



# **Reconciling Image with Innovative Need**

**How Employers Determine the 'Fit' of Engineering Higher Degree  
by Research Graduates for Industry**

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## List of Acronyms

ACED	Australian Council of Engineering Deans
ADTP	Australasian Digital Theses Program
ARC	Australian Research Council
BAA	Backing Australia's Ability
BHERT	Business/Higher Education Round Table
CRC	Collaborative Research Centre
DEST	Department of Education, Science and Training
DETYA	Department of Education, Training and Youth Affairs
DITR	Department of Industry, Tourism and Resources
EHDR	Engineering Higher Degree by Research
EHDRG	Engineering Higher Degree by Research Graduate
GTM	Grounded Theory Methodology
HDR	Higher Degree by Research
HR	Human Resources
IPR	Intellectual Property Rights
KBE	Knowledge-Based Economy

## **Abstract**

A substantial proportion of engineering higher degree by research (HDR) graduates indicate an interest in a career in business and industry. However, little of substance is known about the ways these graduates and the engineering work they perform are perceived and valued by their industry employers. The purpose of this study was to research the beliefs and perceptions of employers of engineering HDR graduates, in order to gain a more complete understanding of how they perceive the abilities developed through higher degree by research study to contribute to the Australian industrial workplace.

Constructionist grounded theory methodology was used to explore the perceptions of 22 employers of research masters and PhD engineers in the fields of mechanical and chemical engineering in two major urban settings, both strong manufacturing and science and technology centres in Australia. The participants were located in a range of workplace contexts: consulting engineering firms, manufacturing firms, public utilities and government funded research organisations.

The study revealed that the employers viewed their engineering HDR employees with positive regard, but maintained a number of ‘theoretical’ concerns about engineering HDR graduates in general. Their concerns mainly emanated from (a) beliefs about the nature of engineering problem solving and how it contributes to the innovative needs of their workplaces, and (b) beliefs about, or the image of, personal characteristics of engineering HDR graduates. With respect to these latter beliefs, it is argued in this thesis that the employers maintained idiosyncratic, implicit personal theories of engineering HDR graduates. When considering accommodating engineering HDR graduates in the workplace, the employers resolved their concerns by engaging in a process of reconciliation between these two sets of beliefs.

The reconciliation process occurred in three stages: establishing innovative context, invoking personal theories and determining workplace fit. The employers were found to accommodate engineering HDR graduates to different extents, depending on the following factors: the value the employers placed on creativity to achieve workplace outcomes; the employers’ tolerance of the perceived personal attributes they

associated with engineering HDR graduates; and the perceived costs they perceived to the workplace of engineering HDR graduates who display personal creativity attributes. A decision pathway, or algorithm, is hypothesised in this thesis that illustrates the way these factors are taken into account by the employers.

In keeping with grounded theory research practice, each of the stages detailed in the thesis is then shown to elaborate, extend or challenge notions found in extant literature on creative achievement, implicit theories of creative people, and recruitment biases. The findings are also argued to contribute to the literature on HDR graduates' employability and, in particular, to what is already known from studies of industry collaborative PhD programs.

## **Thesis Declaration**

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Karen Adams and, to the best of my knowledge and beliefs, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying, subject to the Provisions of the Copyright Act 1968.

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Karen Adams



## Publications

The following publications arose from this study:

Adams, K., Ripper, M., Zander, A.C.& Mullins, G. (2010). ‘The value of creativity in the workplace roles of engineering research graduates’, *Educating Engineers for a Changing World*. In Refereed Proceedings of the 3rd International Symposium for Engineering Education 2010, University College Cork, Ireland, June 2010

Adams, K., Mullins, G. & Zander, A. (2008). ‘Postgraduate research education and the engineering workplace: employers’ perspectives’, M. Kiley and G. Mullins (Eds.), *Research Education in the New Global Environment*. In Refereed Proceedings of the 8<sup>th</sup> Quality in Postgraduate Research 2008 Conference, Adelaide, April 2008.

Adams, K., Zander, A. & Mullins, G. (2007). ‘What do engineering postgraduate research students know about industry work?’, H. Sondergaard and R. Hadgraft (Eds.), *Connecting Teaching, Research and Industry through Engineering Education*. In Refereed Proceedings of the 18<sup>th</sup> Conference of the Australasian Association of Engineering Education. Melbourne, December 2007.

Adams, K., Zander, A. & Mullins, G. (2006). ‘The professional expectations and experiences of Australian postgraduate research students in engineering fields’, In Refereed Proceedings of EDU-COM 2006 International Conference, Nong Khai, Thailand, November 2006.

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# Chapter 1: Introduction

Universities in Australia have long been exhorted to produce graduates at all levels who display qualities deemed valuable by the industrial sector. Consistently highlighted amongst these qualities, and considered by industry employers to be lacking in graduates, are abilities that are tangential to the constitutive knowledge and skills of academic disciplines, such as leadership, communication and teamwork skills. HDR graduates have been further criticised for maintaining narrow interests that are largely irrelevant to the needs of industry employers (Akay, 2008; Gallagher, 2000). However, concurrently with concerns about an academically tangential skills deficit, engineering and science graduates (Hare, 2011; Martin & Johnston, 1999) and HDR graduates in general (Farrell, 2007; Kemp, 1999b; Tyler, 1998) have been extolled as particularly important contributors to economic progress in industrialised countries. This is largely through their capacity to generate knowledge-driven, innovative developments that lead to competitive advantage.

Except for the deficit noted in academically tangential skills, and despite the importance attached to the applicability of the knowledge and skills of engineering HDR (EHDR) graduates for industry work, very little of depth and specificity is known about what employers of EHDR graduates value in them and how they perceive the contribution of these graduates to the engineering workplace. In addition to contributing to the enhancement of industry innovation, such knowledge would be valuable for current and potential engineering HDR students, more than half of whom seek employment in industry, in Australia and elsewhere (Lapidus, 1997; Nerad, 2004; Pitt et al., 2010).

## 1.1 Aims and purpose of the study

The research presented in this thesis was prompted by changes to HDR education that occurred within Australian universities in response to concerns about the quality of candidates' experiences and the relevance of HDR study to non-academic work. The resulting debate between concerns for relevance and employability, and concerns about the nature and integrity of discipline research, led me to question the

extent of current understanding of the employability of engineering HDR graduates. The purpose of this study was to explore, in depth, the perceptions of EHDR graduates held by those who employ them. It aimed to generate a substantive grounded theory that explains the ways employers perceive the knowledge, skills and attributes of mechanical and chemical engineering research graduates in the industrial workplace.<sup>1</sup>

The research presented in this thesis was originally conceived as part of a different study. The aim of the original study was to explore the alignment between the views of EHDR students, academics and engineering employers and their understandings of the relationship between HDR study in engineering and the workplace. I took, as my starting point, HDR students' expectations of their higher degrees for future work and what they felt were workplace-relevant experiences. I then turned to employers in an attempt to capture some initial sense of the engineering workplace environment. I soon came to realise that my initial aims for the study were far too ambitious, and that the views of employers were worthy of in-depth exploration in their own right. The research presented here focuses on employers' views, but also makes use of the findings of the focus group discussions with engineering HDR students that reveal their career aspirations. These add depth and relevance to the findings from the study of employers.

### **1.1.1 Approach to study**

I approached this research with an assumption that employers would seek EHDR graduates for specific roles that made use of their advanced knowledge and skills. I was aware of the academic literature and professional engineering publications that emphasised the need for the development of generic abilities in engineering graduates (for example, DETYA, 2000; Beder, 1999, and particularly for good communication and interpersonal skills. I also assumed that engineering HDR graduates were sought, at least temporarily, if their research experience was directly linked to the work conducted by specific organisations and would, for example, meet a particular research need of a sponsoring company. In this study, I aimed to move

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<sup>1</sup> In this thesis, the term 'industry' is used to connote workplaces that are not primarily concerned with academic work, such as teaching and research within a university environment.

beyond general industry requests for generic workplace capabilities, to determine the following:

- What is different about the work requirements for new EHDR graduates compared to those for commencing undergraduate qualified engineers? In other words, is there anything special that EHDR graduates bring to the workplace?
- How is their higher level of engineering knowledge and skill put to use?
- What are employers' perceptions of the value of EHDR graduates to industry work?

The research questions were deliberately kept open and somewhat inchoate in nature. This was in keeping with the inductive approach taken in the study, which was conducted using constructionist grounded theory methodology (Charmaz, 2000; Charmaz, 2006). This methodology, explained extensively in Chapter 3, was chosen because it allows an open inquiry that admits views, beliefs and perspectives not previously heard in discussions about EHDR graduate employability. The research questions were applied to a study in the Australian engineering and industry context. However, they have relevance for EHDR education in other industrial economies where concerns have been raised about the preparation and suitability of EHDR graduates for industry work.

## **1.2 Significance of the study**

This study has academic, practical and methodological significance. Within the higher education academic context, a refined understanding of employers' views informs the ways in which engineering research candidates consider their future professional roles, thus assisting those who are considering work in a non-academic engineering environment to gain awareness of employers' expectations of them. Although this study does not assume that the aim of the research education process is to prepare workers for industry, it does assume that research candidates can benefit from sound general knowledge of the potential professional work in which they might engage. In addition, a clearer understanding of employers' concerns that

specifically relate to engineering HDR graduates can better assist universities in developing programs that meet the needs of the industry workforce.

In a practical sense, this study explores the relationship between the notions of new knowledge creation and engineering innovation in the industrial workplace. The relationship is realised through the integration into the industrial workplace of the knowledge and skills developed in the research education environment. This integration is assumed here to make use of the following: the products of EHDR graduates' research work; the cognitive skills and strategies mastered during HDR candidature; the ways these outcomes of candidature are conceptualised and valued by employers; and the type of innovation that occurs in a particular workplace.

Within the area of higher education and work, this study appears methodologically unique in its attempt to build theory from an exploration of employers' beliefs about and expectations of HDR graduates, based on their experiences of working with these graduates. The use of an inductive, qualitative methodology posed challenges for me as a researcher working within the engineering workplace and academic contexts. Most engineering academics and workers in engineering fields engage in positivist, quantitative, experimental research work. Hence, they are unfamiliar with qualitative, interpretive social science research designs. Nonetheless, the methodology also provided the opportunity to transgress barriers to better understanding of the social context of engineering work and study, and to introduce a longstanding research methodology to engineering education.

Grounded theory methodology (GTM) has been used in management and organisational research for a considerable time. This is due to its ability to reveal insights into complex and dynamic social processes, driven in part by personal motivations of the participants engaged in these processes. The methodology has been introduced to technical research, with a notable body of work using GTM found in the field of software engineering (Seaman, 1999). Examples include a study of software process improvement in organisations (Coleman & O'Connor, 2007), the use of electronic data interchange (Crook & Kumar, 1998), in information systems research (Urquhart, 2007), and in systems engineering to develop an interpretive framework for the evaluation of non-sequential process models (Galal, 2001). Nonetheless, the comfortable, established position of the quantitative, positivist

approach in engineering culture was evident in the workplace and academic arena throughout the completion of the present research.

### **1.3 Thesis structure**

This thesis consists of eleven chapters. What follows is an overview of the remaining ten chapters of the thesis.

Chapter 2 presents the background and context for the present study. Literature is reviewed concerning the political, economic and industrial concerns that combine to create the various pressures on HDR education. A brief review is provided of the outcome of programs to foster employability attributes in HDR graduates, and particularly programs that make use of university-industry collaborations, to reveal employers' engagement with the process of graduate development. Demographic information is provided about engineering courses at the university level and the prevalence of engineering HDR graduates in the current industry workforce.

Chapter 3 describes the methodological approach taken in the research presented in this thesis. It explains the epistemological underpinnings of this study, and contrasts paradigmatic differences between interpretive and positivist inquiry. The chapter continues by explaining the approach to data analysis taken in constructionist GTM and the role of explicit researcher reflexivity in arriving at research outcomes.

The findings of a preliminary study are presented in Chapter 4. Two focus group discussions were conducted with engineering HDR candidates in chemical and mechanical engineering schools in a large and long established Australian university. As well as serving as a scoping exercise for the study of employers, the focus group discussions provided interesting and relevant insights from the students' perspectives about employability and HDR education. These perspectives are discussed later in the thesis and contrasted with employers' concerns about engineering HDR graduates.

Chapter 5 details the methods used to conduct the employer study and presents sampling, recruitment and interview strategies undertaken in this study. The guiding interview questions are listed, and issues that arose during the interview process are

also revealed in the chapter. Demographic information is provided about the employers who participated in the study. Although such chapters are frequently omitted from the presentation of grounded theory studies, such a chapter is included in this thesis because it provides information for readers who are more familiar with experimental research and prefer to familiarise themselves with this type of information prior to reading the results of a study.

Chapter 6 provides an overview of the emergence of the theory of ‘Reconciling image with innovative need’. This is described through a process of constant comparison and revision of data that led to the identification of three key stages and their categories that form the theory. These stages are ‘Establishing context’, ‘Invoking implicit personal theories’, and ‘Determining workplace fit’.

Chapter 7 elaborates the stage of ‘Establishing context’ by illustrating the different emphases placed on the originality of innovative outcomes sought by the various employers. The chapter presents the argument that an employer’s understanding of the nature of the innovation sought is, to an extent, personally constructed as well as organisationally constructed. The chapter continues by illustrating the employers’ different understandings of the approach needed to achieve the innovative outcome they sought. Two approaches were identified, ‘received’ and ‘intrepid’, and these are explained in the chapter.

Chapter 8 elaborates the stage of ‘Invoking implicit personal theories’. This is a process undertaken by the employers that reflects their idiosyncratic beliefs about EHDR graduates and their predictions of the impact of these graduates on the workplace. These beliefs are formed from notions entertained by the employers about the personal characteristics and work practices of EHDR students and university academics.

An elaboration of the process of ‘Determining workplace fit’ is presented in Chapter 9. In this process, the employers verified, through a series of tests and strategies, the presence or absence of concerns or talents originally ‘imaged’ in the graduates. The process reveals the way that employers’ personal judgements underpinned their views of the value of EHDR graduates and, in particular, how employers who sought



originality in engineering outcomes were more tolerant of the perceived troublesome characteristics than were the employers who did not seek originality.

In keeping with the requirements of grounded theory research, the findings of the study are contrasted with relevant extant literature in Chapter 10. Three themes found in the literature are shown to add depth to the substantive process of ‘Reconciling image with innovative need’: the construct of creativity from a social psychology perspective, the theory of implicit person theories and stereotyping, and the literature that examines the outcomes of attempts to integrate industry-relevant qualities into HDR programs. The substantive theory extends the first two themes evident in this extant literature by illustrating the complex dynamic in which these theoretical notions are enacted in a substantive situation. The findings of this study contribute to the third theme by deepening current knowledge of the ways EHDR graduates are perceived by industry employers. The findings also explain and elaborate the processes that are determined idiosyncratically by individual employers’ beliefs.

Chapter 11 presents a final discussion of the findings and their relevance to the debate in higher education about the employability of EHDR graduates. The findings of the research present an alternative reading of employers’ concerns about EHDR graduates to those commonly expressed in extant reports. The findings also offer an alternative view of EHDR students’ approaches to work and HDR study that better acknowledges both their professional and intellectual motivations for undertaking HDR study. The outcomes of the study are of relevance to EHDR graduates, universities, industry employers and government policy makers. The argument is put forth that attempts to enhance creative innovation in industry by preparing more employable EHDR graduates would benefit from a more informed and considered industry perspective on the value of EHDR graduates. Based on the study findings, such innovation would be best served by an emphasis on the components of creative problem solving during candidature and simultaneously by efforts to disavow employers of inaccurate, discrediting personal images of EHDR graduates. The chapter concludes with suggestions for possible directions for future work.

## Chapter 2: The Substantive Context

In a grounded theory study, literature is reviewed to provide an overview of the substantive context in which the research is undertaken. In its attempt to explain industry employers' beliefs and attitudes concerning EHDR graduates, the present study is situated in a context that is constructed by the fields of higher education and economics. It considers the impact of these fields on concerns about HDR graduate employability expressed by universities, governments and industry figures.

This chapter reviews literature concerning the political and economic influences that shape demand for HDR graduates in industry. It then discusses literature that promotes development of 'industry readiness' in HDR graduates and literature that challenges the appropriateness of such developments. This critical review reveals that, although employers' concerns are privileged in relevant policy documents, they are poorly understood and have never been well researched. Thus, what is perhaps most notable in this chapter is what is absent from it. When it comes to employers' beliefs about the value of HDR graduates, much has been said about very little. Many employer surveys have identified shortcomings in HDR graduates in general (for example, Mann et al., 1994; NAS, 1995); those relevant to the Australian context are outlined in Section 2.4. However, little has been written about the value of characteristics of EHDR graduates to industry; notwithstanding the deficit in HDR abilities identified in the survey responses, EHDR graduates have long been engaged in industry work. In many industrialised countries, 40–60% of PhD graduates are in the sciences and engineering disciplines, with up to two thirds of EHDR graduates employed outside of academia (Lapidus, 1997; Mangematin, 2000; Nerad, 2004; Pitt et al., 2010; Thune, 2010). This suggests that employers who engage EHDR graduates believe that they contribute positively to the engineering workplace, and the views of these employers were explored in the research presented in this thesis.

In the absence of a comprehensive understanding of employers' views, the literature reporting attempts to develop graduate employability in engineering HDR programs is considered in this chapter, because it reveals valuable insights into industry partners' views of HDR candidates and experiences. The few sources of employer

perspective are then critically evaluated. Finally, general information about Australian EHDR graduates and engineering workplaces is provided in order to provide the background context for the present research.

## **2.1 Political, economic and industrial contexts**

As is the case in industrialised nations elsewhere, Australian policy rhetoric has long promoted knowledge and innovation as a means of increasing economic competitiveness. The promotion of this position is consistent with the notion of a knowledge based economy (KBE), defined as ‘...an economy in which the production, distribution and use of knowledge is the main driver of growth, wealth creation and employment across all industries...’ (Wood, 2003, p. 147). The theoretical underpinning of the notion of knowledge as an economic driver is found in endogenous (or new) growth theory, which postulates that knowledge is a capital resource and that ‘economic growth results from the increasing returns associated with new knowledge’ (Cortright, 2001, p. ii). One perspective on endogenous growth theory that is particularly relevant to the applied sciences, including engineering, is its emphasis on the positive effect of innovations in technology on economic growth:

It seems to us—as indeed it did to Schumpeter (1934), Solow (1970, p. 33), and countless others—that improvements in technology have been the real force behind perpetually rising standards of living. Additionally, we believe that most technological progress requires, at least at some stage, an intentional investment of resources by profit-seeking firms or entrepreneurs. This perspective has led us to join Romer (1990), Aghion and Howitt (1992), and others in developing formal models that cast industrial innovation as the engine of growth. (Grossman and Helpman, 1994, p. 24)

Although none precisely defines ‘innovation’, Grossman and Helpman (1994), Pack (1994), Cortright (2001) and Solow (1994) refer to ‘new’ products, inventions or systems as the benefits of a strong KBE. However, much of the innovation that occurs in Australian businesses involves adapting products developed in other countries; less than 2% of all innovative developments in Australian businesses contribute new knowledge in an international context (Cutler, 2008) and less than 20% is new to a relevant industrial context (DITR, 2007). Given that only aggregated information is available for all innovation in all industries in Australia, it is

reasonable to assume that only a fraction of this new knowledge innovation occurs in engineering-related activity.

The nature of adaptive innovation, which predominates in industry and is restricted to the adaptation of existing technologies to new situations, contrasts with the basic aim of a traditional PhD project, which is to make an original contribution to a field of knowledge (Chubb, 2000, cited in Clark, 2000; Evans, 2000; Gilbert et al., 2004; Kehm, 2005). It also contrasts with the apparent aims of government attempts to enhance innovation through more focused preparation of HDR graduates for industry. For example, in the Australian policy document *Knowledge and Innovation: A Policy Document on Research and Research Training*, Kemp (1999b, p.3) commented that 'The producers of knowledge are critical players in our national innovation system, providing the ideas and techniques which can be transformed into economic advancement'.

Knowledge based economies require organisations committed to the production of knowledge through systems that tap into workers' existing knowledge and encourage continued learning and sharing of knowledge throughout the organisation — in other words, to developing, valuing and networking human intellectual capital. Alvesson (2004) categorises two types of 'knowledge organisations': professional services, characterised by their provision of specialised knowledge through consultation with clients in areas such as law, accountancy and management; and research and development firms that apply knowledge to science-based and technology products. He places engineering work into both categories, and the present study reveals additional complexity to this simple dichotomy.

