrial organisations. Due to the relatively recent emergence of an informally administered WIRHD programme, targeted studies on the challenges faced by full-time WIRHD candidates, the development of coping strategies, and procedures for the structuring of this programme, are not evident in the literature. This paper attempts to shed some light on these issues. An in-depth exploratory case study approach involving three current WIRHD candidates was adopted to extract the experiences, benefits, barriers and coping strategies adopted by these students during their studies with the view to develop a preliminary integrative framework and structured WIRHD approach described later.

2. Research approach

McAlpine and Norton (2006) suggested that to analyse and understand the issues associated with doctoral education, the influencing factors within the societal/supra-societal, institutional and departmental/disciplinary context should be taken into the consideration. They proposed an integrative framework which incorporates key contexts that have impact on the traditional PhD programme. At the centre of this framework is the student-and-supervisor relationship, whilst the thinking and learning of supervisors and students is situated within distinct academic communities of practice, e.g. department and disciplines. This departmental/disciplinary context is in-turn nested within an institutional context that is situated within the social/supra-societal context. According to this framework, changes in one context may create disequilibrium or be contestable and contested in another context (McAlpine and Norton, 2006). The challenges of WIRHD candidates have been

studied with these existing contexts considered. However, the study explores other relevant environmental context that may be faced by such candidates.

As a students' learning experience is the focus of higher education (Biggs and Tang, 2007), particularly doctoral research (McAlpine and Norton, 2006), this study aims to explore the benefits and challenges associated with a WIRHD candidates' learning process within their study contexts, and thus seeks to explore answers to the following questions: (1) What are the key components of the contexts of the WIRHD programme that influence the learning experiences of the candidates?; (2) From the students' perspective, what are the benefits and challenges associated with the WIRHD style of learning process?; (3) What are the coping strategies they currently apply?; (4) What support do they require to ensure the WIRHD process is effective?; and (5) What would be an effective approach to mitigate the indicated challenges whilst leveraging the benefits from the WIRHD programme? Since this study was exploratory in nature, qualitative research methods were used to provide some insights into WIRHD studies. In-depth case studies were undertaken with three on-going WIRHD projects whereby interviews were firstly conducted with the WIRHD candidates, followed by focus group discussions with both the supervisor and the candidate in each project. Based on the responses collected, an integrative framework was developed to help understand the learning experience of the WIRHD candidates. This framework helped facilitate the development of a preliminary structured WIRHD approach, which aims to help the candidates manage the challenges associated with this unique research study arrangement.

3. Case studies

Interviews were undertaken with the PhD candidates of three on-going WIRHD projects being conducted in Queensland, Australia. The interviewees were asked to describe the benefits of the WIRHD to their career development, the challenges that were associated with their learning experiences, their adopted coping strategies to address such challenges and their suggestions for both the university and industry partner to manage these challenges more effectively. The case studies helped to inform the development of the structured WIRHD approach described later.

3.1 Case A – University and local government water utility

This PhD candidate is conducting a research project investigating potable water savings attributed to dual reticulation and education measures. The research process involves the installation of high resolution water meters and data loggers into 200 recruited households (four logging periods), an internal and external water audit, two surveys, enactment of water education measures, and interviews with sub-sample focus groups. The candidate initially had a largely full time placement within the organisation of the industry partner (80%) to plan the project and undertake data collection. In the

second and third year of study, her research time will be divided roughly evenly between the university and the partner organisation. The candidate is supported by an Australian Postgraduate Award (Industry) Scholarship with top-up and does not receive direct payment by the industry partner. However, the industry partner funds all equipment and a significant component of the project expenses.

The candidate perceived the primary benefit of the WIRHD is to gain practical and real world applicability of research as well as strong academic support. This is reflected by comments like: *“It is rewarding to know that my research will stem directly into an organisation providing real changes as well as into the academic society. I work with a leading water authority, water management experts and also gain access to resources which ensure that my research is of a high quality. Best of all, I gain experience in both academia and industry for the duration of my research. I believe this significantly improves employability at research completion.”* The candidate felt the challenges of a WIRHD student differ from those of a traditional PhD student. She commented: *“The issue of isolation, I feel, is not one suffered by students, more over exposure. Lack of supervision could be a potential issue although in this case it has not been. Financial stress can be easier to overcome with WIRHD students by doing a few hours of casual work for the company they are embedded in; however it is difficult to balance the level of casual work at times.”* On the other hand, she believed that management of ‘a project’ and ‘a PhD’ within the same timeframe of a traditional PhD student is the primary challenge. Hence, *“time management is a very important skill” for “meeting the requirements of both the university and the company”*. Obviously the requirements from both facets differ and meeting the requirements from both ends can take considerable effort and varying skills. The candidate described that performing some duties as an industry practitioner and studying as a researcher at the same time requires the student to perform in two distinctively different mind frames, like *“switching hats”* and *“ensuring the switch happens can be difficult at times”*. Additionally, the student expressed that it is easy to get distracted by other interesting projects within the organisation. Approached by others working within the company for assistance can also eat into the student’s time. Hence, determining the level of involvement and time spent in the company is important. The candidate managed these challenges through improving project management skills, especially time management and the prioritising of tasks.