The importance to national economic growth with which HDR education in engineering disciplines is considered was highlighted in submissions to the 1998 Review of Higher Education Financing and Policy, the West Review (West, 1997), a precursor to Kemp (1999a; 1999b). These submissions called for a broad range of employment related generic skills and personal attributes deemed desirable in both graduates and postgraduates, such as problem-solving ability, motivation and communication skills (BHERT, 1997). Submissions also called for funding for university infrastructure and technology to allow research to remain regionally competitive (ACED, 1997) and closer collaborations between universities and

industry in general, with further development of 'industrial' postgraduate programs tailored to meet the needs of industry (Walker, 1997). The substance of the submissions reflected what Brennan et al. (1988) earlier described as a common assumption, presented in the literature relating engineering education to industry, that engineering and applied sciences postgraduates need to be appropriately trained to meet perceived industry needs (Farrell, 2007; Osborne, 1997; Whiston, 1993).

The economic impact of these policies, which promoted the development of a national KBE, was felt by Australian universities following federal government policy changes to the funding of research training in Australian universities (Kemp, 1999b). The changes also linked the level of funding of HDR education to rates of degree completion, demanded shorter HDR completion times and required universities to produce management plans for research training which, amongst other aspects, identified provision for training in generic, transferable skills. Park (2005) noted similar pressures in UK universities.

Investment in science and applied science research continues with the aim of further encouraging innovation in these fields. For example, in Australia between 2001 and 2011, government funds committed to research investment were largely directed at engineering developments (BAA, 2005; DEST, 2007). The emphasis placed on engineering and technology innovation was consistent with a belief in the argument put forth by endogenous growth economists that investment in knowledge for technological development is the means to continuous economic growth.

### **2.1.1 International perspective**

Australia is not alone in linking doctoral education in science and technology to national economic prosperity: '...governments in virtually all parts of the world are focusing on the potential of the university as a resource to enhance innovation environments and create a regime of science-based economic development' (Etzkowitz et al., 2000, p. 314). Most OECD countries reported increases to government expenditure on higher education and research and development (OECD, 2005, cited in Davis et al., 2006, p. 232) , with a concomitant pressure exerted in particular on conventional (non-industry linked) doctoral training reported in, for

example, the United Kingdom (Park, 2005), Germany (Enders, 2002), Canada (Allen et al., 2002) and New Zealand (Lockhart & Stablein, 2002).

In the USA, doctoral education was simultaneously reported to be necessary for the social and economic wellbeing of society, with a warning that employment for doctoral graduates in the traditional areas of science and technology research was falling, not only in academia but also in research institutes (NAS, 1995; Salters, 1997). The National Academy of Sciences report (NAS, 1995) called for changes to graduate education to provide more versatile, career-ready graduates, and recommended funding changes to support this move in graduate education in the fields of science and engineering. More recently, Akay (2008) advocated increased emphasis on improving engineering PhD education in the USA to maintain American technological and economic predominance:

To maintain our edge as innovators in an increasingly competitive environment—and to adequately prepare the engineers of this century—we must re-examine how we educate our PhD engineering students and do what is necessary to ensure their relevance in today’s world. (Akay, 2008, p. 404)

Similar trends were found in Europe at the end of last century: a lack of academic post-doctoral positions for graduates, demand for knowledge to boost economic competitiveness (Whiston, 1993), the drive to produce graduates who are employable across European borders (Hall et al., 2006) and increased dependence of universities on corporate funding (Adams and Mathieu, 1999). There are inherent difficulties in cross-national comparisons of doctoral programs and experiences, including differences in definitions, measurements, program structures and expectations of prior specialised learning (Evans, 2000; Hall et al., 2006). Individual countries maintain unique industrial, educational and cultural environments for higher degree research education. However, the questions examined in this thesis clearly have international implications.

## **2.2 The university-government-industry nexus**

The linking of the pursuits of universities to national and global economic development is theorised in two compatible models that conceptualise a nexus of

university, government and industry engagement. Etzkowitz and Leydesdorff (1999) conceptualise a 'triple helix' of interwoven university-industry and government relations, whereby the three institutions are transformed into, respectively, entrepreneurial university, science-based industry, and science- and technology-integrated government administration (Etzkowitz et al., 2000). In this model, each sector undergoes internal change brought about by mutual influences, linkages and networks. In the Australian policy context, Wills (1998, p. 2) refers to a similar concept as the 'virtuous cycle' of mutual engagement between the three sectors.

The triple helix relationship is associated with the production of Mode 2 knowledge, which is knowledge generated through application rather than experimentation (Gibbons et al., 1994). Nowotny et al. (2003) consider Mode 2 knowledge to be a new research paradigm, which they characterise as follows.

- It makes use of transdisciplinary knowledge; that is, knowledge not confined to the paradigms of existing disciplines.
- It makes use of a variety of disciplinary perspectives and methodologies as needed for the creation of new knowledge to apply to an existing situation.
- Mode 2 knowledge production occurs within and across diverse sites and by diverse organisations.
- Mode 2 research is reflexive rather than objective, meaning that the environment in which the problem arises and is solved determines the nature of the research questions that are addressed and the research design used to address them.
- The final and most challenging characteristic is that traditional criteria for assessing the quality of research have been changed to incorporate the views of a broader range of stakeholders. The academic peer review process is therefore no longer the only means to determine the quality of research.

(Etzkowitz et al., 2000, p. 314) present an interesting assumption made by the triple helix and Mode 2 knowledge production models that '...an active role in economic development leaves existing academic missions in place, but it also encourages them

to be carried out in new ways'. They assert that the 'content and format for teaching' can change without change occurring to the 'existing academic missions', including presumably the education of researchers.

### **2.2.1 Criticisms of nexus models**

The assertion of the nexus models, that the academic missions of universities remain intact, is problematic. It is criticised for its premise that the academic mission of universities is to engage in research to produce knowledge as a 'tradable commodity' in the furtherance of economic development (Barnacle, 2004), and thus shifts the definition of knowledge from epistemological to economic terms (Usher, 2002). The ubiquity and dominance of economic discourses over epistemological concerns in discussions about the purpose and function of higher education has led to the observation by Barnett (1997, p. 169) that economic discourses, including employability, are 'saturated with power'. Correspondingly, epistemological concerns of academic disciplines are subordinated to industry demands.

The triple helix model has specific implications for the focus of HDR education. Thune (2010) asserts that the triple helix model changes traditional researcher learning by focusing on values and applications in support of entrepreneurial activity. Tennant (2004, p. 437) notes that the challenge of the call for greater industry influence in doctoral education is in its reconfiguration of students into knowledge workers, with a resultant refocusing of researcher autonomy from independence of thought to 'self-management' and 'self-reflection'. Despite these criticisms, industry expectations and values remain important influences in higher education policy and practice, and especially so in the engineering and applied science disciplines.

The social value of the triple helix construct is dependent on it being mutually beneficial to all stakeholders, including university students. The assumption is made that industry is rewarded in this relationship through direct knowledge transfer and the acquisition of industry-ready knowledge workers (Cruz-Castro and Sanz-Menendez, 2005). Once HDR students graduate, they reasonably expect that they will be employable in industry for non-academic work (Mangematin, 2000; Thune, 2010). However, contradictory evidence exists about the value of university-industry research collaboration. On one level, these arrangements have been described as a



relationship of convenience between supervisors and industry partners, with benefits to industry being mostly through the provision of the cheap labour of HDR students within universities (Slaughter et al., 2002). Other research shows that collaborations mostly involve financial support for low-stake work to which industry collaborators attach minimal importance (Behrens & Gray, 2001; Mangematin, 2000; Thune, 2010). The first contradictory observation implies that little of benefit might be forthcoming for students in such arrangements. The second observation implies that industry might not benefit from important knowledge transfer in the way attested to by the triple helix model.

In addressing the needs of knowledge economies, the triple helix model coincidentally highlights concerns by industry about HDR graduates. However, problems associated with the academic research culture, such as student dissatisfaction with supervision and resources, student attrition, and long completion times, are conflated in policy arguments with the need to prepare students for employment outside academia and with the drive to enhance knowledge capital in industry (Evans, 2000; Halse, 2007). This conflation creates the appearance of universities being dysfunctional and in urgent need of reform. Halse (2007) categorises concerns over doctorate education into issues of employability (appropriate skills, relevance of research experience) and issues of quality (attrition, completion times, supervision). She argues that 'claims that the doctorate is in crisis ... oversimplify the complex entanglement of social, political, and economic factors' that currently impact on higher education (Halse, 2007 p324). To the list of concerns, Park (2005) adds demands for greater clarity and transparency in the examination process, as well as benchmarking of different postgraduate awards to ensure consistency within and across institutions. The research presented in this thesis focuses on the demands for knowledge, skills and training associated with industry employers.

This conflation of supervision quality, time to completion, student resourcing and student attrition with HDR employability and industry readiness is reflected in much of the literature promoting change. Johnston (2003, p. 414) criticises 'the 'grey'

literature of policy-driven research, often published by the funders themselves<sup>2</sup> that is prevalent in extant higher education literature on graduate employability. Johnston suggests that policy-driven research is intellectually ‘fragmented’ and lacks theoretical depth, but nevertheless possesses a sense of urgency for the resolution of issues and thus precludes carefully considered responses to the situations it identifies as problematic. She argues that such writing typically relies upon simplistic quantitative, positivistic methodology and therefore often fails to explain ‘complex processes and human perception’. Johnston suggests that more useful methodologies are ignored by these authors because they are time-consuming and the resultant findings might raise ‘uncomfortable’ questions. The present research makes use of GTM to overcome the limitations identified by Johnston (2003) in order to gain a greater measure of the complexity of employers’ views of the EHDR graduates they employ.

Another criticism of the literature promoting change to traditional doctoral study is that it frequently views employability as a generic capability in its own right. Such literature relies on pan-discipline and pan-industry data that fail to adequately illuminate the differences in discipline epistemologies, industry practices, and requirements for levels of knowledge and expertise. While authors such as Metcalfe and Gray (2005) and Yorke (2006) acknowledge the limitations of their writing, their global perspectives inevitably result in generalisations about the ways HDR education is experienced and graduate knowledge and skills are valued in the workplace. Generalisation fails to capture any of the complexity that authors of such writing agree exists in the interplay of disciplinary and workplace constructs of advanced knowledge and expert performance.

In summary, the nexus models are criticised because they confuse the missions of universities and industry players; ignore exploitation of any nexus model-driven arrangements for the ulterior benefit of collaborators; conflate unrelated problems identified within universities; and fail to probe difficult issues related to the changes promoted by the models.

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<sup>2</sup> Grey literature is defined as documents such as government, university and technical reports that are not published commercially or for wide distribution and are thus usually difficult to locate (Auger 1989).

There is another concern about simplistic notions of HDR work-readiness, especially for engineering professional work. Engineering is a type of ‘knowledge-intensive professional work’; that is, work characterised by advanced problem-solving, the exercise of discretion and professional judgement, autonomous decision-making and ambiguity (Alvesson, 2004; Newell et al., 1962). Those employed in knowledge-intensive firms can present challenges to the organisations that hire them, in the form of tensions between loyalty to their profession, loyalty to the firm, loyalty to their personal career aspirations and, in the case of professional service provision, loyalty to clients (Alvesson, 2004). According to Alvesson, these tensions arise in part as the result of the perceived incompatibility between the professional self-image held by the worker and the financial, processing and marketing goals of the organisation. Thus, it appears almost inevitable that, in work situations where EHDR graduates engage in the sort of professional role outlined by Alvesson, employers will experience the tension as difficulties. Professional knowledge workers with strong professional identities and integrity will always appear problematic.

Despite the concerns outlined in previous sections, integration of academic and industry goals continues and has prompted changes to HDR programs. Most new programs involve collaborative research ventures where the research is closely connected to the needs of industry partners. The experiences of students in these collaborative arrangements shed some light on the views of industry partners, many of whom are potential employers of HDR graduates.

### **2.3 Evolving HDR curriculum in response to nexus models**

This section reviews the universities’ responses to the demands of the nexus models for better industry-integrated research training. These responses include the development of generic skills programs to enhance a wide variety of capabilities that have been identified as lacking in HDR graduates and to enhance awareness in candidates of the abilities they develop during candidature that might otherwise go unnoticed or unarticulated by graduates. This section also reviews the development of industry collaborative PhD programs. Surveys of the experiences of students and the outcomes for graduates of these programs are reviewed because they provide some insight, albeit limited, into the ways in which industry perceives the value of

HDR education. Such insight is particularly apt for EHDR students, because the discipline has maintained a long history of industry involvement in HDR candidature and is in a good position to establish collaborative projects.

### **2.3.1 Generic skills development**

One effect of the presentation of employers' views of HDR graduates as a deficit model is an emphasis in HDR programs on the development of generic capabilities in HDR students. Much of what is required by employers are generic skills seen as easily removed from the cognitive context of discipline research, such as workplace communication skills, group work skills, project management skills, interpersonal skills, and commercialisation and entrepreneurial skills (Adams and Mathieu, 1999; Gilbert et al., 2004; Tyler, 1998). While there is no explicit devaluing of theoretical and technological knowledge by industry, this is somewhat implied in statements that graduates are 'too narrowly focused and too specialised'. This is particularly the case when these statements are juxtaposed with criticism about the length of completion times and deficits in employable skills, as in (Kemp, 1999a; 1999b). Gilbert et al. (2004) point out that exclusive undertaking of exploratory research can result in little or no effort to link the research to a broader context. They suggest that an important advantage of generic skills training during HDR candidature is that it goes some way to addressing this concern by increasing the attention paid to potential applicability of the HDR research to a wider context.

The generic skills training offered by universities to their HDR students ranges from thesis writing workshops to entrepreneurship training (Borthwick & Wissler, 2003; Craswell, 2007), and the definition of generic skills varies from one government or university policy document to another (Gilbert et al., 2004; Hager et al., 2002). Many of the HDR graduate skills identified as professional or 'career management' skills, such as the preparation of employment resumes and interview techniques (Metcalf & Gray, 2005, p.14), can be learned easily through exposure to requirements and with minimal experience. Acquisition of others, such as project management and entrepreneurial skills, requires specialised training or specific experience; their inclusion in the already demanding process of HDR study fails to recognise the demand of both the skills acquisition and the HDR experience. Some 'skills' that are described would more realistically be expected after a lifetime of experience and

knowledge. For example, Akay (2008) argues for PhD programs that develop ‘renaissance engineers’ in part to address non-academic employers’ stated desire for less narrowly focused PhD graduates who are more broadly trained in ‘key professional skills’ that include teamwork and managerial skills and more applied knowledge. He includes what appear to be impossible expectations of a new PhD engineering graduate in the US (Akay, 2008):

- world-class knowledge in a relevant specialty;
- ability to develop world-class knowledge in related areas;
- understanding how specialised knowledge aligns with the larger context of knowing and understanding;
- awareness of *all* effects of globalisation and technology—and the price they exact on society; and
- leadership, as reflected in breadth of knowledge and ability to articulate ideas; confidence, poise and focus (Akay, 2008, p. 409, original italics).

It is not clear from Akay’s writing how training in teamwork, managerial skills and applied knowledge, all within the constraints of doctoral study, will enhance the attributes in his list of expectations.

This thesis is not directly concerned with the suitability, or otherwise, of generic skills training in HDR education. Instead, it aims to move beyond a focus on employability deficits in HDR graduates to gain a clearer understanding of the benefits and concerns perceived by employers who hire EHDR graduates and the ways they perceive these graduates as being of use in industry.

### **2.3.2 University and industry collaborative doctoral programs**

Collaborative doctorates were developed between industry players and universities in part to address the perceived shortcomings of traditional doctoral programs in meeting the demands of industry employers. These programs vary between countries and universities, but all include some level of industry sponsored research training, with or without placement in an industry workplace (Cruz-Castro & Sanz-Menendez, 2005; Harman, 2004; Manathunga et al., 2009; Wallgren & Dahlgren, 2005). Although this thesis is not concerned with the success or otherwise of collaborative doctorates, reports on their outcomes offer indirect insight into industry employers’

approaches to triple helix arrangements. They are reviewed here, in the absence of specific research that reveals a more nuanced understanding of employers' beliefs and attitudes.

The engineering discipline has always enjoyed considerable interaction with industry, and its graduates have maintained interests in private sector work (Mangematin, 2000; Thune, 2010). As a result, within the discipline of engineering, pre-defined projects are often funded by existing external grants designed to meet an identified research need in either government or private industry. These have the advantage for students of providing projects that are of interest and relevance to the industry and can save time during candidature by truncating the exploratory phase during which students would normally define and refine their research topic.

The reliance on industry to determine the academic research agenda has had its critics. For example, Fairweather (1989) associated the following problems with industry-sponsored programs in general:

- universities can be beholden to industry at the expense of provision for the public good;
- topics are limited to those perceived by the sponsor to be valuable;
- projects are focused on application at the expense of basic research;
- intellectual property rights can affect the academic need to publish findings; and
- commercial interests can threaten academic freedom.

In addition to these limitations of sponsor-driven topics, Neumann (2002) notes that the shift in government policy to limit funding for doctoral students in order to ensure timely completions (Kemp, 1999b) could have the additional potential for universities to restrict doctoral research to 'safe students' as well as to uncomplicated topics in disciplines known to have short completion times. Neumann (2002) suggests that pre-defined projects might deprive the candidate of opportunities to explore areas of interest and identify intriguing problems that can contribute important and original findings beyond the existing paradigms.

Despite these reservations, research programs designed to produce industry-ready doctoral graduates have been implemented in many countries. Although many traditional PhD programs provide additional seminars and training on work-relevant topics (Adams and Mathieu, 1999), collaborative programs involve formal working relationships between supervisors and industry partners to sponsor PhD projects (Behrens & Gray, 2001). In Australia, Collaborative Research Centres (CRCs) comprised of university, industry and government partners have been established to foster research projects in targeted priority areas (Harman, 2002)<sup>3</sup>. A number of studies have explored the quality of students' doctoral experiences in these arrangements (Behrens & Gray, 2001; Harman, 2004; Mangematin, 2000; Pitt et al., 2010; Thune, 2010; Wallgren & Dahlgren, 2005) and several studies have investigated the career outcomes of graduates from collaborative programs (Borrell-Damian, 2009; Manathunga et al., 2009; Mangematin, 2000; Pitt et al., 2010). Three of these studies concentrated on the experiences of engineering PhD candidates (Mangematin, 2000; Thune, 2010; Wallgren & Dahlgren, 2005). The findings of these studies are discussed in the following section.

### **2.3.3 Outcomes of collaborative doctoral programs**

Engineering and technology HDR student experiences of collaborative research have been generally positive and students have indicated they have found the candidature process successful (for example, Mangematin, 2000; Behrens & Gray, 2001; Pitt et al., 2010, Thune, 2010). This is despite the fact that Wallgren and Dahlgren (2005) found that one group of software engineering students in consulting firm placements experienced a sense of isolation and being ignored. Industry HDR graduates are equally likely to succeed in completing a PhD (Mangematin, 2000; Thune, 2010) as those who are not in industry collaborations. Graduates of collaborative doctorates are more likely to work in industry than those who were not involved in collaboration (Mangematin, 2000; Cruz-Castro & Sanz-Menendez, 2005; Manathunga et al., 2009; Pitt et al., 2010). Concerns about the negative impact of

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<sup>3</sup> The CRC Program brings together public and private sector groups of researchers and research users, such as industry, in centres of research activity; the Australian government and the CRC partners share funding for CRCs (Slayter 1994). HDR students are frequently involved in CRC research projects.

unrealistic industry expectations and interference in industry-funded research projects have largely remained unrealised.

However, the findings also show that there are costs to the students associated with industry collaboration. In his survey of 400 engineering PhD graduates in France, Mangematin (2000) found that performance criteria differ between industry collaborative PhD and academic PhD candidatures. Those involved in collaborative research tend to be 'locked in' to private sector employment, because the science that underpins their research is skewed toward industry interests and they produce fewer publications during candidature. He noted that this meant candidates had to choose very early in candidature whether they wished to pursue an academic or industry PhD, at a time when many were uncertain about their preferred future career direction.

In Australia, research into CRC outcomes is not confined to engineering and technology HDR graduates, although many CRC projects involve engineering collaborations. Differences in career trajectories are not as marked in Australian graduates, although the employment outcomes are found to be different for CRC and non-CRC graduates. Most non-CRC graduates are employed in universities, whereas CRC graduates are mostly employed in the private sector or public service. Thirty per cent of CRC graduates are employed in the private sector, predominately in non-research positions, compared to 22% of non-CRC graduates, and more CRC graduates work with customers and clients in service industries (Manathunga et al., 2009; Pitt et al., 2010). Interestingly, Manathunga et al. (2009) found that fewer than one third of CRC graduates believed that their candidature in a CRC improved their employment options, and only slightly more than half (58%) believed that the skills they developed prepared them for employment, compared to three quarters of the non-CRC graduates. These differences were not great enough to suggest that either group was 'locked in' to a particular trajectory in the way reported by Mangematin (2000).

Apart from graduate employment outcomes, several other interesting observations were noted in studies of industry doctorates. These include the quality of industry preparation and contact with the candidate, the graduates' awareness of the



importance of certain attributes, the students' level of interest in their research, and the dynamic between supervisors and industry partners.

Thune (2010) found that, in collaborative PhD projects, the firms had little at stake from the research, the projects were not 'cutting edge and did not have to immediate industry application. Rather than interfering in the design or timeframe of the research, industry collaborators often provided little input, and many students found they did not have an enhanced opportunity to interact with their sponsoring firm (Mangematin, 2001; Behrens & Gray, 2001; Pitt et al., 2010; Thune, 2010).

However, for the PhD students, what they experience as lack of interest and lack of contact with the firms is a far more commonly experienced problem than a firm showing too much interest or attempting to steer the PhD students and posing restrictions on publishing due to IPR [intellectual property rights] protection. Rather, all of the 25 PhD students interviewed in this study experienced limited contact with the firms during the PhD period. (Thune, 2010, p. 475–476)

Most students spent their time working under the guidance of their academic supervisors, not their industry partners, and students complained that after the initial project design process was completed, very little contact occurred with the industry partner. Slaughter et al. (2002, p. 290) point out that the companies involved in funding PhD projects were not looking for the knowledge and skills these graduates could bring, but rather they sought these engineering and science doctoral graduates for 'highly routine, unchallenging, tech-prep work'.

In a study of graduates largely from engineering disciplines, Pitt et al. (2010) found that, despite the claim that CRCs produce industry ready graduates, only 26% of CRC graduates received industry or business mentoring during their candidature, compared to 14% for non-CRC graduates. Nor did CRC graduates report any more value from their association with industry culture and environment than did non-CRCs. Out of 30 generic skills queried, only three were more frequently reported to be developed by CRC graduates than non-CRC graduates, and these only to a 'minor' or 'some' extent. The skills that were enhanced were environmental awareness, financial management skills, and understanding of intellectual property/commercialisation issues. 'Passion' was reported to be developed 'to a great extent' by more non-CRC graduates than CRC graduates. The availability of

research funds was ‘important’ or ‘very important’ to topic selections for many more CRC graduates than non-CRC graduates. Perhaps the lesser passion expressed by CRC graduates is related to the similar situation in Norway, reported by Thune (2010), where industry collaborative students pursued a research topic based on funding availability rather than choosing one that interested them.

Industry collaborations reveal an interesting mutuality. Slaughter et al. (2002) claim that university academics use science and engineering HDR students as ‘tokens of exchange’ with industry in a reciprocal relationship where HDR students are ‘gifts’ to industry and industry funding is the gift to academics. Most often, industry funding is in the form of student scholarship money, which allows for more HDR students to support the academic research program. Students are used by academics ‘in building alliances’ with industry.

According to the professors in our interviews, one cannot be a professor unless he or she does research, and a professor cannot do research without graduate students. The graduate students exchanged with industry often remained in industry, where they consolidated professors’ networks within and among companies, creating conditions for further exchange that will maintain or enhance professors’ prestige and power. (Slaughter et al., 2002, p. 285)

It has also been argued that HDR students are the ‘price’ supervisors pay for the prestige of knowledge exchange with external organisations (Slaughter et al., 2002; Adams and Mathieu, 1999).

Another mutual benefit of industry collaboration projects is the maintenance of active networks with industry that supply supervisors with funding for more doctoral students. Industry benefits correspondingly, through cheap research and the opportunity to select students for employment (Mangematin, 2000; Thune, 2010). A disadvantage for supervisors, however, is the lower publication rate of industry doctorates (Mangematin, 2000). For example, the data provided in Pitt et al. (2010) reveals that non-CRC graduates produced at least 20% more refereed publications than did CRC graduates. Similar findings were noted by Gemme (2005) for Canadian EHDR students. Mangematin (2000) argues that the differences in publication rates is a disadvantage for supervisors because academic benefit is derived from being research active and having HDR students who publish and

maintain research networks with the supervisors following graduation. The devaluation of writing is not restricted to producing external publications. Neumann (2002) notes that industry sponsored applied sciences students consider the academic writing demands of their academic supervisors as tedious and of secondary importance to the demands of the industry workplace.

Thune (2010) found that the engineering PhDs in his study who were aiming for a career in industry chose collaborative research because they thought it would help them gain a position. In contrast, Behrens and Gray (2001) studied science and engineering students and found that most students in their sample intended to work in industry, but that having studied in an industry funded doctorate did not influence this decision. There was no difference in workplace outcomes between industry-funded, other-funded or unfunded graduates in their study.

In summary, students who complete industry collaborative doctorates and wish to work in industry tend to find industry employment. Overall, they find their experience of HDR study equally as enjoyable as those who do not undertake collaborative projects. However, it is not clear whether employers are more attracted to PhD graduates who have completed industry collaborative doctorates, especially since the students reported little industry contact in many of these programs, show less passion, vary in their interest in industry work, and learn little about the routine undertakings of the industrial workplace during candidature. In these circumstances, it remains unclear whether students in collaborative PhD projects develop employability attributes that are valued by industry employers and if so, what the attributes are.

## **2.4 Employers' beliefs about higher degree by research graduates**

Consistent with government and industry demands for knowledge workers to fuel innovation, a major argument in support of changes to doctoral programs stems from the reported dissatisfaction of employers about the preparation of HDR graduates<sup>4</sup>.

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<sup>4</sup> Three government policy documents were most influential in promoting changes to HDR education in Australia. West (1997) reported on the results of a review of the 'social, economic, scientific and cultural' effectiveness of the Australian higher education sector and put forth options for the financing of higher education research and teaching. Wills (1998) focused specifically on the effectiveness and

Although her paper influenced the conclusions drawn by Kemp (1999a), Tyler (1998) had also stated the need for a systematic, qualitative investigation into employers' satisfaction with HDR graduates to address a perceived 'cultural gap' between the industrial and academic research environments. To date, exploration of employers' concerns has only been performed perfunctorily.

Employers' views were sought through submissions to West (1997) and the outcome of these submissions was summarised in one sentence:

A key message from employers, such as the Australian Industrial Research Group, to the Committee was that higher degree graduates often possess poorly developed communication, interpersonal, presentational and leadership skills. (West, 1997, p. 140)

Despite what is shown later in this section to be a shallow and incomplete understanding of employers' concerns about HDR graduates, the description of supposed employers' concerns is remarkably consistent in a number of consecutively produced government policy papers in Australia, as well as in much of the literature on doctoral change. In support of his subsequent changes to HDR education in Australia, Kemp (1999a) reiterated West (1997) to argue that HDR graduates were inadequately prepared during candidature for industry work, and stated that

Employers, in particular, have expressed concern with the standard of communication, interpersonal, presentational and leadership skills of research degree graduates, and comment that they are commonly too narrow, too specialised and too theoretical. (Kemp, 1999a, p. 31)

Gallagher (2000) echoed the view that employers criticise the HDR experience as too narrow and specialised for the industry context.

The concerns expressed in Kemp (1999a, p. 32) for a need to provide 'a greater focus on the broader range of skills needed by graduates to operate successfully in an increasingly diverse range of employment destinations' also echo those of the Wills Review (Wills, 1998), which found that there was a need to 'broaden and update

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financing of health and medical research in Australia. Based on the recommendations in the West and Wills reports, Kemp (1999a) produced a discussion paper on the effectiveness of higher education research and research training, followed by Kemp (1999b), a policy on the funding of higher education research and research training.

graduate training to produce more diverse and well-rounded PhD graduates' (Wills, 1998, p.55). Kemp (1999a) then refers again to the West Review (1997) to provide evidence in support of his claims. Of the 391 submissions made to the West Review, 377 were available online to the public until recently.<sup>5</sup> Perusal of these submissions revealed that only a handful of employer submissions to the West Review made any reference to HDR graduates and of these, it appears that only the submission from the Business/Higher Education Roundtable (BHERT, 1997) was critical of postgraduate research degree holders. Specifically, the submission asked for improvements to advanced level graduate preparation, so that graduates become more commercially and financially skilled, better trained in project management, including its social and 'political' implications, understand the principles of organisation, and importance of the timely completion of projects, and display leadership and team membership skills.

The suggestions made in the BHERT (1997) submission were not new. They were the same as the criticisms made by industry participants in a study by Mann et al. (1994), which had been released as a BHERT report. Their study recommended that universities do more to ensure that graduates had the necessary skills and attributes to perform well as research and development managers in Australian industry. Mann et al. (1994) provided views, taken from a number of representatives from industry, research institutes, academia and professional bodies, on engineering and sciences undergraduate and postgraduate (but not necessarily HDR) students' need to develop leadership skills. The industry panel view (Mann et al., 1994, p. 17) recommended preparation of graduates who

1. 'are focused and applied in their interests and can see the commercial potential of research;
2. have basic financial skills and are business 'smart';
3. understand basic principles of project management, including planning and organisation of work and completion of projects within a specified time frame;
4. have learned leadership skills and effective team membership;
5. understand the social and 'political' process involved in project management.'

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<sup>5</sup> These appear to have been removed more recently from the public domain.

Mann et al. (1994, p. 21) also noted that a number of employers expressed the view that in the four-year undergraduate engineering program 'too much engineering science is being taught which will never be used in practice'. BHERT (1999) later contradicted this view by calling for increased investment by government and industry in basic science research as part of the government's general strategy for increased innovation in industry. It is unclear whether the type of engineering science dismissed as unnecessary by the employers who commented in Mann et al. (1994) would create the necessary foundation needed by postgraduate engineering researchers in the basic science research promoted by BHERT (1999). However, these contradictory demands highlight the complexity of the relationship between advanced knowledge, scientific creativity and innovation as perceived by industry and by the academic community. They also demonstrate confusing and contradictory messages about the expectations of industry employers.

Mann et al. (1994) did criticise the limited nature of the industry views expressed in their study, and encouraged industry to take a broader perspective for R&D leaders that included characteristics for effective and creative problem solving. However, the BHERT submission to Kemp (1999a) contained only the industry criticisms. While Kemp (1999a) noted the need to 'strengthen the creativity, communication and problem-solving skills of graduates' in research training, he gave greater emphasis to industry employers' demands, to skills in research training and to commercialisation of research. A later report on innovation in Australia (Miles, 2000) further emphasised a need for increased knowledge about commercialisation of research in HDR graduates.

Mann et al. (1994, p.32) suggested that engineering graduates are more likely to be better prepared for industry research and development (R&D) roles because, unlike science graduates, they enter the workforce after completion of bachelor degrees and so are likely to favour developmental rather than basic research. This implies that the employers believe (a) that engineering PhDs would perform basic research which is unsuitable in industry and (b) that science and engineering HDRs graduates are not likely to be suitable for industry R&D leadership roles.

A similar lack of clarity and precision regarding employers' views is apparent in other literature on doctoral program change and graduate employability. Adams and

Mathieu (1999) identified a dearth of academic positions as the driver for changes to PhD education aimed at better preparing graduates for industry work. They specified industry related requirements as follows:

During their educational process, Ph.D. graduates must acquire problem solving skills (planning, regular structural reporting, project management, etc.), an initiation in areas of industrial techniques, management, economics, etc., as well as communications and language skills (with the practice of at least two languages in addition to the mother tongue). Knowledge building and scientific research must be well equilibrated through the educational process. ... The length of the doctorate should be reduced to 3 to a maximum of 4 years. The efficiency of graduate studies should be increased. (Adams and Mathieu, 1999, p. 149)

Although they mention management initiatives, no employer data is provided, or referred to, to support their speculation on changes that might improve graduate employability. Akay's recommendations (Akay, 2008) for the development of arguably unrealistic professional skills in engineering doctoral graduates, noted in Section 2.3.1, is based on evidence from industry reported earlier by the National Academy of Sciences (Akay, 2008).

Primarily in industry, these employers claim 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, appreciation of applied problems, and knowledge and culture of other fields. (p. 406)

Nerad (2004) stated that the employers' criticisms presented in the National Academy of Sciences report were difficult to substantiate: 'In other words, we do not really know by what criteria industry is determining this assessment' (Nerad, 2004, p. 188).

An extensive report into European industry doctorates (Borrell-Damian, 2009), published as the present study was concluding, surveyed 33 companies in 20 countries and focused on three broad discipline contexts that included science, engineering and technology. The report states clearly that it provides a distinctive European perspective, and that the breadth of doctorate and career typologies encountered renders it unable to provide more than a broad perspective on careers and employment of doctoral graduates. Despite the size of the survey sample, the findings offer little insight to what has long been known about employers views of

HDR graduates: after more than two decades of industry collaborative HDR programs in Europe, industry employers are still reporting that graduates lack a business and commercial mindset, lack communication and teamwork skills, and are ‘too oriented towards publication’ (Borrell-Damian, 2009, p. 89). Nevertheless, EHDR graduates continue to be employed in industry workplaces throughout the world, suggesting that there is still much to be understood about the tension between an apparent reticence of industry employers toward EHDR graduates on the one hand, and on the other a continued willingness to engage them.

## **2.5 Demographic context of the present research**

The substantive context for the present study involved Australian firms that employ EHDR graduates. In general, mechanical and chemical engineers in the regions studied are employed in Australian-based industries specialising in mining, energy technologies, aeronautics, materials manufacturing, defence technologies, and professional and technical services; these industries reflect common destinations for Australian engineering graduates (DETYA, 2000; Hager et al., 2002; Kasparu, 2008). Further information about the types of engineering work undertaken in the region of Australia involved in the study is outlined in Chapter 5, Section 5.4 of this thesis.

The academic discipline of engineering has maintained a longstanding relationship with the professional practice of engineering outside the academic arena. In Australia, the term ‘professional engineer’ is applied to an engineer who has completed a four-year Bachelor of Engineering (abbreviated as BEng or BE) program accredited by Engineers Australia (Kasparu, 2010). Attainment of the qualification indicates that the graduate has achieved a minimum level of engineering competence for the professional engineering workplace. The competences aimed for in the education of a professional engineer are described as follows:

Professional Engineers apply lifelong learning, critical perception and engineering judgment to the performance of engineering services. Professional Engineers challenge current thinking and conceptualise alternative approaches, often engaging in research and development of new engineering principles, technologies and materials. Professional Engineers apply their analytical skills and well developed grasp of scientific principles and engineering theory to design original and novel solutions to complex



problems. Professional Engineers exercise a disciplined and systematic approach to innovation and creativity, comprehension of risks and benefits and use informed professional judgment to select optimal solutions, justify and defend these selections to clients, colleagues and the community. (Kasparu, 2010, p. 2)

In the Australian engineering workforce, 17% of practicing engineers have obtained higher degrees, 4% of professional engineers have PhDs and 13% have masters degrees(Kasparu, 2010)<sup>6</sup>. No breakdown was provided of research and coursework masters for that year, but in 2004, 2% of the engineering workforce had obtained a masters by research degree. Most doctorate and masters-qualified engineers work in manufacturing, which includes food processing, petroleum, and metal production; professional and technical services, which includes private consulting; public administration, including the defence forces; or education (Kasparu, 2010).

Data are available for engineering student commencements, enrolments and completions up to the year 2008 (Kasparu, 2010). For that year, almost 7% of students in engineering fields commenced HDR study. Since 2001, doctoral enrolments have increased by 40%, due mostly to a large intake of international students, and research masters enrolments have remained static. In the same period, from 2001 to 2008, bachelor level enrolments increased by 15%. In 2008, 697 doctoral students completed their degrees, which is an increase of 65% over 2001 figures. However, the doctoral completions as a percentage of doctoral enrolments have not changed substantially between 2001 (15.3%) and 2008 (16.5%). The static rate of completion suggests that any changes have occurred to HDR programs have not affected completion rate in engineering disciplines.

Unlike the engineering undergraduate qualification, no formal accreditation for workplace competence is recognised for HDRs attained by engineering graduates. Outside the academic workplace, the appropriateness of EHDR knowledge, skills and relevance to a workplace is confined to the conceptualisations of individual employers. Very little of depth is known about what employers of EHDR graduates value in them and how they perceive the contribution of these graduates to the

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<sup>6</sup> These figures are calculated from information in Kasparu (2010), which are in turn based on figures calculated by the Australian Bureau of Statistics from data provided in the 2006 national census.

engineering workplace, both in Australia and abroad. Such knowledge would be valuable for two key reasons. Firstly, more than half of EHDR graduates seek employment in industry (Harman, 2002; Pitt et al., 2010); further, Harman (2002) found that many science and technology HDR students are disinclined toward an academic career, due to a perceived lack of available positions as well as poor resourcing and funding of universities. The second reason is that EHDR graduates in the industry workplace are considered essential contributors to national economic prosperity (Farrell, 2007; Harris, 1996; Kemp, 1999a).

## **2.6 Summary of chapter**

Concern about the employability of engineering HDR graduates is situated within the context of economic and higher education concerns. Advanced engineering knowledge is understood to be an essential force in innovation-driven national prosperity and EHDR graduates are understood to play an important role in that regard. The triple helix model of interdependence of government, higher education and industry in the production of innovative outcomes has resulted in considerable change to the ways HDR graduates are educated, with increased emphasis on industry needs and involvement in the HDR process. These changes of emphasis have been criticised as undermining the nature of disciplinary knowledge and independent research in favour of an economic imperative.

Although there has been considerable concern about the need to prepare HDR graduates to work in industry and there is an oft-repeated list of HDR graduates' inadequacies for industry work, there have been remarkably few sources of information about the expectations of industry employers. Further, the information that is available is poorly defined and elaborated, and frequently lacks in contextualisation for discipline or industry type. Currently, the most valuable source of information about the expectations of industry is found in the literature on collaborative PhD programs, both in Australia and abroad. Even so, these are based on surveys of student and graduate experiences of the programs; no employers' views have been canvassed.

It was in this sparsely informed context that the research presented in this thesis was conducted. The number of engineering doctoral graduates is growing in Australia

and many of these graduates wish to work in industry. Yet, the concerns expressed by employers about the employability of EHDR graduates have remained underexplored. No substantial study of EHDR employability has been undertaken and there is no clear notion of how EHDR knowledge and skills are understood by employers to contribute to the engineering workplace. The aim of this research is to gain a more complete understanding of the beliefs and expectations of employers of two EHDR discipline groups and how they affect the engagement of EHDR graduates in industry.

## **Chapter 3: Theoretical and Methodological Approach**

This chapter presents a description and explanation of the research approach taken in this study. This includes decisions about the methods and procedures used, the methodology used and the epistemological perspective that underpins these decisions. A brief overview of the development of GTM, which was used in this study, is provided as necessary background to the justification for the decision to use a recent version of the methodology. The intention in this chapter is to provide methodological discussion that is readily accessible to a broad, transdisciplinary audience. To this purpose, an explanation of important basic differences between the notions of quantitative and qualitative research is also provided in Appendix 1. The background to the development of GTM is provided in Appendix 2.

### **3.1 Research paradigms**

Social phenomena can be considered from a number of perspectives. Therefore, unlike the positivist research of science, where principles of scientific method and thought are implicit, social research requires an explanation of the underlying assumptions that inform the approach taken to the study of a social phenomenon. In this respect, descriptions of the theoretical underpinnings of social research frequently begin with the suggestion that it is from the researcher's worldview, including assumptions about what is real (ontology) and knowable (epistemology), that a method is finally settled upon for the study. However, Crotty (1998) and Ercikan and Roth (2006) suggest that it is an initial consideration of method and methodology to be applied to the research question that ultimately leads the researcher to questions about the ontological and epistemological assumptions behind the research. Cresswell (2003) suggests that a research topic itself, particularly if it is exploratory or focused on a group of people not previously studied, influences the choice of approach. The following section explains the nature of the questions explored in this study.

### **3.1.1 Beginning with the questions**

Ercikan and Roth (2006, p. 21) classify research according to three types of research questions: 'What is happening?', 'Is there a systematic effect?' and 'Why or how is it happening?'. They link these questions to the decision for choice of method and the level of inference that the researcher intends to make. The aim of this study was to gain insights from employers of EHDR graduates about the ways in which they believe these graduates to be valuable (or not) to the engineering workplace. Thus, the study asks 'Why do employers employ engineering HDR graduates?' and 'How do these employers view engineering HDR graduates?'