Moreover, the candidate also stated that being primarily embedded in an organisation made it sometimes difficult to maintain a strong attachment with the university. She felt that regular contact and assistance from her supervisor helped to mitigate this, as he stressed the importance of a continued attachment with the *“academic world”*. She also suggested a supportive system: strong supervision and guidance from supervisors, web-based access to appropriate university systems and resources externally, and ongoing communications between the industry, university and student.

3.2 Case B – University and corporatized local government water business

This PhD candidate was undertaking a research study with Queensland's only corporatized local government water business. The research investigates the impact of an automated meter reading system implemented at a citywide scale. All 22,000 domestic water meters incorporate data loggers that can record water consumption in real time. The project is focused on post meter leakage detection using smart meters and the subsequent optimal approach to rectification. Work is currently undertaken at the macro level, with strategies and guidelines to identify and manage water losses across the total network. This research has implications for a new least cost water demand management scheme.

The candidate indicated that the research imperative is to investigate an issue currently facing the water industry. As she said: *“...The practical experience is invaluable, working with people across all levels of the organisation; involving the application and testing of theories in real situations. ...The company is able to provide access to historical information, relationships and contacts established over many years in Australia and overseas. ...The company is able to provide the actual resources necessary to undertake the study: the equipment, the technology, and relevant personnel. Consequently this alleviates many pressures that traditional university based PhD students face, working independently yet seeking the support and interaction of their invested field of study.”*

When describing the challenges associated with the project, the candidate's comments reflected some degree of confusion about the role and duties of the PhD student in the partner's organisation. This reality is best described by the comment: *“the reason for the placement is not necessarily made apparent to all members of the workforce and this can create uncertainty; the student may be viewed as an extra head count to undertake menial tasks.”* In addition, short term pressures in the work environment manifests a preference for quick results. This work related culture factor is reflected by the comments: *“...the company primarily focuses on the quick translation of research findings into new insights that can be developed into new services. The practical and applied nature of the work can often entail working with new technology and innovative applications: as such there was little previous work conducted in the field.In reality, achieving the desired research findings is not always straightforward and involves lengthy time trials; again this is not always anticipated or incorporated into work schedules and the student might be viewed as a panacea to obtain the results.”*

With regard to workplace supervision, the candidate revealed another challenge associated with time pressure in the real industry environment: *“...Substantial time is required for interaction between student and workplace supervisor(s) to discuss project challenges and constraints. In reality, there are other demands placed upon the workplace supervisor, and as such this resource is not always available to the student which leaves them in isolation when attempting to anticipate the company's*

requirements. Moreover, progress and issues are not always communicated to the wider organisation or senior management.” Such limited support is undoubtedly a concern for students.

The candidate is a mature student with over 13 years work experience and understands the demands of business. She has been managing these challenges through establishing relationships with people identified as key to her research. These people provided time outside of their normal duties and assumed the role of work supervisors, though were not officially recognised for doing so. The candidate suggested a Charter for WIHRD students to clearly indicate the role of the candidate as well as the requirements from both the university and the industrial partner/s. She also suggested training sessions for all concerned parties at the beginning of the project to explain some key concepts for a successful WIRHD programme, such as the difference between research and consulting work.

3.3 Case C – University and specialist environmental consultancy

This student conducted their PhD programme with an environmental modelling company that specialises in marine and freshwater environmental modelling. Typical projects include: (1) the fluid modelling of oil spills as well as the associated contingency plans to be applied by oil and gas companies such as Woodside, Santos, to name a few; (2) water quality modelling in lakes/harbours/river for local and state governments; (3) industrial wastewater modelling (e.g. hypersaline discharge from salt farm, effluent from fish farms); and (4) search and rescue modelling for the Australian Maritime Safety Authority and the State Water Police operating throughout Australia and New Zealand.