My own experience working in small to medium sized companies, and conversations with managers in private enterprises led me to believe that anything but personal contact and open interviews would prove fruitless, due to time constraints and work pressures placed on such people. In large organisations, a paper or online survey would either be ignored or addressed by someone with little first hand experience of employing EHDR graduates; in small companies, the survey would be ignored. This view is supported in the literature (for example, Bernard, 2002; Cohen et al., 2000; Neuman, 1991), by my own experience as a co-researcher in a survey study of engineering managers (Svistounov et al., 2007), and by employer participants in this study who were adamant that they would not have answered a mailed or online survey questionnaire. The decision to conduct open interviews and to engage in a conversation of inquiry with the interviewees, with a view to gaining better understanding from their perspectives on working with EHDR graduates, lent itself to the use of GTM. This methodology is a social research process whereby theory is systematically generated from data and analysed using a strategy of comparative analysis (Glaser and Strauss, 1967).

Crotty (1998) placed these initial choices of method and methodology into a nested relationship of four elements to be considered in devising a cohesive social research design: methods, methodology, theoretical perspective and epistemology (Figure 3.1). Methods are the techniques and procedures to be used; methodology is the 'strategy' for using the products (i.e. data) of the methods; theoretical perspective is the philosophical underpinning of the methodology; and epistemology is the position the knower takes in relation to that which is known. In a research design, a choice

made within one element must be consistent with choices made within each of the other elements. In the present study, the methods were focus group discussions, interviews and observation; the methodology was grounded theory; the theoretical perspective was interpretivism informed by the theory of symbolic interactionism; and the epistemological stance taken was constructionism. The methods used in this study are explained in detail in Chapter 4, on EHDR students' perspectives, and in Chapter 5, which introduces the employers' perspective. The remaining elements are explained later in this chapter.

NOTE:  
This figure is included on page 36  
of the print copy of the thesis held in  
the University of Adelaide Library.

**Figure 3.1: Four elements of a research design (based on Crotty, 1998), with the approaches taken in the present study highlighted in bold italics**

Crotty's framework was useful in the initial design of the present study because it focuses on the methods and methodology first. However, it does little to position social inquiry within a larger perspective of research activity that encompasses the physical sciences. In order to explain constructionist GTM, it is necessary to briefly contrast constructionist epistemology with other epistemological stances.

### **3.1.2 Epistemologies and paradigms in social research**

Guba and Lincoln (1994, p. 105) clarified approaches to research by categorising them into four paradigms that each carry 'assumptions and the implications of those assumptions for a variety of research issues'. In their model, paradigms cluster the methods, methodologies, theoretical approaches and epistemologies, similar to those

noted by Crotty (1998), to display consistent, workable approaches to social research. Table 3.1 presents a tabular form of the four research paradigms they described: positivist, postpositivist, constructionist and critical and similar theories. Research conducted in a particular paradigm displays the ontology, epistemology, methodology and aims of that paradigm. Guba and Lincoln (1994) define these concepts as follows:

- Ontology is the view of that which is to be known. It addresses the question ‘Is the thing to be known a real object that exists independently of human awareness (for example carbon, wheat), or is it something that only exists in the knower’s mind (for example motivation, social class)?’ The subject matters of physical and natural science research tend to be viewed as objects that exist outside of human consciousness, and the subject matter of interest in social inquiry as that which exists primarily with human consciousness. However, it is also possible to view all subject matter exclusively as objects or all as mental constructions. The researcher’s ontological approach determines the view taken.
- Epistemology is the position the researcher maintains in relation to the subject matter of the research. Crotty (1998) distinguished three epistemological perspectives. These are objectivism, where the researcher is completely independent of the object under investigation; constructionism, where the researcher ‘constructs’ mental representations of the subject matter ('Meaning is not discovered, but constructed.' p.9); and subjectivism, where the researcher views meaning as imposed on the subject matter and the research act actively advocates for a new meaning or other change. These correspond to the paradigms outlined by Guba and Lincoln (1994): objectivism with positivism and postpositivism, constructionism with constructivism, and subjectivism with what Guba and Lincoln term 'critical theory et al.'.
- Methodology is the process used to address the research questions. It combines the notions of methodology and method, which are separated in Crotty (1998).

- The aims of the research are the expected achievement from the completion of the research. Two of the paradigms described by Guba and Lincoln (1994), positivist and postpositivist, aim for new knowledge, true to that which is real and generalisable, to be gained by the knower. The other two paradigms, constructivist and critical theory et al., aim for an enhanced or altered perception by the knower of a phenomenon that can only ever be known through an individual's perception. In these latter 'perceived knowledge' paradigms, there is no objectively true knowledge of the phenomenon, only the relative knowledge of one's perceptions.

Table 3.1 makes use of an insightful analysis of Guba and Lincoln (1994) offered by Annells (1996) to illustrate the contrast in paradigms.



**Table 3.1: Framework of research paradigms: Summary of Annells' (1996, p. 384) outline of Guba and Lincoln (Guba and Lincoln, 1994)**

<b>Paradigm</b>	<b>Positivism</b>	<b>Postpositivism</b>	<b>Constructivism (Constructionism)</b>	<b>Critical Theory et al.<sup>1</sup></b>
<b>Ontology</b>	Reality is apprehendable truth that is discovered through research.	Reality is 'truth', but not fully apprehendable through research.	Reality is a local and specific mental construction formed by a person.	Reality is shaped by values over time.
<b>Epistemology</b>	Dualism and objectivism: the researched object is independent of the researcher.	The researched object is independent of the researcher. Objectivity is an ideal, but reality can only be apprehended probabilistically.	The knower (researcher) constructs knowledge through interaction or relationship with what can be known (the researched).	A 'reality' can be apprehended for practical purposes of the transaction of findings between researcher and participants. The practicality reflects a need to constrain research into a timeframe.
<b>Methodology</b>	Hypothesis generation and verification through experimental manipulation of variables.	As per positivism, but with consideration of personally constructed viewpoints in determining variables.	Research 'creates' knowledge through interpretation of dialectically transacted constructions.	Reconstructive dialogue and dialectical process.
<b>Aims</b>	Aims to accumulate knowledge through prediction and control.	Aims to accumulate knowledge through prediction and control.	Aims for sophisticated consensus constructions to provide a better understanding of a phenomenon.	Aim is 'emancipatory praxis', i.e. change to social practice that frees participants from previously un-apprehended constraints.

<sup>1</sup> Critical Theory et al. includes poststructuralism and postmodernism.

### **3.1.3 Objectivist and constructionist interpretivism**

Two elements of Crotty's framework, interpretivism and constructionism, underpin the current study. Interpretivism is the approach taken to determine meaning in qualitative research data. From a strictly objectivist stance, a researcher could simply assume that everyone entertains the same meaning for a notion such as 'social class', and conduct a study based on that assumption. Interpretivism demands that the researcher takes 'to the best of his ability, the standpoint of those studied' (Denzin, 1978, p. 99). Schwandt referred to this process as 'empathic identification' (Schwandt, 2000, p 192). However, the degree to which a researcher can faithfully 'represent' the meanings held by participants, without inadvertently making use of her or his own meaning, is debated in the literature on qualitative methodologies (Schwandt, 1994).

Much early twentieth century social research was conducted in an objectivist interpretivist manner within disciplines that strove to make social sciences adhere to the tenets of the then dominant paradigm of postpositivism, particularly the need for researcher objectivity and personal distance from participants. However, as social research evolved, some interpretive approaches rejected the imperative to maintain a position of observer neutrality when representing meaning, because attempting neutrality denied that meaning is personally constructed by individuals, including by the researcher in the research act (Annells, 1996; Crotty, 1998; Hall & Callery, 2001; Schwandt, 2000). This latter notion is reflected in the construction of the present study; examples of the ways in which I interpreted the participants' comments are elaborated throughout this chapter.

#### *3.1.3.1 Influence of symbolic interactionism on interpretivism*

The rejection of an objectivist stance in social research corresponded with the rise of the theory of symbolic interactionism, a sociological concept that emerged from the field of social psychology and particularly from the ideas of George Herbert Mead. Mead (1964) viewed the creation of the self as an emerging product of the interaction of an individual with others. In this process a person internalises and mirrors the role and attitudes of real and imagined others perceived through symbols such as gestures and language; displays the roles and attitudes through language and symbolic

communication; and continually reflects on perceived responses of real and imagined others. The relationship between the individual and the social context is expanded upon in the three basic tenets of symbolic interactionism (Blumer, 1969, p2):

- that human beings act toward things on the basis of the meanings that these things have for them;
- that the meaning of such things is derived from, and rises out of, the social interaction that one has with one's fellows;
- that these meanings are handled in, and modified through, an interpretive process used by the person in dealing with the things he encounters.

Symbolic interactionists view meanings as socially constructed through the interpretations made by individuals during the course of their daily existence. Each interpretation by each individual in the environment will be brought to further interactions in the environment. In this way symbols, systems, values, understandings, attitudes and behaviours are socially produced and create the cultural milieu in which a given phenomenon occurs. Social phenomena are viewed as dynamic constructions within cultural contexts, and individuals construct personal meanings for the phenomena within these contexts. In the present study, the views of the EHDR students and the employers are understood to have been shaped and to be enacted in this manner.

#### *3.1.3.2 Constructionist interpretivism*

The emergent variation in approaches to the meaning of social research data reflects changes to underlying epistemological stances. According to Schwandt (1994, p. 118), the concepts of interpretivism and constructionism 'share the goal of understanding the complex world of lived experience from the point of view of those who live it'. However, unlike the objectivist interpretive approach, the constructionist viewpoint maintains that what is presented in research are the mental constructions of participants and researcher alike, and constructionist interpretivist research explicitly acknowledges this in research design and presentation.

Constructionism places the researcher in the role of jointly constructing, with the participants, the meaning of the studied phenomenon:

We interpret our participants' meanings and actions and they interpret ours.... Rather than explaining reality, social constructionists see multiple realities and therefore ask: What do people assume is real? How do they construct and act on their view of reality? Thus knowledge and theories are situated and located in particular positions, perspectives, and experiences. (Charmaz, 2006, p, 127)

The study presented here is situated within the constructionist paradigm and was conducted using a version of GTM, constructionist grounded theory methodology (Charmaz, 2006). The aim of the study is to present a picture of the ways in which employers view and value EHDR graduates. The result is constructed from their and the researcher's interpretations of these concepts. A detailed description of this version of GTM and the rationale for using it are elaborated in the remainder of this chapter.

## **3.2 Grounded theory methodology**

The remainder of this chapter presents an explanation of the generic sampling, coding, and categorisation processes used in GTM, an explanation of the logic and inferential processes used in GTM, a discussion of divergences in approaches to GTM relevant to this study, and a description of constructionist GTM—the particular version of the methodology used here.

### **3.2.1 The process of developing a grounded theory**

GTM is a social research methodology that uses constant comparison of data to generate and test hypotheses through the process of analytical induction. Denzin (1978) outlines six steps that describe the process:

- A rough definition of the phenomenon to be explained is formulated.
- A hypothetical explanation of that phenomenon is formulated.
- One case is studied in light of the hypothesis.
- If the hypothesis does not fit the facts, either the hypothesis is reformulated or the phenomenon to be explained is redefined so that the case is excluded.

- Practical certainty may be obtained after a small number of cases have been examined, but the discovery of negative cases disproves the explanation and requires a reformulation.
- This procedure of examining cases, redefining the phenomenon and reformulating the hypothesis is continued until a universal relationship is established, each negative case calling for a redefinition or a reformulation.

These analytical stages can be seen in the developmental process of a grounded theory summarised by Sarantakos (1998, p. 201), who splits the inferential process into three stages:

- Induction (development of temporary/conditional hypothesis).
- Deduction (derivation of implications of hypothesis).
- Verification (testing of validity of hypothesis).

Analytical induction as used in GTM relies on theoretical sampling rather than statistical sampling. That is, the sample is selected and extended based on the emerging hypotheses and the continual need to select cases with the greatest chance of disconfirming the emergent theory and requiring its reformulation. Theory is developed and refined through this process of continual testing, until a point of theoretical saturation is reached in which the theory explains the full complexity of the data.

Different versions of GTM have evolved since its inception in the early 1960s; however, there are certain features that are fundamental to the methodology. Charmaz (2006, p. 5–6) identifies the 'defining components' of GTM, as established by Glaser and Strauss, as follows:

- Simultaneous involvement in data collection and analysis.
- Constructing analytic codes and categories from data, not from preconceived logically deduced hypotheses.
- Using the constant comparative method, which involves making comparisons during each stage of the analysis.
- Advancing theory development during each step of data collection and analysis.
- Memo-writing to elaborate categories, specify their properties, define relationships between categories and identify gaps.

- Sampling aimed toward theory construction, not for population representativeness.
- Conducting the literature review *after* developing independent analysis [author's italics].

The final item regarding the conduct of a literature review has been the focus of dispute amongst theorists relating to acknowledgement of what the researcher brings to the research process in terms of prior knowledge and experience. The requirement to avoid a review of the literature before analysis illustrates the strength with which Glaser and Strauss originally sought to break from the hypothetico-deductivism prevalent at the time in social research, while they simultaneously retained an objectivist viewpoint. This paradoxical situation is discussed in Appendix 2.

The aim of the process of grounded theory development is to move from substantive concepts displayed explicitly in the data to increasingly abstract conceptualisations. Although the process later appears in the written research to be linear and sequential, it is not. During analysis, the researcher constantly develops, reviews and compares new concepts and categories with earlier ones, which ensures consistent 'grounding' in empirical data. New findings that challenge earlier ideas are brought back into an earlier coding phase for reconsideration.

### **3.2.2 Data collection and coding**

There are two main coding stages in GTM, although different terminology and sub-coding stages are identified by the different proponents of the methodology. Throughout the coding process, questions are raised, sometimes in the form of minor hypotheses, and further data is collected from sources that are considered most likely to test and challenge these hypotheses; this process is called theoretical sampling. The coding stages move the emerging ideas from the concrete or substantive level to increasing levels of abstraction or theorisation. As more information is gathered through targeted sampling and analysed for fit to the increasingly abstracted categories, it confirms a hypothesis, adds to it or changes it. At the point in this process where no new or disaffirming information is being found, 'theoretical saturation' is said to have been reached. The theory should be sufficiently robust to

account for the full complexity of the data. The coding stages and analysis process provided here are based on definitions found in Charmaz (2006).

*Initial or open coding:* This is the stage where the researcher first becomes immersed in the data. It involves carefully considered reading of the interview transcript, line-by-line and sometimes word-by-word, to identify essential ideas or concepts that Fendt and Sachs (2008) refer to as the 'keywords'. In this study, I first listened to the recording of each participant while reading, to ensure no typographical errors had occurred during transcription; quite a few were found. I then listened to each recording several times in order to capture the inflection and tonal characteristics displayed by the speakers, which revealed much that was not evident from reading the written text alone. This concurs with the view expressed by Mishler (2003) that working with transcription is an interpretive process. This initial coding process produces many substantive concepts, and I found it useful to avoid trying to match like-with-like concepts in these early stages.

*Selective coding:* Eventually during the initial coding stage, many concepts begin to form conceptual categories. In this study, for example, the concept 'determining [an EHDR graduate's] ability to cope' mentioned by Employer 4 combined with similar ideas expressed by other participants into the category 'judging personal attributes'. These early categories remain closely linked to the substantive data. An essential part of a grounded theory is that it explains how people act on their thoughts and the outcomes of those these actions (Charmaz, 2006; Glaser & Strauss, 1967). For example, the concept 'judging personal attributes' presented a process, or activity, on the part of the research participants.

Charmaz (2006) referred to this early conceptual categorisation as focused coding, where codes 'synthesise and explain' larger segments of data and are formed from the 'most significant and/ or frequent earlier codes' (Charmaz, 2006, p. 5). Her later comments also reveal the non-sequential iterations that occur as analysis begins to move from concrete data to abstraction:

But moving to focused coding is not entirely a linear process. Some respondents or events will make explicit what was implicit in earlier statements or events. An 'Aha! Now I understand,' experience may prompt you to study your earlier data afresh. Then you return to earlier respondents

and explore topics that had been glossed over, or that may have been too implicit to discern initially or unstated. (Charmaz, 2006, p. 58)

The experience described by Charmaz was one I frequently encountered during the course of data analysis for the present study. It illustrates the nature of emergence in grounded theory analysis.

*Axial coding:* Introduced by Strauss (1987) and developed by Strauss and Corbin (1990; 1998), this type of coding ‘specifies the properties and dimensions of a category’ through attempts to answer questions of ‘when, where, why, who, how, and with what consequences’ (Strauss and Corbin, 1998, p. 60). The properties and dimensions of each category are identified to determine cause, consequence, contingency, condition and covariance revealed in the data. Glaser (1992) and his proponents (for example Christiansen, 2008) strongly objected to this technique, claiming that it forces the data into preconceived and formulaic notions; this led to a now infamous disagreement between Barney Glaser and Anselm Strauss. Debate continues amongst grounded theorists as to whether axial coding is too prescriptive and formulaic. I have chosen to take the view posed by Charmaz (2006), Kelle (2005), and to some extent even Glaser (1992), that axial coding techniques can help to generate ideas from the data. They advise researchers to use the techniques as needed, rather than prescriptively, to enhance theoretical sensitivity. I found this more accommodating and flexible approach to the methodology enhanced my ability to explore categories for deeper interpretations in this research.

*Constant comparison:* What Glaser and Strauss (1967, p. 1) introduced to social research practice was 'a general method of comparative analysis' to be used as a strategy for the development of theory grounded in data. With each reconceptualisation or attempt at categorisation, emerging concepts and categories are compared with earlier data, concepts and categories to confirm their relevance and fit. This process of constant comparison results in changes to, and occasionally rejection of, earlier conceptualisations, and the reconsideration of emerging concepts. Such changes and reconsiderations are the results of inductive inferences, which themselves lead to levels of greater abstraction. Eventually, a core category emerges that captures the main theme or concern in the data. Constant comparison can occur



throughout all coding stages, although it becomes a constant process after initial open coding has taken place.

*Theoretical sampling:* As questions emerge or information is needed in the analysis process, the researcher selects sources of data, such as interviewees, who might be able to provide the needed information. This information is used to challenge and ultimately to elaborate the properties of developing categories. The researcher actively seeks conflicting or alternative information that must then be integrated into the developing theory. This type of sampling is an important characteristic of GTM and illustrates its move away from the objectivist requirement for random sampling.

*Memos:* Memos are notes written by the researcher at all stages of the analysis and act as a journal of the theorisation process. They articulate the inference making of the researcher, reflections on points of confusion, and moments of insight. They need not be eloquently written and are frequently diagrams, dot points or notes (Glaser, 1992; 1998) that, over the course of the research project, reveal the thinking that leads to theory formation. Some reveal pathways to dead ends, and others reflect moments of important forward movement. The researcher retains these memos and revisits them to further reflect on and retrace the process of theory development.

*Theoretical saturation:* Once a core category is identified, theoretical sampling is undertaken to find examples and variations of the category properties. Saturation occurs when no new information is found that provides variation or disaffirmation of the category.

### *3.2.2.1 Working with grounded theory methodology*

The description of GTM processes provided in the previous section shows that there are disagreements about even the basic coding procedures. As indicated above, the analysis undertaken in this study was informed by the open and flexible approach to GTM espoused by Glaser and Strauss (1967), Strauss (1987) and in particular the constructionist GTM of Charmaz (2006). My understanding of the methodology greatly increased as I used it and reflected on my own research activity. As the research unfolded, I became increasingly confident in allowing the data and context to determine subsequent activity. I revisited the seminal texts frequently, often taking up suggestions that I had earlier dismissed. This was challenging for me because my

previous research experiences had been postpositivist and quantitative, with the methods clearly set out before data analysis commenced. To a large extent, I took comfort in the similar experiences of others, such as Fendt (in Fendt & Sachs, 2008) and Williams (2005), and from the literature that encourages extension and better explanation of the methodology.

As evident in the following section, GTM is a highly regarded methodology in social research, but much is still being discovered about the means by which it yields its valuable insights about social phenomena. Additionally, a more detailed analysis and critique of GTM is presented in Appendix 2.

### **3.2.3 Constructionist grounded theory methodology**

The original epistemological foundation of GTM was objectivist, and thus certain positivist traditions of sociological research at the time, such as concepts of theory verification and attempts at objectivity, are evident throughout *The Discovery of Grounded Theory* (Glaser & Strauss, 1967) and the later writings of Glaser, Strauss, and Strauss and Corbin. Nevertheless, much of what Glaser and Strauss wrote, both jointly and separately, was instrumental in moving social inquiry into modes of research that abandon the epistemological perspective of objectivism (Annells, 1996; Bryant & Charmaz, 2007a; Clarke, 2005). Constructionist GTM represents one notable paradigmatic shift in the application of the methodology. It aims for socially constructed grounded theories that incorporate explicit interpretative and reflexive elements in the research act. As noted earlier in this chapter, constructionist research maintains the notion that social knowledge is an interpretation of the meanings constructed by participants and researcher concerning a social situation or phenomenon. Consistent with this is the view that knowledge is relative to the people and context in which it is studied. This view underpins the decision to capture employers' perspectives, understandings and interpretations at an individual and personal level of inquiry, with full acknowledgement that the findings could only reflect my understanding of their views.

### 3.2.3.1 Reflexivity

Constructionist GTM takes an unambiguous view of researcher reflexivity and sensitivity to the ideas, concerns and assumptions that prompted the research in the first place. Charmaz (2006, p. 188) defines reflexivity as:

...the researcher's scrutiny of his or her research experience, decisions, and interpretations in ways that bring the researcher into the process and allow the reader to assess how and to what extent the researcher's interests, positions, and assumptions influenced inquiry. A reflexive stance informs how the researcher conducts his or her research, relates to the research participants, and represents them in written reports.

This contrasts with the view that requires the GTM researcher to begin the enterprise with no preconceptions or research questions and encourages researchers to aim for objectivity in their data collection and analysis (Glaser, 1978; Strauss & Corbin, 1998). In arguing for reflexivity in GTM research, Hall and Callery (2001, p. 258) wrote the following:

Strauss and Corbin (1998) have stated that the researcher must take appropriate measures to minimize the intrusion of subjectivity into analysis; our proposals acknowledge the intersubjective construction of the data.

Reflexivity and the associated notion of relationality, which is the consideration of the influence of power on researcher and participants, are argued by Hall and Callery (2001) to add rigour to GTM studies. Further, although he did not discuss reflexivity explicitly in his writings, according to a former doctoral student of his, Strauss encouraged her to consider her own history and what she brought to her doctoral study (Covan, 2007).

Mruck and Mey (2007) outline four strategies for enhancing researcher sensitivity:

- Reflexion on decision for choice of research question and project design;
- Reflexion during sampling and data collection processes;
- Reflexion during data analysis;
- Reflexion on influence of writing and publishing.

The fourth strategy refers to anticipation of audiences and avoidance of invisibility in authorship. They describe three presentation styles for reflexivity: confessional style, radical unmasking of hidden agendas, and ‘modest’ explorations of ‘what is going on’ in the research process. In this thesis, I have engaged all four strategies outlined by Mruck and Mey (2007) and have used their second and third presentation styles.

In summary, constructionist GTM makes use of the inferential processes of GTM to arrive at a shared, constructed understanding and this, along with its quality of reflexivity, is consistent with the aim of the inferential process for best explanation rather than objective truth.

### **3.3 Grounded theory methodology in the present study**

Like many grounded theorists, I adjusted my approach to analysis as I gained experience with the process. I had encountered practitioners who argued for a dogmatic approach to either Glaserian or Straussian GTM, and who suggested that I had to decide early and stick to one approach. Eventually, guided by the words of Glaser, Strauss and Corbin, and the more recent writings of Charmaz (2006), Dey (2004), Fendt and Sachs (2008), Mruck and Mey (2007) and Suddaby (2006), as well as the criticisms by Miller and Fredericks (1999) and Thomas and James (2006) (Appendix 2), I became more confident about listening to the data and less concerned about following a doctrinaire or formalistic approach. Like others (Fendt & Sachs, 2008; Williams, 2005), I became aware that much of the confusion surrounding GTM was likely the result of over-explanation and theorisation about the theorisation process itself. Bryant & Charmaz (2007b) comment on the development of GTM over the past decades and the need for practitioners to be flexible and open to the use of the methodology as appropriate to their research:

GTM is based around heuristics and guidelines rather than rules and prescriptions. Moreover researchers need to be familiar with GTM, in all its major forms, in order to be able to understand how they might adapt it in use or revise it into new forms and variations. (Bryant & Charmaz, 2007a, p. 17)

Ultimately, I came to see the methodology as a well-conceived guiding framework for an inductive inferential cognitive process that enhances intuition and leads to

highly plausible, pragmatic insights into a substantive area of educational and commercial interest.

## Chapter 4: Student Perspectives

This chapter reports on a preliminary study of EHDR students that explored their beliefs about the value of EHDR study to their future professional goals. This exploration of students' perspectives was undertaken prior to the study of employers' views, to provide background and scoping information for the subsequent study of employers. Using a focus group format, the students were asked to discuss their reasons for undertaking EHDR study, their future professional goals, the ways their experiences of EHDR candidature prepared them for the workplace and whether they believed it presented any impediments to their professional development. The aim of the focus group study was to acquire a sense of what EHDR candidates hope to achieve professionally by undertaking HDR study.

The EHDR candidates who participated in this preliminary study were based in an Australian university that provides many engineering graduates to local industry and research organisations. The university is in the same location from which most of the employers who participated in the main study were drawn. Thus, the views of these students were considered to be part of the substantive area of investigation. Their perceptions were considered a useful contribution to the scoping of the main study because they may have undertaken previous work with the employers to be interviewed, they have experienced HDR training similar to many of the EHDRGs who would be employed by the employers in the main study, and some would likely apply for employment in the organisations associated with the participants in the main study. The insight gained into EHDR students' perspectives on their future engineering work sensitised me to the comments offered by employers in subsequent interviews. In particular, my understanding of the students' beliefs allowed me to more accurately imagine EHDR graduates as the employers saw them, to contrast my own perceptions with those of the employers, and to query specific areas where the students' understandings appeared at odds with those of employers. Most importantly, contrasting the students' beliefs about their employment prospects with the employers' beliefs would reveal any discrepancies between the expectations of the two groups. The assumption is that any such revelation could inform initiatives to

achieve more accurate professional expectations of engineering HDR candidates and potential employers.

The students' views were explored in two ways: by content analysis and by concept analysis. Content analysis allowed me to determine the specific answers to the discussion guideline questions and concept analysis allowed me to benefit from the insights that were forthcoming in the free-flowing group discussions. Descriptions of these techniques are provided in Sections 4.3 and 4.4.

## **4.1 Use of focus groups**

A focus group is a group discussion that is 'designed to obtain perceptions on a defined area of interest in a permissive, nonthreatening environment' (Krueger, 1988, p. 18). In this study, focus group discussion was undertaken because it offered an efficient way to gather information, in the form of similarities and variations in ideas, about the perceptions of EHDR candidates of the relevance of EHDR study to their professional goals. The group format has the capacity to spark new ideas in participants by providing them with the opportunity to consider alternative viewpoints, to share information and strategies, and to gain perspective on their own experiences (Carey, 1994; Krueger, 1988). Other advantages include the high face validity of focus group results (Krueger, 1988) and the flexibility that focus groups offer in addressing interesting responses and issues that arise during the discussion.

### **4.1.1 Elements of focus groups**

An important characteristic of focus group discussion is that the outcome is generated from group interaction (Asbury, 1995). This occurred in the two focus group discussions for this study. However, despite the benefit of group dynamics in generating ideas, the nature of the guiding questions tended to restrict the participants' responses, particularly at the commencement of each discussion. The benefit of this early restriction was that I was able to gather direct responses to the questions, which could be tallied in a content analysis. The free-flowing discussion that followed provided richer information about the participants' experiences and expectations of engineering practice beyond their research candidatures. Insights were also gained into the way EHDR candidates understand the experiences of

research candidature. The following elements contributed to the optimal functioning and discussion outcomes of the focus groups in this study.

*Group participants:* An essential quality of focus groups is that participants share the phenomenon in question (Asbury, 1995). Groups function best if there is little or no status differential amongst the participants. This influences participant comfort and likelihood of frank disclosure (Carey, 1994). In the current study, all the participants were active HDR candidates in the engineering schools of the target institution (See Section 4.2). I was the only investigator in the room and, although I was a member of academic staff in the same university, I did not have responsibility for assessment of the participants' performance in their studies. I considered this and my own HDR status to be levelling influences.

*Group structure and process:* Ideal focus group discussion duration is usually between one-and-a-half to two hours (Asbury, 1995). The recommended group size is between four and twelve participants (Cohen, Manion & Morrison, 2000; Krueger, 1988). In this study, both focus groups were of the recommended duration. One focus group (Focus Group 1) had five participants and the other (Focus Group 2) had ten.

The use of more than one group has been suggested to increase likelihood of saturation, with Asbury (1995) suggesting conducting up to four focus groups on a single topic. While the use of numerous groups affords the potential for a greater range of responses to complex questions and provides opportunity for inter-group comparisons, neither of these benefits were necessary in the present study. Two groups were considered adequate for a preliminary study because the responses, if not the frequency of them, were similar for both groups; the topic for discussion was not complex, and the HDR student population size in the engineering schools would not have yielded many more participants.

*Number of guideline questions:* Carey (1995) recommends that no more than five questions should be put directly to the participants, as more than this number tends to fracture the discussion and results in a survey type question and response process. Five guideline questions were used in the focus group discussions for this study.



*Physical environment:* Asbury (1995) commented that the environment for focus group discussion must be comfortable and that participants should be positioned so that they see each other. A sense of trust can be encouraged with an appropriate opening question that acts as an ‘icebreaker’ and seeks limited personal disclosure. Carey (1994) suggested that providing food can establish comfort and rapport between participants and with the group leader. Both focus group discussions in this study were conducted in comfortable board rooms in the respective engineering schools, with participants seated around a large table. The first guideline question did not demand revelation of much personal information and provided an opportunity for the participants to become better acquainted. Focus Group 1 was conducted in late afternoon and Focus Group 2 during lunch time. In both cases, food and non-alcoholic drinks were provided.

*Data analysis:* A frequently used analytic technique in focus group studies is content analysis, which quantifies the number of utterance units that address a pre-determined question or a hypothesis (Insch et al., 1997). Initially, I used content analysis as the technique for determining the responses to the focus group guideline questions (see Section 4.3). The results provided basic background information about the participants, including their initial reasons for commencing EHDR study, their existing knowledge about professional engineering work, and their future professional intentions. However, I concluded that much interesting information was missed by restricting the analysis to a number of utterances of a certain type. Concept analysis, a more sensitive, qualitative approach, revealed more from the ensuing discussions between participants. Carey (1995) suggests that simple first-level (open) coding and category formation of grounded theory analysis (Glaser & Strauss, 1967; Strauss & Corbin, 1990) can be used to conduct concept analysis of focus group data. This was the approach I took to analysing the richer data provided in these group discussions.

## **4.2 Method**

Ethics approval was sought and obtained from the Research Ethics and Compliance Unit of The University of Adelaide (Appendix 3). Postgraduate research students from the Schools of Mechanical and Chemical Engineering in an Australian

university were invited to participate in a discussion centred on their beliefs and understandings about the ways in which candidature prepares them for their anticipated professional roles. The communication sent to students prior to the focus group discussion is presented in Appendix 4. Five key questions prompted the open discussion:

- Why did you choose to undertake postgraduate research?
- What do you plan to do when you finish your studies?
- What is your professional work experience so far?
- What elements of your postgraduate research experience contribute to your preparation for your eventual professional role?
- Does anything in your postgraduate research experience appear to detract from or be irrelevant to your future goals?

The discussions were audio recorded and transcribed, with the understanding that participant confidentiality would be maintained. Participants were asked to sign a written consent form (Appendix 5) prior to commencement of the discussion.

Participants were identified according to their seating position during the discussion; this was done to aid my memory during analysis. Each participant in Focus Group 1 was given the identifier ‘A’ and a number according to her or his seating position: A1, A2, etc. Participants in Focus Group 2 were given the identifier ‘B’ and a number in the same manner. All of the participants were PhD candidates.

### **4.3 Method 1: Content analysis**

This technique was used for the initial analysis of the focus group transcripts because it provides a straightforward means of determining basic, uninterpreted answers to the guideline questions (Insch et al., 1997). In this approach, textual units of meaning are defined, identified and counted, and the totals for each unit are interpreted.

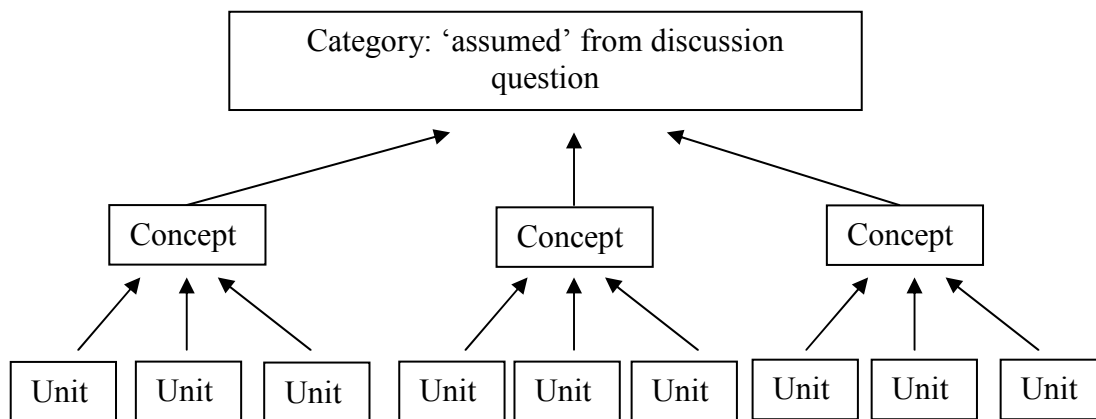
### 4.3.1 Coding

The analysis units used to analyse the text in each focus group transcript were word, word sense, phrase or sentence. Due to the relatively informal and unstructured nature of focus group discussions, comments addressing one question occasionally had relevance for another question. In such cases, they were treated as multiple classifications (Insch et al., 1997) and counted both times. For example, the following comment was made in response to Question 2:

‘As for teaching or lecturing, I may or may not become involved with that also, because I’ve always enjoyed being able to teach people. You know, seeing that little light bulb come on.’ (*Underlining indicates my emphasis.*)

The third phrase, ‘because I’ve always enjoyed being able to teach people’ implies the speaker has had teaching experience. The fourth phrase strengthens the implication. Phrases 3 and 4 are equally relevant to Question 3 about professional work experience, and so were ‘counted’ twice. An unavoidable result of this method during the report of its findings is the repetition of quotes that illustrate several meanings.

A unit of text was coded under the question to which it was related. The questions were used as assumed categories, meaning they were categories determined prior to the data collection (Insch et al., 1997). Categorised units were then further clustered into concepts according to their meanings (Figure 4.1).



**Figure 4.1: Structure of content analysis.**

### 4.3.2 Results

Fifteen postgraduate research students in the Schools of Mechanical Engineering and Chemical Engineering at the University of Adelaide responded to a request for participants in one of two focus group discussions (five and ten participants respectively). In the content analysis, the five key questions formed the categories for analysis.

The responses to the guideline questions are presented in Tables 4.1 to 4.5. Each table lists the concepts that emerged, the cluster of similar responses to the question, the number of Focus Group 1 (FG 1) participants who provided a positive response for the concept, the participants who provided the responses, the number of Focus Group 2 (FG 2) participants who provided a positive response for the concept, and the total number of positive responses for the concept. A positive response was a comment made by the participant that expressed ideas akin to others that formed the concept.

The responses to Question 1, ‘Why did you choose to undertake postgraduate research?’, were analysed and the resulting concepts and number of comments relating to each concept are shown in Table 4.1.

**Table 4.1: Reasons given for undertaking higher degree by research study, in descending order of frequency**

Concept	FG 1	Participants	FG 2	Participants	Total
Believed EHDR would enhance employment/promotion	4	A2, A3, A4, A5	7	B1, B2, B3, B6, B7, B8, B9	11
<sup>1</sup> (Specifically sought research career)	(4)		(1)		(5)
Offered an opportunity for interesting, challenging work	2	A1, A2	3	B1, B3, B4	5
Offered scholarship/seen as temporary job	1	A1	3	B4, B5, B10	4
Wished to pursue a field of interest	2	A2, A5	1	B2	3

<sup>1</sup>Parentheses indicate response was embedded in previous responses about employment enhancement.

Most participants chose to undertake HDR study because they had considered an EHDR as a means of enhancing career opportunities. For some, this meant a way to move more quickly up the career ladder, either in research or industry:

*[I]* sort of convinced myself that doing a PhD was the right thing *[and]* maybe when I get in the workforce it will allow me to climb the ladder with greater speed. (B6)

Five students specifically stated that they wished to pursue a research career when they commenced HDR study:

I was actually offered a job at the end of the degree, which is something, not in the field I wanted to get into, which is one reason why I knocked it back. And more so did the PhD to try and get into research. (B8)

Okay well I've always been interested in research as such... I'd like to be involved in, uh, more pure forms of research and basically doing a PhD is an obvious stepping stone to be able to do that. (A4)

Only three identified a wish to pursue a specific field of interest as their reason for undertaking further study. Two of these were primarily interested in research careers and one (B2) sought a career in industry:

I wanted to go into the *[named specialised]* field in particular and decided that I needed some experience in that field, period. So I came and approached people here and I'm mostly using my degree as a way to gain experience in *[specialist]* research. (A5)

Five participants mentioned their desire for interesting, challenging work and voiced a strong belief that work as a graduate engineer would fail to deliver the intellectual and creative stimulation they wanted from their work:

‘For me it was a bit of a disappointment with actually being in the industry to begin with. Didn’t meet sort of my expectations and realisations. I think some of it can be boring...’ (B1)

Yeah a wider range of different things not like, working perhaps on a production line where you’re installing a bolt on the under side of a Magna all day everyday. (A2)

Four students identified that being offered a scholarship was a catalyst for undertaking research studies, while two viewed higher degree candidature as a temporary, interesting job. This was an added incentive to their decision to undertake EHDR study, in that it combined with their desire to engage in interesting work:

And then [I] got a PhD offered here, completely independently and it’s essentially something I like, something that was fun, and job security for three years under full payment. Under some payment which is enough to get by. (A1)

Only one student openly admitted that he wanted the status of being called ‘Doctor’, but a large number also laughingly implied accord with this view.

The responses to Question 2, ‘What do you plan to do when you finish your studies?’ are shown in Table 4.2.

**Table 4.2: Plans for post-completion work**

Concept	FG 1	Participants	FG 2	Participants	Total
Industry employment (includes private sector research and development)	3	A1, A2, A5	5	B2, B6, B7, B9, B10	8
Research (in research organisation or university)	3	A1, A3, A4	3	B3, B4, B8	6
Teaching	4	A1, A2, A3, A4	1	B10	5
Self-employment (as consultant)	1	A5	1	B1	2
Pursue challenging work (including internationally)	1	A1	1	B9	2
Does not know	0		1	B5	1

Most respondents identified more than one potential path. None mentioned availability of a definite job prospect, and all seemed unsure about their post-candidature future. Only two participants (A4 and B8) restricted their future roles to the pursuit of research careers. Five students said they would consider teaching and lecturing because they enjoyed the teaching experiences offered during candidature:

Having had some experience this term with lecturing that was not as bad as I'd expected. At least not for me. (A1)

As for teaching or lecturing, I may or may not become involved with that also because I've always enjoyed being able to teach people. You know seeing that little light bulb come on. (A4)

That's interesting because I always thought if I stayed with a university, I'd only want a teaching role. It's interesting. I'd quite enjoy teaching. (B10)

However, there appeared to be a lack of interest in academic work that required both teaching and research roles because the participants perceived it to be frustrating and difficult, with little opportunity for research and career advancement:

But I also see the lecturers at our university, and ...they're expected to do research on the side, they're expected to be involved in research but the reality is they have absolutely no time for that. I think for one or two years that would be really interesting but I'd get to a stage where I felt I'd no longer be furthering myself. (A4)

I'm not all that interested in it [*academia*], mainly because if you look at all the research grants that everyone does, they've got to promise the earth and they achieve nothing of what they proposed that they're going to do. And I just find that quite irritating and depressing just repeatedly putting up this huge big ARC [*Australian Research Council*] plan and then sort of only achieving a small proportion of it. So I don't really want to do that. (A2)

Well I kind of wanted to continue working in research ... Maybe [*Named research institute*] or something like that. Or research with a university but not necessarily as a lecturer, more like post doc or something like that. (B3)

The responses for Question 3, 'What kind of professional experience have you had so far?' are summarised in Table 4.3.