The PhD students’ project aimed to produce an industry standard procedure for designing artificial water bodies connected to their adjacent estuary by navigation locks, flow structures or some combination of these. Specifically, the study area targeted a local man-made water body where a number of numerical modelling routines were developed and run to simulate the flushing within this water body. The study also involved physical modelling in the field to verify empirically developed models.

When questioned about the benefits of the current arrangement with regards to the conduct of the project, the student provided some very positive responses. This was reflected by comments like: *“Having the opportunity to conduct a PhD project in conjunction with a niche consultancy firm provided not only technical skills, but a diverse range of project management and administration competencies.... Two of the Company Directors have PhDs and are aware of the academic requirements of this rigorous research programme and have been great mentors in both a research and business sense. Moreover, my University supervisor has physical modelling expertise which complements the strong analytical modelling of my industry supervisors”* The candidate specifically

mentioned the benefits of being able to access resources from both the company and University, which was best described by the statement: *“I have access to very expensive modelling software through the company and the University has a marine vessel and associated measurement devices capable of experimental studies.”*

The student acknowledged a number of challenges he has faced during his project. The primary impediment appeared to stem from the candidate being largely embedded into the company where he was, over time, lured to undertake consultancy projects. A statement which reflects this issue was: *“In the first two years of study I was focused on my PhD studies and only did not some minor consultancy projects in my spare time. However, after demonstrating strong capabilities on some minor projects, during busy times, I began to put up my hand to undertake more and more projects to undertake after hours and eventually during my dedicated PhD time. In no time, my PhD programme became a secondary objective and I deferred it to work overseas for six months to manage a major project..... However, after some consultation with my University supervisor I have managed to regain focus on my PhD studies and will be submitting a draft version of my thesis soon.”* This response emphasises the importance of agreed values and conditions of project conduct right at the very commencement of the PhD project. This view was also expressed by the PhD candidates in the other case studies.

The PhD candidate offered a number of coping strategies that he now utilises to ensure that project milestones are met and quality academic outcomes are derived. The key point made was that: *“regular communication between both the University and industry supervisor and me is paramount to successfully completing my PhD..... Just as important has been the maintenance of a strong relationship between the two sets of supervisors. By being the glue between these two parties I am the best person to foster this relationship. They do not always see eye to eye on things but their healthy debate often leads to an innovative outcome which is attractive to both researchers and practitioners.”* The candidate recommended that for future projects, agreed principles need to be laid out at the very commencement of project initiation and that a formalised communication and reporting structure would ensure that PhD candidates do not stray too far from established project deliverable milestones.

As a final important finding that should be noted from this interview, this statement reflects that the student has no regrets that his project has taken longer than the traditional 3-3.5 timeframe of a typical Australian PhD programme: *“Whilst I sometimes feel that all parties associated with my project could have managed the process a little better, I would not change anything since my journey has involved exploring both an industrial and research agenda simultaneously. Thus, this ever diverging path has provided me with a skill set that puts me in a strong position to secure a higher level professional position within this or another company post PhD completion, which may not be true for all graduates of this programme that often appear to be too narrowly trained.”*

4. Structured WIRHD framework and approach

In an attempt to map out a more structured approach to the management of the various stages of the WIRHD projects, a contextual analysis was firstly conducted to examine relationships between parties. Following this, an approach was developed which attempts to mitigate the shortcomings of this form of PhD whilst leveraging its benefits. These aspects are discussed in detail in the following sections.

4.1 Contextual analysis

Based on the findings of the interviews, focus group discussions were undertaken with the two PhD candidates and their supervisors. The framework developed by McAlpine and Norton (2006) for analysis of traditional PhD programmes was presented to the groups at the beginning of the discussions. The purpose of the discussions was to guide the groups to link the issues (e.g. challenges and benefits) under investigation with the contexts of the WIRHD provision, and to identify the contextual factors that affect the learning experience of the candidates. The discussions resulted in the development of an integrative framework which reflects the unique composition of the WIRHD contexts. Figure 1 presents a graphical illustration of this integrative framework.

(INSERT FIGURE 1)

The groups agreed with McAlpine and Norton's (2006) proposition that the powerful supervisor-student relationship should be the central context, which is nested within three-tiers of department/discipline, University/Organisation and social/supra-societal contexts. As illustrated in Figure 1, the student's learning process involves both academic and industry supervisors, and is occurring within multiple nested contexts of both the university and the industry dimensions. Therefore, WIRHD candidates' learning is social and complex in nature. The organisational policies and culture of these contexts interact with each other and have potential to enhance or constrain the learning experience of both the student and the supervisors.