**Table 4.3: Previous professional experience**

Concept	FG 1	Participants	FG 2	Participants	Total
Worked prior to commencing candidature	1	A1	5	B1, B3, B4, B9, B10	6
Teaching in a tertiary institution during candidature	4	A1, A2, A3, A4	2	B9, B10	6
Consultancies while in university	2	A3, A4	2	B6, B10	4
No experience prior to or during candidature	1	A5	3	B2, B7, B8	4
Non-engineering professional level work during candidature	0		2	B9, B10	2

More than half the participants had no previous experience working as engineers outside the university and had undertaken their postgraduate training following directly from their undergraduate study. Three had worked as graduate engineers in industry (B1, B4, B9), two had worked as graduate engineers in a research organisation or university (A1, B3), and two worked in non-engineering specialised technical employment (B3, B10). Of the five who had previous engineering workplace experience, three had worked in a number of jobs and found the type of work they were offered to be unsatisfying.

Four students had been engaged in engineering consultancy work during candidature and six mentioned casual teaching work during their candidatures. However, it is likely that others had this teaching experience, since casual tutoring and demonstrating positions are commonly offered to and undertaken by postgraduate students.

The responses to Question 4, ‘What have you learned from candidature that you believe is of value to prospective employers?’ are shown in Table 4.4.



**Table 4.4: Contributions of higher degree by research experience to professional role**

Concept	FG 1	Participants	FG 2	Participants	Total
Communication skills	1	A3	10	B1, B2, B3, B4, B5, B6, B7, B8, B9, B10	11
Organisational skills (time mgt, task preparation skills, meeting org skills)	0		8	B2, B3, B4, B5, B6, B7, B8, B9	8
Technical knowledge/advanced problem solving	2	A2, A3	5	B1, B2, B6, B7, B9	7
Ability to work independently	3	A1, A2, A3	4	B5, B6, B8, B9	7
Large-scale project management	4	A1, A2, A4, A5	1	B10	5
Self-confidence/self-appraisal	0		3	B1, B5, B8	3
Learned how to teach/supervise	1	A3	1	B3	2
Persistence	2	A4, A5	0		2
Experience of creative/intellectual freedom	0		1	B10	1

Communication skills were identified eleven times as an outcome of value to the EHDR candidates' future professional work (see also Section 4.3.3.1, Group Differences). These skills can be associated with many of the other items listed in Table 4.4 and, therefore, were coded as such in this study only when the following were identified: the ability to write for various purposes and audiences, including non-technically trained audiences; the ability to speak both in formal and informal settings; and development of negotiation skills and group management skills specifically related to dealing with people such as supervisors. Including their responses to Question 4, during the course of discussion the participants made eleven references to communication skills and communication-related professional experience gained during candidature. Participants believed that they benefitted by presenting their research and having the opportunity to see and hear others present:

... experience you get from going to seminars and some of those conferences is very good ... but actually listening to other people, also sort of shows you how not to give a presentation (*B1*)

They also believed that they gained skills in general communication with a wide range of people in the university and beyond:

I think sort of the communication between sort of myself and people higher in the department and also staff in the department is good. There's, I don't, haven't necessarily got on well with everyone and sort of learned to deal with that as an experience in itself. (B10)

I had the same experience with consulting which is always something that employers would like to see. You do have some, you had been involved with industry people, you do know how to talk to them and you do know how to write a report that the manager can understand or write a report that engineers can understand. So it's not just the academic, it's not just the research, do the experiment and analysing data. (A3)

Organisational skills that involve cooperation with other people require good communication skills. However, the concept is treated separately here because it includes personal self-regulation skills such as time management and personal task planning. Organisational skills also include the planning and organisation of meetings and the planning and structuring of work tasks. The students also believed that they learned how to run efficient meetings and they valued the experience of attending conferences and learning about conference organisation. Most often mentioned was the value of time management skills developed during candidature:

A lot is on time management and especially preparation. My PhD is more in biotech sort of field, so if I want to do an experiment I sort of have to start planning one to two weeks in advance to get things ready. So I've got a time management area there. (B8)

Despite the frequent mention of time management, one participant who had previous industry experience offered a contrasting comment:

To be honest I wonder why everybody is focusing on this time management thing as though that's something useful to get out of this experience. I don't even think it's necessary because you can learn about time management far quicker when you actually get into industry. (B1)

Seven students noted the value of an enormous amount of technical and theoretical knowledge, including a deep understanding of the theoretical concepts relevant to their area of research, which they learned from working on their projects. Several claimed that this far exceeded what they had grasped in their undergraduate

education; it is noteworthy that these students were some of the best achieving undergraduate students:

So when I go out into industry and someone says, ‘Do you know how to design a gas adsorption column?’ or something like that, I do and I’ve taught people how to do it. And so I sort of remember it now, whereas as an undergraduate I thought, ‘Ah I remember passing that exam but didn’t really get it.’ So I think that knowledge has been consolidated a lot. (B9)

The participants also believed that they had developed advanced technical problem solving abilities:

What I’ve learned from my supervisor is how to tackle problems, methodology, application of experience from one area or one area of research to another, and that’s, that’s something that I’ve learned just from being involved with my supervisor. He supervises many, many, many students. And who are all doing relatively different, different areas of research. (A3)

Yeah, the [EHDR] study has helped me to learn to identify problems from different perspectives. (B2)

The ability to manage a large-scale project was specifically mentioned by five participants as a professionally valuable outcome of their postgraduate research studies. This was considered valuable because they believed it provided evidence of some or all of the following abilities:

- to conceptualise a problem;
- to critically assess the approaches used previously on the same or related problems and to develop a novel solution;
- to break the project down into a series of manageable tasks, each requiring a diverse skill set;
- to negotiate with a wide range of professional and technical staff; and
- to display flexibility in approaching tasks and unforeseen difficulties.

EHDR studies also demanded the ability to build the equipment and tools required and to manage all of the skills and attributes necessary within tight budget, time and resource constraints:

Because what I'm going to get out of it and where I will be able to market to future employers, whoever they're going to be is that I have long-term experience in long-term project management. I have undertaken a three year project. In my case especially... because another person who was involved in the project originally deviated in a different direction. So I ended up doing the initial experiments, preliminary experiments. I've completely designed a new research facility, build a research facility myself, done my experiments and now analysing my results. So I've done the whole thing from start to finish. [...] And seeing it through to the end, essentially writing a thesis is just the finish of a, of a project management. (A1)

Participants identified a number of personal characteristics they believed to be developed or enhanced by engaging in HDR study. These were clustered around confidence, independence and persistence. The development of confidence in oneself was identified as an attribute in its own right and was associated with other skills gained, such as communication or independence:

And also the self-confidence has built up, doing this work fairly independently. (B8)

...cause that gives you a lot of confidence to be able to communicate with other people. (B1)

The HDR process was viewed by the students as character strengthening in its demand for the personal characteristics such as independence, persistence and determination to continue in the face of discouragement:

For me probably, probably the best thing I'll get from the PhD is just learning how to survive such a job with so much flexibility and self-motivation, and self-discipline required to complete it... it's [a] very slow, very painful process for me. (A5)

Several participants believed their capacity for self-appraisal, by which they meant the ability to reflect critically on one's own work without losing self-esteem, had developed during candidature:

Independence, self-appraisal ...Yeah, having to think that you're alright.  
(B5)

In addition, the ability to work independently is strongly fostered in the Australian postgraduate research process; seven candidates felt that this ability had been extensively developed during candidature. The long-term nature of this type of project means that it requires vision, persistence and flexibility:

... the ability to be able to work in a research project, for most of us ...our thesis topic, our research towards our PhD is the biggest single task that we've ever undertaken. However much our supervisors have been there for us, however much they've supported us, we're the ones that have done the research, we've done our experiments, played around with our equations, written it up and submitted it. Some employers will appreciate that. Others won't. (A4)

I think the most important thing is I've managed to succeed in a project, I think I have anyway, independently. (B6)

Teaching and supervising undergraduates was understood to be a valuable form of professional development by some students:

I've always, every single year, I've supervised a fourth year student on a project. So I've learned how to supervise individuals as well and try and get the most out of them. And that's something that I think will be beneficial to me later. (B3)

One thing I don't think anyone else touched on was the skills you develop that are outside of your, the research project. In my time here I've done a lot, a lot of teaching, not just marking and tutoring whatever, but actually development of lecture material and delivery of lecture material. (A3)

The responses to Question 5, 'What, if anything, has interfered with your professional preparation during candidature?' are summarised in Table 4.5.

**Table 4.5: Beliefs about impediments to professional preparation**

Concept	FG 1	Participants	FG 2	Participants	Total
Supervisor/supervision	1	A2	5	B2, B3, B4, B6, 10	6
Irrelevant compulsory activities	3	A2, A4, A5	2	B6, B4	5
The PhD	1	A3	3	B1, B6, B10	4
Lack of adequate remuneration	0		3	B1, B6, B10	3
Opportunity for poor time management/ bad habits	1	A5	3	B9, B9, B?	2
Lack of resources	0		2	B4, B10	2
Confidential HDR research	0		1	B3	1

The participants tended to interpret this as a question about both their professional and personal goals. With the exception of the third item, ‘The PhD’, participants focused their responses on obstacles to PhD completion, rather than on any aspect of their learning that they felt might be irrelevant to their future workplaces. The participants wished to complete their candidatures and start professional work. In this respect, supervisors were seen by candidates as placing obstacles in their way toward completion, particularly in their demands for conducting additional research perceived as irrelevant to their study focus:

I mean they, supervisors are really great at halting your momentum. Especially here, especially when they say, ‘Right just do a few more experiments in this area’. (B3)

Some students were frustrated that their momentum was halted further because they were required to meet administrative demands of the University or their departments, such as presenting seminars or submitting progress reports. Additionally, for some participants the unstructured nature of candidature was blamed for engendering in them an undisciplined approach to their work schedule. They viewed this as unprofessional behaviour and likely to be unattractive to employers:

I think there are two different types of time management though. The one in industry is you’ve got deadlines that you have to meet, whereas here you’ve just got this massive ‘doesn’t matter’ time. [*laughter, talking over each other*] (*speaker unidentified*)

I think that, sort of it's tied in with the time management thing, being a PhD student here it's a very, it can be a very comfortable lifestyle. There's no set time you have to turn up and you can fall into very bad habits, and I think that when you go back out into the industry it's very, it can be a bit of an adjustment to like have to suddenly be at work on time. (B9)

Perhaps the most interesting finding of this study was that four participants believed the PhD itself to interfere with their opportunities for professional work. Their pessimism related to the time they spent out of the workforce and their perception that employers did not value PhDs:

That was actually going to be my serious answer, is that I'm concerned, because I'm not interested in working in academics [*sic*], that a PhD may restrict in the areas that I want, I potentially want to work in. And I'm just still not sure whether that's the case. (B10)

I went to a job interview about two months ago ... they let me know that the PhD was of no value to them whatsoever. They said, 'We hire your learning capacity and previous experience'. (B1)

Although I would be interested in working in an industry, at this stage I wouldn't see how I could actually move in to that given my age and how I've been here for so long. And my lack of industrial experience, I wouldn't see how I could actually move in there. (A2)

Lack of resource availability hindered momentum and completion by using valuable time searching for access opportunities or waiting for equipment:

I've got probably two months worth of experiments to do and that will be all with my PhD. I bet you it takes me five months to get enough lab access to do that. (B10)

Only one participant worked with confidential research that was embargoed. The participant found that the restriction placed on his communication of research results presented a significant constraint on his future professional work:

Doing confidential research. When I started my PhD I was working with [*research institute name*] as well and they want an embargo on my thesis and they also wanted, you know, proof, everything I wrote and things like that. So you get the delays with that but plus if you've got an embargoed thesis and you're going for a research position it makes it a lot harder. (B9)

This is a potential disadvantage of confidential industry research topics (Slaughter et al., 2002) and an occasional by-product of external sponsorship of research in EHDR projects.

### **4.3.3 Summary of content analysis**

The students in this study chose to pursue EHDR study primarily because they believed it would enhance their career opportunities. Most participants identified more than one potential type of post-completion work they might pursue. Less than half identified careers as professional researchers in a research institute or university. This number included participants who expressed a desire for industry work but did not believe they would be attractive to employers. Most participants expressed a desire to work in industry.

Nine students had experienced previous employment in engineering fields or consultancy work during candidature. This is equivalent to or greater than the experiences of many EHDR candidates noted in industry-collaborative projects.

A majority of the participants believed they had developed communication and organisational skills, and particularly improved the ability to manage their work time. They also noted much improved knowledge and problem-solving ability, independence, and skills in managing all aspects of a large engineering project.

The main immediate professional goal of many of the participants was to complete their HDR program and pursue paid work. Less than half identified what they believed to be significant obstacles to this achievement. Those who did identify obstacles mentioned supervisor and administrative demands on their time to pursue activities they believed irrelevant to the achievement of their goal to complete. Several participants mentioned their concern that pursuit of a PhD in particular had removed them from the workplace and, as a result, jeopardised their chances for employment.

#### *4.3.3.1 Group differences*

A number of interesting differences were observed between the two focus groups. FG1 had five participants and FG2 had ten. All of the participants in FG1 were from the same school, whereas FG2 consisted of both mechanical engineering and



chemical engineering HDR candidates. The smaller numbers in FG1 were likely explained by the timing of the group meeting, just prior to the end of the year and a major public holiday. This meant there were fewer students in the university at the time. Notwithstanding that FG2 had twice the number of participants as FG1, a number of noteworthy differences were evident between the number of responses provided by both groups.

Four of the five FG1 participants pursued HDR study because they were interested in a research career; only one FG2 participant stated this as a reason for commencing. The large proportion of FG1 students interested in research careers might be explained by the timing of the discussion; those interested in research might find the pursuit of research more engaging and prefer to spend more of their time at the university.

Question 1 asked participants for reasons why they chose to undertake HDR study and Question 2 asked what they planned to do when their studies finished; responses reflected how the students felt at the time of the discussion. Not surprisingly, some had changed their minds over the course of candidature. The reasons for these changes are explained in the concept analysis, Sections 4.4.1.3 and 4.4.1.4.

The biggest difference between the responses of FG1 and FG2 are those found to the question ‘What have you learned from candidature that you believe is of value to prospective employers?’. Only one FG1 participant identified communication skills as a professionally valuable element of the professional postgraduate research experience; all ten FG2 participants mentioned the value of these skills. No FG1 participants mentioned any of the tasks grouped into organisation skills, whereas most of the FG2 participants did. Possible explanations for these differences are that the research-inclined FG1 participants did not distinguish between the role of researcher and the role of research communicator, but saw communication to be intrinsic to research:

Primarily from what I see around me, people who are more involved with research end up writing papers, be involved in publications, and end up furthering their career. (A3)

Thus, by stating they were interested in being researchers, perhaps they believed that by implication they were already operationalising the skills necessary for research.

As for the difference between groups in the identification of organisational skills, it was the more externally focused participants in FG2, such as B2, B6, B7 and B9, who identified the types of tasks they associated with industry employment, such as conducting meetings and completing tasks efficiently. This was particularly evident in the number of responses from FG2 participants that related to time management.

It is possible that these responses were the result of a group effect; this is the concept that once an idea is presented by a participant, others are made aware of it and, if they agree with it, will assume a similar position (Carey, 1994). Thus, when communication skills were initially mentioned by a participant in FG2, other participants tended to amplify the response. FG1 participants tended to consider project management and independence as important developments once the idea had been presented by a single participant. However, although a group effect might have had some influence within FG2, it seems unlikely to have been a major factor, given that there were also instances in which participants openly disagreed with each other and displayed rigorous independence in their responses.

A similar phenomenon appears to have been evident in the tendencies by both groups to consider the demands of supervisors and administration as obstructions to the completion of candidature. According to Carey (1994), negative views are more frequently influenced by the group effect. She notes that it is unclear whether this is because a comfortable focus group elicits more candid responses than do individual interviews or surveys, or because there is a ceiling effect on positive but not negative views in focus group responses.

#### **4.4 Method 2: Concept analysis**

The previous section presents the results of content analysis with concepts organised under assumed categories that were pre-determined by the guideline questions. Content analysis offers clear responses to the immediate questions, but does not reveal all the participants' interpretations of their experiences of candidature, as related to their future professional work.

This section reports on the findings from analysis using ‘open coding’, which is the first level coding and conceptual ordering of qualitative interview data as described by Strauss and Corbin (1998). Open coding is the process of ‘naming and categorising phenomena’ (Strauss & Corbin, 1990, p. 62). It involves close examination of text, focusing on participants’ words and phrases to identify basic notions or concepts that were expressed by the participants. The researcher then compares these elements of the text with each other, and identifies relationships between concepts. The concepts encapsulate not only the participants’ descriptions of their experiences, but also their explanations, interpretations, feelings and reactions to events (Strauss & Corbin, 1998). Then, rather than using pre-determined categories as was done in the content analysis, coded concepts are further compared and linked to form categories; each with properties, dimensions and relationships to other categories. Codes are the labels used to identify concepts and categories.

An example of the open coding process from this analysis is as follows. During the discussion, I noted that, when discussing the reasons for embarking on HDR study, the focus group participants used the expressions ‘bored’ or ‘boring’, or expressed similar sentiment about graduate engineering work. I then analysed the transcripts at the word and phrase level for basic ideas expressed by the participants.

I looked at the situations that participants felt likely to be boring, such as professional engineering work routinely performed by undergraduate qualified engineers. This was viewed as work where little freedom was allowed for the professional engineer to make decisions about what, when and how their work should be undertaken, whether during industrial project work or pure research work. I clustered the similar emergent ideas into concepts and then searched for relationships between the concepts:

I’d get bored doing the same thing.

...it [graduate work] can be boring.

...they find it boring.

Boring.

I was rather bored.

No, not rewarding ... seen as a ‘gopher’ really.

you sit in front of a desk...just want to get out.

... all they're [*lecturers*] doing is teaching the same subjects year in and year out.

... not like you know, working perhaps on a production line where you're installing a bolt on the under side of a Magna all day everyday.

These comments formed an early concept of 'Avoiding boring work', suggesting that work performed by undergraduate qualified engineers and academic teaching staff was considered monotonous and not enough to maintain interest. This concept appeared to align with other emergent concepts of 'Seeking challenge', 'Seeking variety', 'Seeking to indulge curiosity' and 'Seeking freedom and autonomy', all of which indicated that the participants wanted something 'more' than undergraduate qualified engineering work or routine academic work: thus, the category 'Wanting more' was formed by these concepts. Other categories emerged in a similar manner, and concepts could fit into more than one category.

Since the same data were used for both the content and concept analyses, some of the participants' comments presented throughout Section 4.3 are repeated in the concept analysis presented throughout Section 4.4.

#### **4.4.1 Emergent categories from focus group discussion data**

In total, four conceptual categories were evident from the participants' discussions, which I labelled as follows: 'Wanting more', 'Knowing their worth', 'Feeling stuck', and 'Moving away' (Table 4.6). These concepts occasionally overlap with the concepts revealed in the content analysis results. They also reveal the students' expanded explanations as to why they chose HDR study, how they coped with the increasing demand of the HDR experience, their beliefs about the value of HDR study and opportunities it presents for their futures, and their beliefs about letting go as well as strategies for moving beyond the experience.

**Table 4.6: Four emergent categories and associated concepts from conceptual analysis of the focus group discussions**

Wanting more	Knowing their worth	Feeling stuck	Moving away
... opportunity to excel	Gaining problem solving awareness	Feeling devalued	Feeling duped
... autonomy	Knowing financial worth	Stuck in the mid-ground	Boycotting as a completion strategy
... intellectual challenge	Claiming independent ownership of achievement		
... freedom and variety	Prioritising personal goals		
... opportunity to indulge curiosity			

The following subsections describe the properties of each category and provide comments made by the participants that capture critical attributes of the categories.

#### 4.4.1.1 *Wanting more*

The participants considered bachelor-level professional engineering work to be ‘not enough’. They wanted more opportunity to excel in their professional work, along with more intellectual challenges, personal freedom, variety and greater autonomy than they believed would be available to them with a bachelor-level qualification.

##### 4.4.1.1.1 *Wanting more opportunity to excel*

Many students were motivated by their belief that HDR study offered greater opportunity to get a job or to move ahead more quickly in the workplace, compared to bachelor-level engineering opportunities.

It seemed like it would give me like a bright prospect for *[the]* future. (B2)

I look at post grad study as a chance to, probably later on when I get the degree, and maybe I have more opportunity to get *[a]* job. (B7)

##### 4.4.1.1.2 *Wanting more autonomy*

The participants viewed EHDR achievement as potentially providing more opportunity, compared to bachelor-level engineering work, for them to exert autonomy and control over their work-related decisions. This related particularly to what they would do and how they should do it:

Where someone else is the manager, them giving you what research they want you to do and that in a way is against what I want to do. Because I want to be able to, as much as possible, choose my own areas, choose what I want to focus on. (A4)

Short-term goal is, is to get a job in the industry but long term I don't want to be stuck in the industrial thing. Much the same as [A4's] comments is that you don't, you want to feel that you have some control over your own destiny. If you're constantly being told what to research and such, that probably doesn't work. (A5)

I thought I was quite well qualified and experience, having a [Bachelor] degree to begin with, but I find at the end of the day you're still just really, you know, seen as a gopher really. (B1)

#### 4.4.1.1.3 Wanting more intellectual challenge

A serious misgiving about bachelor-level engineering work was the belief that it lacked the opportunity for intellectual stimulation. Graduate work was seen as failing to engage or challenge the intellectual interests of the participants:

And I did some work with [Name of company] while I was there, but yeah, I just find it, a lot of my friends have done it and they find it boring. (B3)

I'd gone out working in industry after I graduated under grad. But I found most of the jobs I was being offered I was overqualified for and therefore I was rather bored. (B4)

#### 4.4.1.1.4 Wanting more freedom and variety

The students expressed a strong desire to encounter varied tasks and challenges in their work. Many participants identified a desire to move easily from one employment position to another if they found these qualities to be lacking in a particular job. In addition, an EHDR was viewed by the participants as a portable and universally recognised qualification:

I actually want to do a fair bit of travel and one of the reasons is I did a PhD, I sort of mentioned, is that it's a very portable qualification and as far as getting work visas in other countries the PhD opens a lot of doors there. (B9)

If I can't, if [I'm] ultimately not suited to research and I find I don't like it, I'd like to do consulting as well. I just want to do something that's different every day or it has more challenges in it and it changes continually. I'd get bored doing the same thing. (B3)

#### 4.4.1.1.5 Wanting more opportunity to indulge curiosity

The desire to indulge curiosity was expressed as a love of the exploration of an area of interest and a drive to find answers and discover new things. For some, the drive was very strong and created a passion:

I like doing the research, I like sitting there and ... finding out, like sitting down and thinking, 'Right, no one knows how to do this, how can I do it?' I love that bit. ... I like the research, so I like finding out new things and you know. (A3)

Yeah I took up PhD mainly yeah because I'm interested in research. Doing things that's slightly new or novel. ... Yeah a wider range of different things. ... you really got to, basically have, you know, a sort of a vibe about it. You know, you want to do it, you know, because it's something new, you need to have a reasonable sort of motivation to do it. (A2)

I'm here 7 days a week pretty much as soon as I wake up till as soon as I get tired... so it's an obsession then isn't it? (A3)

For others it was strong but felt overwhelming. Having indulged their intellectual curiosity by exploring an area of interest and undergoing the experience of research study, these students were interested in moving on to other types of engineering endeavour:

... you know, comes from here [*points to his head*], you know, your mind keeps ticking over it. I find it a little bit hard to get away from work a lot of the time. Because it just sort of comes home with you. But I don't see myself impressed with research, I guess for that reason. [...] I like to do it. I just find it very draining. (B10)

#### 4.4.1.2 Knowing their worth

Part of knowing their worth was the strengthening of the participants' sense of self-worth. The students were aware of what they knew and claimed ownership over the amount and nature of what they had learned, sometimes emphasising how they have surpassed their supervisors in technical knowledge related to their research area. The participants' comments revealed that they were impressed with their persistence and determination and explained their future goal achievements largely as the result of these personal characteristics. However, they still sought affirmation from the broader community. A comment about 'ego' reinforced this interpretation that they

viewed the achievement of an HDR completion as the result of their own abilities and effort:

And there's probably a bit of ego involved in having Dr in front of the name. (B2) Yeah! [*spoken laughingly by several participants*].

I like the research, so I like finding out new things and you know. Yeah, it's a bit of ego with it as well (B1)

With the exception of participant A5, all were in their second or subsequent year of candidature. The candidates showed awareness of their development during the HDR experience, self-valuing of their strengths and abilities, and clarity of their goals and resolve to achieve them. The participants also revealed awareness of their growing capacity to solve large, complex problems and identify strategies for doing so. Their self-worth was revealed in their prioritising of their own goals in undertaking PhD study; they revealed awareness of their financial worth both to the University and to themselves, and they asserted independent ownership of their achievements.

#### 4.4.1.2.1 Gaining problem-solving awareness

This involved recognition of the ability to tackle problems and awareness of the problem-solving strategies the participants learned and strengthened through their studies. The ability was exemplified in the application of knowledge across research fields of interest, skills in dealing with a large and long-range task, and awareness of the usefulness of unstructured contemplation for revealing new ideas:

What I've learned from my supervisor is how to tackle problems, methodology, application of experience from one area or one area of research to another, and that's, that's something that I've learned just from being involved with my supervisor. He supervises many, many, many students and who are all doing relatively different, different areas of research. (A3)

But that's [*little direction during study*] beautiful too, though because it does give your brain the chance [*to*] like roam free. Most of my best ideas have actually come through being, not necessarily totally slack but just by meandering down a path which maybe if you had a boss on your shoulder they'd be saying, no just forget that. These little tangents have often been the best things I've found. [...] Just that freedom to actually move laterally on a few issues, we ended up finding a whole bunch of stuff that's going to be the, be my PhD. (B10)



Yeah, the study has helped me to learn to identify problems from different perspectives. ... And also I learn how to solve, I learn how to put bits and pieces together to solve problems. And I got an opportunity to learn new things that I didn't learn during my undergraduate time. (B2)

#### 4.4.1.2.2 Knowing financial worth

Part of the participants knowledge of their worth was expressed in their awareness of the income they were missing due to candidature. As professional graduate engineers in Australia, they would have been amongst the highest paid commencing graduates in the workforce (Graduate Careers Australia, 2009). For those who wished to work in industry, every year they spent out of the workforce was viewed as a substantial loss of income, and particularly so if their three year scholarship was finished:

However, I've got a supervisor who has promised me that is, once I have enough, he will say, start writing, write it up. Don't worry about anything else. That will do. ... If they want me to do further research after that, I've got no problems with that. But please for a correct price. [...] It's [*the PhD*] taken longer but because I've actually done things that don't belong into a PhD, I'm building a research facility actively with my hands; it's not part of being a PhD student. And that has taken essentially a year and a half and has cost \$150,000. That's the actual value of the facility including work costs and, and labour costs. (A1)

If I finish my PhD in three years as opposed to five years I'll probably be \$100,000 better off. (B10)

Awareness of their financial value to the workplace as graduate engineers also contributes to the participants' sense of being devalued, as is discussed in Section 4.4.1.3.

#### 4.4.1.2.3 Claiming independent ownership of achievement

The participants reached a point in their candidature where they credited themselves for their own work and claimed ownership of it. They were proud of their achievements and the time and effort that they expended performing work that was important to themselves and others:

... our research towards our PhD is the biggest single task that we've ever undertaken. And we've undertaken off our own backs. However much our supervisors have been there for us, however much they've supported us, we're the ones that have done the research, we done our experiments,

played around with our equations, written it up and submitted it. Or hopefully we will submit it one day. So it's something we've done and I think some employers will appreciate that. Others won't. It's just going to depend upon what areas you're working in. But I think the fact that we can commit ourselves to a long-term project - three, four, five year project and be able to actually complete this task in itself is the one biggest things that I'll gain out of it. [...] It's the people that want to finish, are the most persistent, they get there. (A4)

I was actually, beat my own trumpet, the groundbreaker in the particular area of research that we were doing in our lab downstairs. And a lot of the infrastructure, a lot of the problems with equipment of this and that, I sorted out on my own ... the next guy is in there now and he's almost started collecting data within a month, where it took me probably six to get going. And so it's, it's the experience gained by having problems really that's, that's *[what]* I'd rather have. Rather than someone show me, say 'Oh here is the set up. Go do it'. *[Group agreement]* (A3)

#### 4.4.1.2.4 Prioritising personal goals

One development that became evident was the students' determination to achieve their goals. The goals they wished to achieve had become clearer to the participants and their resolve to attain them resulted in their spurning certain activities and developing strategies to avoid anything they viewed as extraneous to the achievement of their goals. The most important goal was completion—'finish a PhD', and attaining this goal appeared to be the extent of their planning:

The best thing I'll get from the PhD is just learning how to survive such, a job with so much flexibility and self-motivation, and self-discipline required to complete it. ... so now it's sort of getting to something I'm enjoying. It's, I'm having to pull those skills together and it's very slow, very painful process for me. But I am, I am very slowly doing it. So hopefully by the end of the PhD I'll have gone a good way to learning how to, how to stick with something and work at it slowly but surely for an extended period of time. So that's, that's a huge personal goal because that's not something I'd previously had up to this point. [...] I find that *[extraneous demands]* very, very interfering and when you're trying to get things, just get down to work and get things done. (A5)

This is something I've been discussing a lot with my friends, and it's where the roles of a supervisor and academics are not in line with the roles of PhD students. My job is get a PhD. The fact that I'm doing research to get a PhD is incidental. My job is to get a PhD. An academics job is to publish and present and find new research. Now sometimes they co-align and when we agree, when we all agree that the fastest and most productive way to finish a PhD is by doing this, that's great. When they say, 'Yeah but you can also

do this, and then that, and then that'. ... I've never been told to do anything that I felt was bad research. But there have been suggestions to do things that would not directly aid me in completing my PhD. So I think it's a case of academics aims not always being aligned with the aims of PhD students, which is purely to get a PhD. (B10)

#### 4.4.1.3 *Feeling stuck*

The participants described their diminishing estimation of the value of HDR study and lack of optimism for their professional futures as a result of the belief that employers might not appreciate their abilities. The extent of disillusionment varied, but there was a sense that all the participants felt some dissatisfaction with the experience of HDR candidature. Concepts that reflected these sentiments were feelings of their work being devalued or unrecognised and a sense of being stuck between professional roles.

##### 4.4.1.3.1 *Feeling devalued*

Graduates who chose to embark on HDR study to gain greater employment opportunities and freedoms had, ironically, fewer options available to them:

...just on the diversity of tasks and all that sort of thing, we're saying is what we're getting out of it. I don't really think that's really all that well recognised or considered by employers. They look at your thesis title and go, 'Well **that's** what they do'. ... But they haven't seen the, you know, optical related stuff, all the electronic related stuff. (A2)

I went to a job interview about two months ago for a similar background to what I was doing previously. So similar, not the same consulting company understand, but a similar one, the opposition. And you know they let me know that the PhD was of no value to them whatsoever. They said, 'We don't, we hire your learning capacity and previous [*workplace*] experience.' I said, 'Well you know I'm not really too comfortable with that because I like to think that I'm getting some value for this PhD. I appreciate that it's probably not necessary for what happens to me here, but perhaps I'm not, you know, suited to actually working here.' (B1)

An important factor in this diminishment of optimism was the knowledge that engineers in the paid workforce are well paid; thus, a decision to study equated to substantial financial loss. The following exchange, which occurred during FG2 discussion, was lively and included much interjection from many participants, all in agreement:

**B10:** What about this experience detracts from reaching your future goals? Well you know, I'm looking at buying a house with my partner now.

**B6(?):** Well that's what I was going to say.

**B10:** And if I finish my PhD in three years as opposed to five years I'll probably be \$100,000 better off. So this all does tie in.

**B6(?):** Yeah!

*[PhD]* experience doesn't detract in the interview, because any experience is good experience. The only negative thing is that we're not earning salaries. If we could be earning competitive salaries then we wouldn't [be behind], because as these people said, if you do the numbers you're actually so far behind once you've finished your PhD five years down the track. But if you compare yourself to someone who goes into industry and starts working, paying off your superannuation, etc, etc, they bought a house. (B1)

It appeared that, despite their previously described sense of worth, these engineering HDR candidates reached a stage of candidature where they doubted the perception of their worth to their university departments and to industry.

#### 4.4.1.3.2 Stuck in the 'mid-ground'

The participants described their experiences of feeling 'stuck' in a position between EHDR student and industry work, and where there was no clear path or direction forward. The 'mid-ground' was an expression coined by A2 to describe his situation, in which he felt too grounded in research to be interested in the purely practical requirements of industry and too practical to continue in pure research. It was not clear whether he believed he would not be of interest to industry employers or that he would not find industry interesting. Nevertheless, he stated that he was applying for industry-based employment:

I also ... would like to get a few years of industry sort of experience so perhaps some sort of mining or manufacturing company sort of thing. Because that's where I've mostly been applying for jobs. Although, yeah most of, I think I'm perhaps a little bit too researched for a practical industry things and a little bit too practical in industry things for research so. I think it's the mid-ground, I think a lot of people slip into, I'm not too sure, moving forward in their particular field. Maybe I'm wrong but that's just what I perceive from the people around me. (A2)

Sure. There's a difference between what I'd like to do and probably the reality. ... Although I would be interested in working in an industry. But I, at this stage, I wouldn't see how I could actually move in to that given my age [*late twenties*] and how I've been here for so long. And my lack of

industrial experience, I wouldn't see how I could actually move in there.  
(A3)

Others expressed an obsession with their work or the tendency to succumb to the lassitude induced by unstructured time:

No, it's scary. It [*the PhD*] would never end. You can keep going forever and it would never end. [...] I'm treating it as everything. I work everyday. I'm here seven days a week pretty much as soon as I wake up till as soon as I get tired, so it's basically I'm devoting all my efforts to it until I do finish ... It's an obsession, then, isn't it? (A3)

I think that, sort of it's tied in with the time management thing, being a PhD student here it's a very, it can be a very comfortable lifestyle. There's no set time you have to turn up and you can fall into very bad habits, and I think that when you go back out into the industry it's very, it can be a bit of an adjustment to like have to suddenly be at work on time. (B3)

I think that's sometimes, because there's, in a way so little direction, it's very easy to just form bad habits. I think if you stay here too long, which lots of us do. (B9)

One participant referred to this as 'the vortex of procrastination'.

#### 4.4.1.4 Moving away

At some point in the 'mid-ground' doldrums, the participants described becoming re-energised for independent action. The category 'Moving away' is characterised by comments that indicate the participants were motivated to fight for their own deliverance from the confines of EHDR study. It reveals the impact of their sense of personal and financial worth, a strengthening of their drive to achieve their personal goal of completion and a determination to move beyond being 'stuck'. This took the form of a rejection of the demands of the HDR program and particularly those of supervisors. An interesting example of this attitude was found in the comment by A3:

...this is my PhD and if anyone knows anything about it, it's me and not necessarily my supervisor. I'm sure he knows about it and he knows how to manage the PhD but at the end of the day it is mine. He wanted me to get out of the lab a long, long time ago. I just said 'No, there's not enough data'. And he said, 'There's twice as much data as you need'. And I just say 'I don't have anything nearly enough'. So we didn't see eye to eye on those

things but at the end I ended up taking as much as I wanted, not as much as he wanted. (A3)

The comment challenges the notions put forth in ‘Prioritising personal goals’, which revealed the participants wishes to complete their candidatures as soon as practicable. A3 appears to be arguing for extending candidature by collecting more data and was the only participant to express such views. Nevertheless, the quote is a clear example of an EHDR student taking ownership and responsibility for the process and outcome of the research.

#### 4.4.1.4.1 Feeling duped

There was a perception expressed that the students had been given misinformation about EHDR candidature. Students expressed disappointment that resources and expertise were not readily available and, particularly, that the goals of their supervisors did not align with their own goals for candidature completion and progressing into new professional work. They felt that efforts by their supervisors and the university to meet different goals were at the EHDR candidates’ expense:

I don’t know what’s the reason my supervisor accepted this topic, because all the equipment needed for this topic is not here. So I’m trying to get access to external facilities, even to [*Named institute in another city*], just to get, just to produce my sample. (B2)

But supervision, the way that you’re supervised at the university actually detracts from how you can be perceived in the workplace. (B3)

It should be the PhD, not the supervisors smoking you dry and seeing you as cheap labour and getting out as much as possible which is always, always a thing they want to do. They want to get as much as they can. (A1)

...it’s probably taught us a more valuable lesson about how life just isn’t fair and if you’re going to, whether it be academia or industry, no matter how much you enjoy work, there’s going to be a lot of crap that you just don’t like. So, I mean that’s valuable experience in itself quite frankly. (A5)

Oh you know, the seminars we go to about you know, ‘Do postgraduate research, it’s great, you’ll get this, this and this’. You know, the propaganda. However, during my years as a PhD student I’ve learned that that’s not true. [...] And I find this more and more as I talk to more HR people. [...] If they [supervisors] have the student writing lots and lots more papers, say a student published ten times in their PhD, they get more money from that, and so don’t see any more goal. (B6)

#### 4.4.1.4.2 Boycotting as a completion strategy

The participants acknowledged an attitude toward the demands of their supervisors and departments that amounted to the avoiding or ignoring of requests or demands for work that the students believed to be irrelevant to their completion:

In the end I just went on my own way. Things like, and other things like seminars, writing pages or, ‘Can you do this? Can you do that?’ In the end I just ignored it; boycotted it; did my own thing. (B6)

But sometimes supervisors can say, ‘Why don’t you do a few extra experiments in this area and we’ll get another paper out of it?’ because that helps the department out and the university out financially. But it doesn’t necessarily help you towards your PhD. (B9)

You just need to learn to say ‘No. Go away’. You can do that. [...] There’s...stuff which I just couldn’t care for and really didn’t do. [...] So I just ignored it and there was no consequences because no one cared. So if you can, if you really think it’s just not worthwhile, yeah, yeah, just let it float under the carpet. (A3)

Except for expressing dissatisfaction with what were perceived as hindrances, no other strategies except boycotting were identified for avoiding hindrances and ultimately attaining the goal of completion.

#### 4.4.2 Summary of concept analysis findings

Conceptual analysis was used to explore the focus group participants’ experiences of EHDR candidature, their desired future professional goals and their beliefs about their preparation for the engineering workplace. Their comments revealed four emergent categories that captured the participants’ initial expectations and goals, their perceptions of the EHDR experience, their beliefs about the value of their work both to themselves and to others, and their strategies for professional goal achievement while engaging with the difficult demands of candidature. The students wanted more than what they believed a graduate engineering job could offer, they displayed awareness of their own worth, they felt stuck and unsure about their post-candidature futures, and they strategised to achieve their main goal, which was to complete their candidature and move into the workplace.

Key findings from the conceptual analysis revealed the EHDR candidates’ initial motivation to seek more from their future professional roles than they believed likely

to be forthcoming from the work of a bachelor-level engineer. This included greater potential for promotion in their future workplaces. The EHDR candidates also sought increased autonomy and independence in their future work performance and control over professional decision-making, including the opportunity to indulge their intellectual curiosity, and greater challenges and variety of work tasks.

The participants recognised their increased knowledge and problem-solving ability and an awareness of their own professional and financial worth. They asserted their ownership of the research they conducted, their expertise over others in their area of interest, and mentioned a wide range and depth of skills and abilities they believed they had developed over the course of candidature. It was from this stance that they asserted their goal of completion. For the participants, this goal took priority over the demands of their supervisors, departments and the university.

Concurrently with their strong assertions of self-worth and determination to complete candidature, the participants experienced a sense of being 'stuck'. They appeared to have lost confidence in the value of the decision to pursue a HDR, and those who wished to pursue careers in industry suspected that the EHDR experience was not valued by industry employers. In addition, participants maintained a strong perception that their supervisors were prioritising their own research career requirements at the expense of the participants' speedy HDR completion and this resulted in considerable frustration. The most telling evidence that they felt 'stuck' was in the students' sense that they were not ready for research careers but had removed themselves from industry work during candidature, which they feared rendered them less attractive to employers than other graduate engineers.

The final category that emerged was 'Moving on', in which the participants identified a strengthened perception that they were misguided or misinformed about the value of EHDR study to their professional goals. Ultimately, it appeared that the EHDR candidates' determination to complete led them to 'boycott' any request that did not assist them in reaching their goal of completion. Since none of the focus group participants had finished their EHDR study at the time of data collection, it is not clear whether this strategy was successful.



## 4.5 Summary and discussion

The participants believed that employers valued a number of learning outcomes of the postgraduate research experience: advanced technical and problem-solving ability, large-scale project management expertise, a broad range of professional and people management skills, and personal characteristics of independence and persistence. They had undertaken higher degrees because they were strongly motivated to engage in autonomous, intellectually challenging work and they had anticipated that an EHDR would enhance their opportunities to engage in such work after EHDR completion. Most of the participants preferred to work in industry; however, many appeared uncertain about the direction their careers might take, and none had definite prospects of employment. Over the course of candidature, those not intent on pursuing professional research careers also appeared to lose confidence in the suitability of their EHDR study to meet their professional goals. The participants felt undervalued by employers and were particularly concerned that their time out of the industry-based workplace, taken to pursue HDR study, would disadvantage them in their attempts to gain industry employment. Concurrently, they felt hindered in their drive to finish by their supervisors' requests and administrative demands on their time, which they considered to be interferences. Either despite this, or because of it, most viewed the completion of their HDR study as an important professional goal to be met because they wished to expedite the move from higher degree research into the professional engineering workplace.