4.2 Proposed approach overview

Based on the understanding of these contexts of the WIRHD, the groups recommended a more structured approach to help both the student and their supervisors to manage the WIRHD process. Such an approach should include two core phases that consists of seven consecutive steps that facilitate heightened student learning and research outcomes. Figure 2 provides an overview of the proposed structured WIRHD approach, which is explained in detail in the following sections. Readers

should note that the below descriptions on each step are largely centred on the PhD degree. The MPhil will follow the same stepwise procedure but be less involved to meet the 1.5-2 year timeframe for this programme.

(INSERT FIGURE 2)

4.3 Phase 1: Research project initiation, design commercial agreement and partnering charter

4.3.1 Step 1: Preliminary project plan and commercial agreement

The applied nature of WIRHD projects requires vigorous dialogue between an academic and an appropriate industry supervisor, especially in the important first step of the process. An essential ingredient of a well designed WIRHD project is that the industry partner company allocates a supervisor to the project team that has a strong appreciation for research. In larger or specialist companies, industry supervisors with a Doctorate Degree or extensive research training are best suited. The reason why an appropriately qualified supervisor is pivotal for a successful WIRHD is that the partnered company research objectives must be carefully reviewed and refined by the academic supervisor to ensure that the research outcomes will be deemed sufficiently innovative that it adds to the specific research fields' body of knowledge, leading to publishable articles in high quality research journals and a successful PhD completion under the conventional examination process.

Equally important, the academic supervisor must be able to appreciate the applied research objectives of the company and can structure a research plan that may incorporate some application based deliverables also, within the typical PhD timeframe. Thus, the key enabler that will ensure that this discussion will be productive is that both the industry and academic supervisor recognises the values of the other partners' endeavours and viewpoints. Ideally, WIRHD projects will function most effectively when all supervisory parties have spent a portion of their career in both the academic and industrial sectors.

The project plan should also consider the resource requirements of the project. The core premise of the WIRHD project is the formation of a PhD scholarship with associated project support funds. The scholarship can be sought through Federal Government funding schemes such as the Australian Research Council (ARC) Linkage Project scheme, University scholarship schemes, direct industry funds or a combination of project funders. However, for larger collaborative projects, a number of WIRHD projects may be embedded as well as other project support staff research assistants and fellows. As a cautionary note, the larger collaborative projects should only be attempted by academics with robust project management skills in addition to their academic credentials.

The other key aspects of the project plan requiring careful consideration include: (1) developing a project schedule which provides sufficient flexibility, particularly in the early stages of the PhD, for the student to explore a wide range of research avenues before narrowing the research down to a definable direction; (2) identification and mitigation strategies for key project risks as well as ethical clearances that may need to be sought; (3) literature review and documented persuasion that the research topic is targeting a gap in the research; and (4) project team members and their responsibilities.

The final, but often most difficult, aspect of this step is the formation of the research project agreement covering commercial and intellectual property aspects. Intellectual property is often a key point of contention when industry partners are involved. Such property should not be assigned completely to the industry partner as this would go against the ethos of the PhD. Ideally, it should be predominately assigned to the PhD candidate with lifetime utilisation licences extended to University and industry partners. Alternatively, joint ownership could be negotiated, which has its merits as industry partners are often better at turning new knowledge into commercial products than Universities. As a final note, the PhD candidate must also agree to the intellectual property arrangements, thus this matter must be clearly explained to any potential candidates during the recruitment stage to avoid later conflict.

4.3.2 Step 2: Draft WIRHD project partnering charter

The interviewees all suggested the establishment of a project based partnering arrangement between the university and the industry partner to facilitate enhanced communication and co-operation between the two parties. According to the discussions, a partnering charter needs to be drafted and agreed by both parties as an expression of intent on how to behave in a spirit of mutual trust and co-operation. The charter specifies the objectives of the WIRHD project, outlines the duties and roles of the student, supervisors, as well as the department context of both university and industry dimensions, and establishes the principles for performance monitoring, information exchange and dispute resolution.

The charter is the most essential element of the proposed WIRHD approach. As with most other partnering charters utilised in business arrangements, it is not a form of contract or agreement, but a statement of the values and mechanisms which represent the spirit of the relationship. Some specific aspects that should be addressed in the charter include: communication channels; student issue resolution processes; relationship management procedures; supervision roles and responsibilities; student professional conduct expectations; level of direct supervisory support as well as other required support; to name a few. As a final note, only a draft charter can be formulated prior to the recruitment of the PhD candidate as their input is fundamental to its finalisation. However, it is advised that the supervisory team develop a draft charter prior to the PhD candidate being recruited so they can communicate a coherently aligned approach to project supervision and team communications.

4.3.3 Step 3: WIRHD candidate recruitment

As highlighted in Figure 1, the PhD candidate is central to any WIRHD project and the selection of the right candidate is paramount to its success. A candidate that may perform exceptionally well in a conventional PhD programme may not have the personal attributes to succeed in a WIRHD where strong communication skills and intuitive emotional intelligence is an essential driver of project outcomes. Therefore, ideal candidates for such WIRHD projects, should not only possess a high intellect and a background of research training usually required for conventional PhD entry, but other attributes which would suit an experienced engineering role with a company (e.g. leadership, high written and verbal communication skills, project management skills, etc.). Obviously, to attract such a candidate with this wealth of skills the offered PhD scholarship should be of considerably higher value than the basic government scholarships currently offered in Australia and elsewhere. As a final note, the recruitment process must include the involvement of both the academic and industry supervisor during the short listing, interviews and selection stages, in order to foster industry partner buy-in to the research project arrangements.

4.3.4 Step 4: Finalise WIRHD project plan and partnering charter

Once the recruited PhD candidate has accepted their scholarship and just prior to formal project commencement, the project plan, commercial agreement and partnering charter documents should be revisited. This step is essential for WIRHD projects to ensure that the PhD candidate is familiar with all of the various sections of the project plan, commercial agreement and partnering charter and that their comments and concerns are adequately incorporated or addressed, respectively. This last step ensures student buy-in to the WIRHD project plan, commercial agreement and charter is secured prior to formal research commencement.

4.4 Phase 2: Research project conduct and delivery

4.4.1 Step 5: Project induction workshop

A logical first step for the project is to conduct an induction workshop for the student and supervisors as well as the formed Project Reference Group (PRG) associated with the project. This group should include relevant academic and industry professionals, which may provide insightful input to the project at the annual review symposiums and at other times, to ensure that the WIRHD project is covering all aspects of the research at hand. The induction workshop is also an opportunity for relationship building and to set the scene for the subsequent conduct and delivery for the research. Any potential issues should be addressed here, such as additional training and support that may need to be provided for the student. Depending on the nature of the research study, the student may need training in the use of specialist software tools and equipment. Such training should be completed in the

early stages of the project to maximise research accuracy whilst reducing error and the consequent requirement for rework.

4.4.2 Step 6: During year conduct

During year conduct activities in the proposed WIRHD approach is very similar to the traditional PhD process in Australia, having a weekly (or bi-weekly) meeting between the supervisors and student. However, it is a little more rigid in structure in that it requires a quarterly workshop with short informal seminar and milestone report to be completed by the student. This activity is generally not a requirement in the conventional PhD programme in Australia but informal presentations by research students to their peers is often conducted within Faculties or Research Centres. The benefit of the presentations and seminars is more for the student to reflect on their conducted research activities, direction and progress to date. Additionally, project management aspects, particularly past and possible future issues and constraints should be tabled and addressed. Moreover, the workshop provides an opportunity for the supervisors and members of the PRG to attend and provide commentary to the project. This measure should ensure that the WIRHD student maintains focus, particularly in the difficult early stages of their research, facilitating a timely PhD or Master of Philosophy (MPhil) completion.

4.4.3 Step 7: Annual review symposium

The annual review symposium is often used by Australian and international Universities as a means to review the various stages of the research. As with some countries, it is not common in Australia to have a “Research Defence” as part of the examination process, but this may be conducted informally as part of the PhD programme. The proposed WIRHD structure proposed herein aims to formalise three review symposiums as WIRHD Project Gateways, that occur after the first, second and third year of study (six months either side permitted).

The first year gateway is the confirmation symposium and report whereby the student presents/reports on their first year of study, consisting predominately of their literature review, persuasion for research, project aims and method, as well as any pilot studies conducted. This is the most important of the three proposed gateways since it requires the student to demonstrate that their research investigation is innovative, tightly scoped, and deliverable within the resource and time constraints. Some research projects may require major revisions at this stage, and in a very few number of cases usually where the relationships are damaged beyond repair and the project has become directionless, it may be prudent not to confirm the project, thereby decommissioning it and requesting the student undertake a conventional PhD in a different topic area or cancelling their enrolment where their individual performance has been well below standard.

The second year gateway is a project progress review that should be largely focused on the outcomes of the experimental/data collection stage, such as data analysis techniques, sources of errors, preliminary research findings, to name a few. The PRG are particularly important at this stage as they will be able to provide constructive criticism as well as point out the implications of the research to both the industry and society at large. Suggestions on any deviations in research direction should be limited at this stage as stakeholder input should be more focused on adding value to the study outcomes. As a final note, it would be expected that after the second gateway review the WIRHD candidate should be near the end of their data collection phase and have a very clear vision on the structure and content of their final PhD report that they should commence writing within six months from this seminar.

Approximately three months prior to the completion of the WIRHD project, the candidate should complete their final review and seminar. This final gateway review provides an opportunity for the WIRHD candidate to present to the supervisory team and PRG the outcomes of their research study. It is not proposed that this be a part of the formal thesis examination process, but could be conducted in a similar manner to a thesis defence. However, the purpose of this symposium is more focused on tightening any weaknesses in the research and including any required minor research additions. Also, the final seminar offers an opportunity for the supervisors and PRG to provide comments as to possible future research that could be conducted in subsequent studies. A successfully managed and delivered WIRHD may result in the creation of larger research projects and funding.

Shortly following this final step in the proposed structured WIRHD approach, the candidate will submit their thesis to the University. The thesis will then be examined in a similar way to the long-established process conducted in Australia. This involves an examination of the thesis by two or more independent academics that have expertise in the field of research. These academics provide a written assessment on the thesis to the University, which is moderated by an internal Chairperson of Examiners. This process is fundamentally similar to the peer review process conducted by high quality journals.

5. Conclusions, implications and future work

5.1 Conclusions

In response to the call for ensuring engineering doctorates' relevance to today's competitive environment, the WIRHD has emerged in an informal manner and is perceived as a vehicle for contemporary research students to develop both high-level professional capabilities in a real industry environment as well as strong research skills, which create knowledge through original research of academic rigour. For this very reason, the WIRHD study is both a rewarding and challenging journey

for its candidates. Like Lester (2004) pointed out, that on one hand, they need to engage with the knowledge-in-use that thinking practitioners develop and use in the course of their work; whilst on the other hand, they need to meet an academic requirement that normally rests on notions of advanced scholarship and extending the boundaries of knowledge. The WIRHD graduates have potential to develop their career as ‘professional researchers’ or ‘research professionals’ depending on their focus of attention during their research process, in particular their personal career development interests. The case study on the three on-going WIRHD projects in Australia revealed that the students experienced unique challenges caused by the complicated contexts of the WIRHD. Factors such as organisational policies and culture issues in both the university and industry contexts could enhance or constrain the learning experience of the students. In addition, the study determined that strong skills in project management, interpersonal communication and time management are essential for successful WIRHD studies. The outcomes of the case studies was a structured WIRHD approach that included two phases and a total of seven steps which served to better manage the distinctive research process.

5.1 Implications

The study developed a well structured partnering approach for facilitating enhanced communication and co-operation between the university department and the industry partner organisation. It is expected that the implementation of this partnering approach would build the necessary infrastructure to formalise the research-based learning experience of WIRHD candidates. Through this infrastructure university and industry partners could communicate and co-operate more effectively and efficiently, and consequently develop a stronger partnership. The improved contextual environment would facilitate the learning process of the students, and help to improve their degree of satisfaction. These outcomes would increase the number of opportunities for the university to develop more jointly funded research projects. These work integrated research projects would offer the students a wealth of experience in both academia and industry, hence could significantly improve their employability for a wider array of jobs at graduation. Although the case studies and structured WIRHD approach were based on the engineering discipline, it is expected that the core findings/outcomes contained within this paper would translate to a range of other professional disciplines. In view of this, the framework for the WIRHD programme developed initially in the context of engineering, and the knowledge and experience gained through its implementation could be highly transferable to other programmes and schools across the various disciplines. A new federally recognised and funded WIRHD programme is possible in the longer term.

5.3 Future Work

Future research is required to better specify the principles and strategies for WIRHD projects, and examine the effectiveness of this distinctive programme, through comparisons with traditional RHD and professional doctorate programmes. Further research studies currently underway by the authors

include mapping further experiences of informally managed WIRHD candidates in Australia and at overseas universities. Based on the findings a draft policy framework and manual for the WIRHD programme can be developed. A pilot roll-out of the formally managed WIRHD programme and associated approach can be undertaken to investigate its feasibility in the wider Australian University context as well as the suitability of the framework and manual in terms of enhancement of learning and teaching practices, procedures and environments. Moreover, the learning outcomes and satisfaction of the pilot roll-out will be evaluated and compared against a sample of traditional RHD as well as professional doctorate candidates. Supported by the outcomes of the pilot programme roll-out and candidate evaluations the WIRHD framework and manual will be refined with the view to implement the programme across a range of disciplines and Universities.

References

- Akay, A., (2008). A renaissance in engineering PhD education. *European Journal of Engineering Education*, 33(4), 403-413.
- Abanteriba S. (2006). Development of strategic international industry links to promote undergraduate vocational training and postgraduate research programmes. *European Journal of Engineering Education*, 31(3), 283-301.
- Altbach, P. G. (2004). Doctoral education: present realities and future trends. *College and University*, 80(2), 3-10.
- Biggs, J. and Tang, C. (2007). *Teaching for quality learning at university : what the student does*. Buckingham, UK: McGraw-Hill/Society for Research into Higher Education & Open University Press.
- Boud, D. and Tennant, M. (2006). Putting doctoral education to work: challenges to academic practice. *Higher Education Research and Development*, 25(3), 293-306.
- Gardner, S. K. (2008). "What's too much and what's too little?": the process of becoming an independent researcher in doctoral education. *The Journal of Higher Education*, 79(3), 326-350.
- Haksever, A. M. and Manisali, E. (2000). Assessing supervision requirements of PhD students: the case of construction management and engineering in the UK. *European Journal of Engineering Education*, 25(1), 19-32.
- Kerr, C.I. and Ivey, P.C. (2003). The engineering doctorate model of consultant/researcher/innovator/entrepreneur for new product development – a gas turbine instrumentation case study, *Technovation*, 23 (2), 95-102.
- Kolmos, A. Kofoed, L.B. Du, X.Y. (2008). PhD students work conditions and study environment in university- and industry-based PhD programmes, *European Journal of Engineering Education*, 35(5), 539-550.

- Lee, A., Green, B. and Brennan, M. (2000). Organisational knowledge, professional practice and the professional doctorate at work, in: I. Garrick & C. Rhodes (Eds) *Research and Knowledge at Work: perspectives, case studies and innovative strategies* (London, Routledge).
- Lester, S. (2004). Conceptualizing the practitioner doctorate. *Studies in Higher Education*, 29(6), 757 – 770.
- McAlpine, L. and Norton, J. (2006). Reframing our approach to doctoral programs: an integrative framework for action and research. *Higher Education Research and Development*, 25(1), 3-17.
- Manathunga, C. and Lant, P. (2006). How do we ensure good PhD student outcomes? *Education for Chemical Engineers*, 1 (1) 71-81.
- Pearson, M. (2005). Framing research on doctoral education in Australia in a global context. *Higher Education Research and Development*, 24(2), 119-134.
- Schäfer, A. I. and Richards, B. S. (2007). From concept to commercialisation: student learning in a sustainable engineering innovation project. *European Journal of Engineering Education*, 32(2), 143-165.
- Maxwell, T. (2003). From first to second generation professional doctorate. *Studies in Higher Education*, 28(3), 279-291.
- Walker, D. H. T. (2008). Reflections on developing a project management doctorate. *International Journal of Project Management*, 26(3), 316-325.
- Wellington, J. and Sikes, P. (2006). 'A doctorate in a tight compartment': why do students choose a professional doctorate and what impact does it have on their personal and professional lives? *Studies in Higher Education*, 31(6), 723-734.
- Wright, T. and Cochrane, R. (2000). Factors influencing successful submission of PhD theses. *Studies in Higher Education*, 25(2), 181-195.

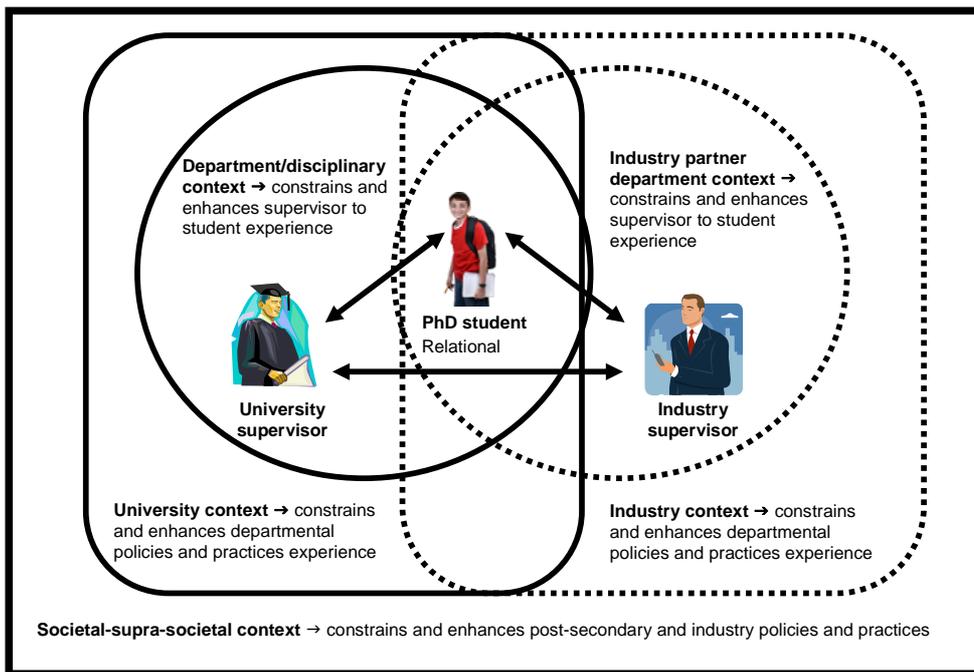


Figure 1. Multiple nested contexts for the WIRHD student

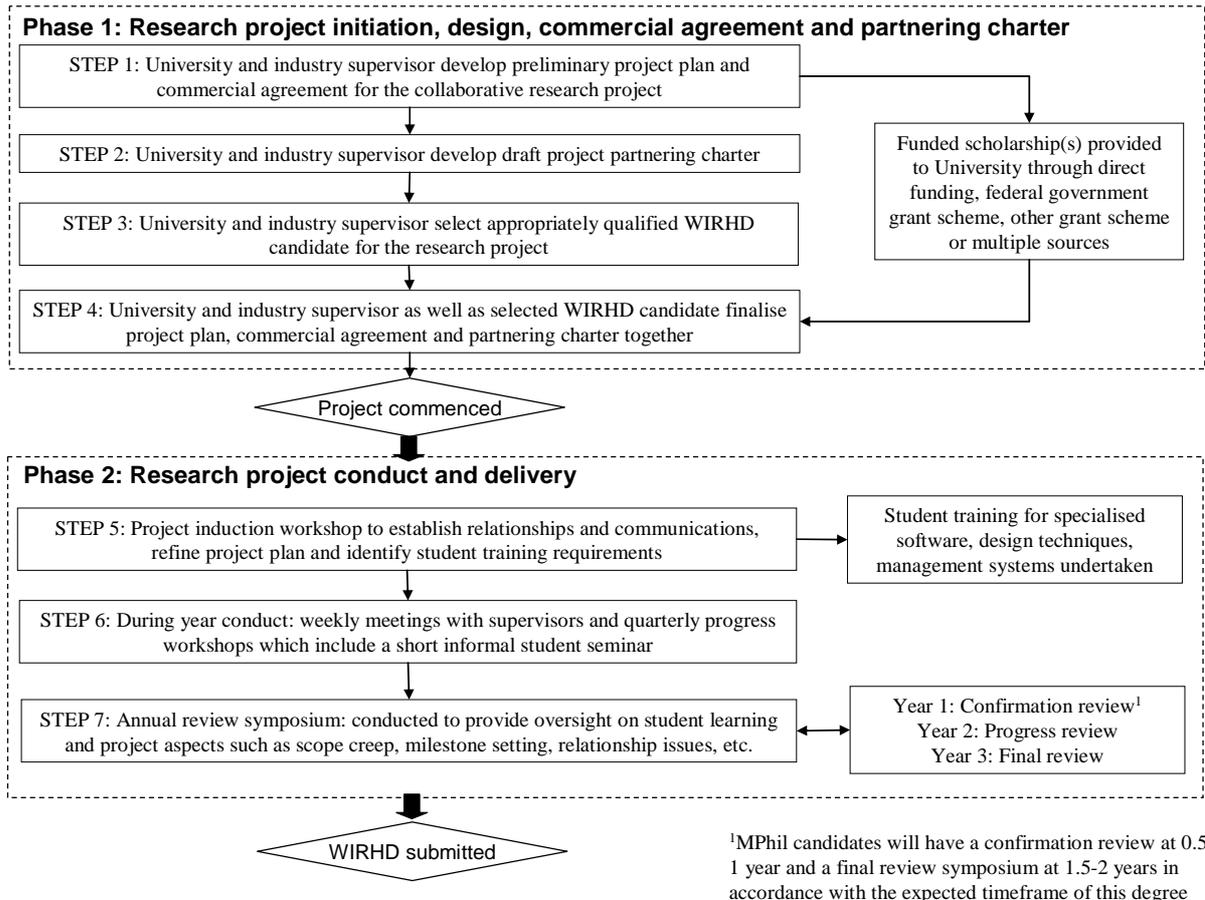


Figure 2. Structured WIRHD approach