The concern for lost income resulting from the participants' displacement from the paid engineering workforce exerted a powerful influence on their beliefs about the extent to which they were valued by the university, the profession and, it would seem, society. Nevertheless, although they felt undervalued, the participants in this study displayed strong, confident professional engineering identities, as defined by Alvesson (2004), based on their awareness of their own intellectual and financial worth. They were confident of their advanced knowledge and problem-solving abilities and proudly, even stridently, acknowledged their independent research achievements. They overcame their sense of being hindered from achieving the goal of expeditious completion by maintaining control through the use of boycotting strategies, whereby they avoided undertaking any work they considered irrelevant to

their goal. The EHDR candidates in this study can be said to have acted autonomously to identify goals, prioritise activities, and restrict their focus to achieving their goals.

This study of EHDR students was conducted prior to the main study of employers' views. The students' views served to help scope the substantive area of study by providing (a) their perspectives on the views of employers of EHDR graduates and about (b) their beliefs about their potential contribution, as EHDR graduates, to the industrial workplace. The focus groups also revealed the motivations and expectations of these EHDR candidates for their future professional work and these justified the subsequent employer study. Subsequent chapters reveal that substantial discrepancies existed between the value placed on certain abilities by the EHDR students and by employers of EHDR graduates.

## **Chapter 5: Methods for Employer Study**

The previous chapter described the preliminary focus group study of HDR students in the disciplines of Mechanical Engineering and Chemical Engineering at an Australian university. The findings from that study, along with information gathered from literature on graduate employability attributes, engineering colleagues, former supervisors of industry-employed EHDRGs, and from the first employer interview, served to scope the main field of interest: employers' perceptions of EHDR graduates in their workplaces.

The current chapter describes the sampling techniques and recruitment procedures that were used for the study of employers. It is usual practice in grounded theory theses to incorporate descriptions of research methods into a flowing account that documents an unfolding process of data collection and analysis, leading to emergence of the theory (for example Kriflik, 2002 and Gregory, 2006). Such an unfolding account, which is presented in Chapter 6 of this thesis, allows for clear demonstration that findings and analysis are grounded in the data. However, because this research is presented to an audience that includes readers who are more familiar with the structures of research writing for the physical sciences, a variation to grounded theory orthodoxy is presented here: sampling and recruitment methods are outlined separately in this thesis to provide an overview of the sampling procedures and the participants' basic demographic information. By separately summarising the details of participant recruitment and identification, and by providing basic demographic information about the participants, this chapter functions as background material to the subsequent analysis chapters.

### **5.1 Epistemological basis of the interviewing strategies**

The contrasting standpoints of objectivist and constructionist epistemological approaches to research are outlined in Chapter 3 of this thesis. Charmaz (2006, p.32) explains the difference between a constructionist and an objectivist line of questioning in a grounded theory study: the former attempts to elicit participants' 'assumptions, implicit meanings, and tacit rules', whereas an objectivist

epistemological approach emphasises 'chronology, events, settings, and behaviors'. Consequently, the aims and intended outcomes of the study, by reflecting the epistemological foundations of the research, determine the type of questioning and the focus of discussion. The present study sought to gain greater understanding of the employers' implicit meanings and assumptions that influence the value they place on EHDR graduates in the workplace, following a constructionist mode of inquiry.

Morse (2007) suggests three principles of sampling that underpin all good qualitative research:

**'Excellent research skills are essential for obtaining good data'**: This is true of all research, but in good qualitative inquiry Morse (2007, p. 230) emphasises the need to develop excellent interviewing and observing skills through practice and self-critique. Sections 5.1.1 and 5.2.2 describe the challenge I experienced while interviewing the participants. I became aware that, through the process of reflexivity, my interviewing and analysing developed during the course of this study. I was increasingly able to control the focus and dynamics of the later interviews, while allowing participant candidness.

**'It is necessary to locate 'excellent' participants to locate excellent data'**: Excellent participants are those who have experienced and are expert in the phenomenon under investigation, are reflective and willing to provide information, and can express their ideas adequately. The relevance of this principle to the present study is detailed throughout Sections 5.2 and 5.3 of this chapter.

**'Sampling techniques must be targeted and efficient'**: This principle relates to the demands placed on a researcher when conducting in-depth analysis of qualitative data, which is very time-consuming and labour intensive. Therefore, researchers must endeavour to find optimal data that characterises the range and complexity of the phenomenon under investigation.

For the reasons explained previously, the sampling techniques used in GTM are non-probabilistic: they do not attempt to create a representative sample from which the researcher can generalise to the wider population. This is consistent with the aims of GTM: 'Our criteria are those of theoretical purpose and relevance...our main purpose is to generate theory, not to establish verifications with the "facts"' (Glaser & Strauss,

1967, p.50). Sampling proceeds in tandem with analysis, with new participants being sought to test, extend and challenge themes and ideas that have emerged from previous interviews. The process of theoretical sampling is one of the ways that rigour is ensured in grounded theory research.

### **5.1.1 Issues arising in the study**

Despite her principle that excellent qualitative research data requires ‘excellent’ participants, Morse (2007) acknowledges that, even with the use of ideal sampling methods, some interviewees will have less to offer than others, particularly as saturation is reached and little more useful data is being gleaned. This was my experience in the present study, and the following observations that I made during the course of the research, on the interview process and on the participants, reveal some of the pitfalls and limitations I experienced during interviews for this study.

1. Some interviewees ostensibly were perfect candidates at the recruitment stage but provided little personal insight into their own beliefs or decisions. Other interviewees rightly identified that they had something of significance to say and provided stories and information that greatly enhanced the developing research picture.
2. While some of the participants were frank and open from the start, others appeared guarded and circumspect, and expended the early part of the interview time relaxing into the process. They seemed concerned to avoid offending me as a researcher, or academics and universities in general. A few, like those described by Bryant and Charmaz (2007b), seemed to have agendas of only indirect relevance to the current study, such as, for example, concern about a vexing business relationship or competition between industry and universities in tendering for projects.
3. Some interviewees had difficulty with the semi-structured interview process and appeared to treat it like a poorly conducted survey style interview, in which information was expected in a pre-determined order. One, who had prepared written responses to the guiding questions, was intent on returning to his predetermined responses to ensure he provided the ‘correct’

information. This occasional occurrence was despite several participants commenting off-record that they would not have answered a survey questionnaire and appreciated the opportunity to speak about what they deemed important. All of the participants eventually provided some open and useful data.

4. PhD research is a learning process. My inexperience with the methodology and the intensive interviewing that it requires early in the process meant that I was less able to overcome the difficulties described above in the early interviews than in later ones. Chase (2003) described her development from a controlling to an enabling interviewer by phrasing questions in everyday language and avoiding sociological language; and by inviting participants to share their experiences, thoughts and feelings. I also noted that Chase made use of simple 'how' questions such as 'How did you decide?'. I increasingly gained confidence with the interview style and became more adept at allowing the participants to tell their stories and share their views in their own ways and at their own pace. In particular, I learned to speak less and listen more. This also helped with the problem I encountered that is described in the memo excerpt below.

*Memo*

*20 December, 2007:*

If I attempt to draw a link between the PhD personal attributes and an employer's beliefs or actions as they describe in interview, the employer draws back. I feel they almost chastise me for anything that smells of me trying to draw a generalisation. At that point they clam up on their spontaneity and explain that it is important not to draw conclusions from their personal ideas. They start to self-correct and qualify their views or talk about **some** people, the general population type thing, rather than focus on the HDRs. They attempt to create the correct generalisation so that I avoid making an incorrect one. If I let them go, fortunately, caution slips away again and they return to their spontaneous expression. I've learned that direct questions don't always lead to direct answers. Maybe that's normal? If you ask someone why they think or feel, they immediately exercise conscious

control, interpret or censor their thoughts rather than just expressing them—so I have to think of an ‘experimental set up’ where I create the space or situation whereby, if a phenomenon is to occur, it will reveal itself.

## **5.2 Selection of participants**

In GTM, data collection and analysis occur concurrently, and sources of new data are determined by the unfolding concepts and hypotheses that the processes generate. It is not possible at the start to predict what data will be useful. Participants were approached on the basis of their suitability to contribute to the richness and depth of categories, to address hypotheses and ‘to follow up on analytic leads’ (Charmaz, 2006, p. 105). As mentioned in Chapter 3, this process is referred to by grounded theorists as ‘theoretical sampling’ (Glaser, 1978; Glaser & Strauss, 1967); the term refers to a rationale for determining the best next source of information. Morse (2007) describes theoretical sampling as ‘pointed and confirmatory’ in nature as it seeks to verify or disconfirm the emerging theory, and in so doing to modify and ultimately establish a robust theory. Information is sought that will explicate and deepen understanding of the main concern revealed by the data analysis.

This use of the term ‘sampling’ to refer to the underlying rationale and logic of the GTM data collection and analysis process can be confusing, because the term is generally understood to mean techniques or tools for locating and selecting suitable research participants prior to commencement of data collection. To assist the process of theoretical sampling in this study, I used convenience and snowball sampling techniques, as described in the following sections, to identify suitable employers of chemical and mechanical engineering HDR graduates to take part in semi-structured interviews. Following Morse’s (2007) suggestion, these sampling techniques were used to select usefully informative participants who were recognised as such by other knowledgeable members of the community of interest; in this case these community members were academics, engineering research graduates and employer peers.

### **5.2.1 Convenience sampling technique**

The convenience sampling technique is used, usually in the initial scoping stage of inquiry, to identify likely knowledgeable participants who are in the best position to

provide an overview of the situation in which the phenomenon in question occurs (Glaser, 1978; Morse, 2007). These participants can help to determine likely fruitful lines of inquiry, identify salient issues, and suggest practical boundaries to the data collection endeavour. In this study, the convenience sample comprised the EHDR students in the preliminary study, engineering students and recent graduates encountered during the course of my professional practice over a number of years, engineering academic colleagues, and professional practicing engineers in a variety of contexts. In particular, through discussions with engineering colleagues I identified certain companies that are considered most likely to hire EHDR graduates. This convenience sample of people known to be familiar with the likely employers of EHDR graduates provided a starting point for locating suitable employers to interview.

At times, throughout the study, I returned to the convenience sampling technique by approaching colleagues and professional associates for guidance in identifying suitable participants. This occurred when the snowball technique described in the next section led to dead ends or offered no suitable contacts. Approximately half of the participants were recruited by convenience sampling.

### **5.2.2 Snowball sampling technique**

As implied by the term ‘snowball sampling’, interview participants were asked if they knew of others who might be of interest to the study, either because they had direct knowledge of the recommended participant, were aware of the participant by reputation or third hand information, or were aware of particular characteristics of an organisation that might prove a fruitful source of information. The study sample expanded over time as more participants were suggested and recruited using this technique.

Snowball sampling is particularly suited to inductive, theory generating research (Miles & Huberman, 1994) and for small scale studies targeting particular social groups that are difficult to access (Cohen et al., 2000). Additionally, it is particularly suitable for populations made up of members of small, informal networks or organisations who are difficult to access without using social contacts (Bernard,



2002; Cohen et al., 2000; Neuman, 1991). In this study of employers, all three of these population descriptors are applicable.

In many ways the employers interviewed were like the elites described by Neuman (1991):

Powerful leaders in business, government, and so on are difficult to reach. Assistants may intercept mail questionnaires and restricted access can present a formidable obstacle to face-to-face or telephone interviewing. Access is facilitated when a prestigious source calls or sends a letter of introduction .... Personal interviewing with a high percentage of open-ended questions are usually more successful than all closed ended questions. Confidentiality is a crucial issue and should be guaranteed, since elites often have information that few others do. (Neuman, 1991, p. 253)

Charmaz (2006) commented on the impact of relative differentials in power and status between interviewee and interviewer:

Powerful people may take charge, turn the interview questions to address topics on their own terms, and control timing, pacing and length of the interview. (Charmaz, 2006, p. 27)

She also pointed out that there can be an element of distrust about the stated purpose of the interview and that ‘professionals may recite public relations rhetoric rather than reveal personal views, much less a full account of their experiences’ (Charmaz, 2006, p. 27). Such challenges arose during some of the interviews conducted for this study. Nevertheless, I was surprised at the amount of time the participants were prepared to give to the interviews. Of the 22 interviews conducted, only one employer (Emp 6B)<sup>7</sup> appeared to be pressed for time; his interview concluded after 40 minutes. Snowball sampling proved to be a very useful means of acquiring access to participants and fruitful data. Approximately half of the participants were recruited through snowball sampling.

### **5.3 Participant contact and recruitment**

I was aware that a remote, impersonal approach to potential employer interviewees was not likely to be successful. Three factors influenced this awareness: my personal

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<sup>7</sup> Employer identifiers are described in Section 5.4.

experience of working in busy private businesses; my perceptions of the pressure of engineering work environments; and the potential difficulties encountered when attempting to interview members of elites. By first approaching potential participants recommended by engineering colleagues and contacts, and making use of convenience and snowball sampling techniques, all 25 potential participants who were approached over the course of the data collection process initially agreed to participate. Three of these were eliminated from selection because during initial contact it emerged that they had no experience of hiring or working directly with EHDR graduates. Nevertheless, the positive response received from the potential interviewees suggests that the approach undertaken was universally effective. Data from 22 participants were used in this study.

Ethics approval for the employer study was sought and obtained from the Research Ethics and Compliance Unit of The University of Adelaide (Appendix 6). Employers were first approached by email (Appendix 7) or telephone and provided with information (Appendix 8) and a consent form for the study (Appendix 9). For their convenience, employers were offered a choice of locations in which the interview could take place: thirteen interviews were conducted in the interviewee's workplace and nine in restaurants or work canteens over lunch. The offer to meet over lunch was made so that the participant could save time by eating and talking, or to avoid demand on the participant to reserve a private interview space in the workplace. Interviews held in workplaces were conducted in the employer's private office, an open-space office carrel, or in a sequestered boardroom; the environments ranged from cramped, noisy and utilitarian to tranquil and salubrious. Only one office-based interview, Emp 11C, was held in an unsecured environment where access to the participant's office was completely unrestricted. Security restrictions featured in all the other workplaces visited for this research and included the following: simple screening by reception staff and phone confirmation with the participant, the addition of an identity check, electronic doors, visitor tagging, electronic equipment confiscation (unless prior written permission was obtained by the employer) and, when vehicular access was required to an internal compound, further electronic security screening and perimeter gate controls.

Twenty-one interviews were audio recorded. One employer, Emp 14D, declined to be recorded because recording equipment was prohibited in his work area for

security reasons. All the employers offered to be available for follow up and any needed clarification. Each participant was sent a *précis* of her or his interview transcript for feedback and correction, and 19 participants returned responses. Three participants, Emp 2A, Emp 9C, and EmpHR 13D, never responded to further, repeated contact attempts, and I felt justified in assuming that they were satisfied with the transcript.

#### **5.4 Participant characteristics and identifiers**

Of the 22 employers of mechanical and chemical engineering HDR graduates who were interviewed, twelve had engineering qualifications, eight had science qualifications (one participant held an engineering qualification and a postgraduate science qualification), and three possessed postgraduate qualifications in administration or human resources (HR) management. None of the HR managers was an engineer or scientist (see Table 5.1). All the participants currently or recently performed management roles. Seventeen were directly responsible for hiring engineers (including HDR graduates), two had been responsible for doing so until recently prior to the interview, two worked closely with EHDR graduates and held responsibility for work outcomes, and one was a professional engineer, former employer and academic who worked in an administrative capacity for a large national professional body involved in the education, accreditation and employment pathways of professional engineers.

The organisations in which the employers worked ranged in size from 25 employees to several thousand and were engaged in a variety of principal activities. For the purposes of this study, organisations of 200 or fewer employees are identified as small organisations, while those with over 200 employees are classified as large (see Table 5.1). Employers in the large organisations were only responsible for the workers in their immediate groups or work units and these rarely exceeded 200 workers. The data of most interest in this study were those that reflected the personal perspectives of the participants, including their experiences throughout their own work histories, and the size of the organisation in which the employer worked did not impact on the quality of the data provided. Many of the participants explicitly

commented that they were providing their personal views on the issues under discussion in the interviews.

In this thesis, the participants are identified in the following way (see also Table 5.1):

- Each participant was given a number in accordance with her or his chronological position in the interview process; for example, first interviewed is 1, second interviewed is 2, and so forth.
- Thirteen participants are assigned a letter which indicates that each was one of a number of participants who worked in a single organisation; for example, 2A and 5A both worked in the same firm.
- Each participant is identified as an employer (Emp). An employer of an engineering HDR graduate was identified as (Emp), an employer participant who provided useful and relevant information but had not directly employed engineering HDR graduates was identified as an employer participant (EmpP) and an employer with a HR role was identified as such (EmpHR).

Participants 1, 3, 16, 19 and 20 were EmpPs. EmpP 1, 16 and 19 had been or were currently employers of graduate engineers but not of EHDR graduates. EmpP 1 was selected purposefully for his role as a representative of a large organisation representing professional engineers in Australia. Despite the remaining four participants having been informed of the essential criterion that interviewees be employers of a postgraduate engineering research degree holder, and unlike the three eliminated employers mentioned earlier, they each agreed to be interviewed and it was not until their interviews were underway that it emerged that they were not actually employers of EHDR graduates. Nevertheless, they each contributed insights, particularly about workplace contexts and characteristics of engineering colleagues that proved to be valuable for this study; hence, the decision was made to include their interview data in the analysis where appropriate. The use of such data is supported by Charmaz (2006, p. 16):

Yes, everything you learn in the research setting(s) or about your research topic can serve as data. However, data vary in quality, relevance for your emerging interests, and usefulness for interpretation. Researchers also vary in their ability to discern useful data and in their skill and thoroughness in

recording them. [...] Whatever stands as data flows from some purpose to realize a particular objective. In turn, purposes and objectives arise under particular historical, social, and situational conditions.

Additionally, Morse (2007) noted that it is commonly the case in grounded theory studies that some participants will be less or more useful than others, some will be extremely useful, and some will provide data that initially appears irrelevant but is found to be useful on later reflection.

The four participants who were not employers of EHDR graduates were the following:

1. EmpP 3B was an EHDR graduate whose work included collaboration with HDR graduates and candidates on engineering projects in a consulting firm. He was interviewed early in the study, and his experiences and descriptions of hands-on project work, along with his relatively current experience of HDR candidature and transition to work, proved a valuable contrast with the previous and subsequent interviewees. He was the only interviewee who had recent experience of current HDR processes and the first to provide an intimate description of the work done in concept design and development. His views reinforced those of Emp 2A, thus allowing a confident contrast during comparative analysis with the data provided by Emp 4.
2. EmpP 16 was a PhD engineer who provided insights, from extensive prior experience in industry, into the interpersonal dynamics and motivations of management in engineering organisations. He had worked in a parallel situation to many EHDR graduates, in that he lobbied for the inclusion of graduate engineers into the professional engineering workplace at a time when technically trained engineers perceived university graduates as over-trained. EmpP 16 was identified through the convenience sampling technique; he engaged in conversation about the research and shared his experiences of interpersonal dynamics in the engineering workplace, which seemed highly relevant to the study. Data from the interview with EmpP 16 was used to provide some insight into engineering management practices.

3. EmpP 19 held a PhD in an area of engineering specialisation and worked for a private consulting firm. He employed many engineers but had not employed an engineer who held a research degree, although he claimed he had no particular concerns about EHDR graduates. EmpP 19's comments were of interest to this study because he held a research degree himself and presented views that revealed a different perspective to those of other employers. Since EmpP 19 was an active and well-respected member of the professional engineering community, his contrasting perspective was considered important to this study.
4. EmpP 20 was a research scientist with extensive experience selecting and working with EHDR graduates on large-scale research projects. He provided many interesting insights into the perspective of a research scientist who had trained earlier as an engineer, who worked closely over many years with research engineers and who supervised EHDR candidates outside the university environment. Data provided by EmpP 20 compared interestingly with that of Emp 15D, also a non-engineering scientist, whose views of engineers were slightly different to those of EmpP 20.

## **5.5 Interview content**

The interviews were semi-structured around the following six questions, which were presented to the participants in the introductory email (Appendix 8):

- Why do you decide to employ a postgraduate engineer for some positions? (What sorts of positions require postgraduate education and training?)
- What attributes do you believe postgraduate engineers should bring to a position?
- What attributes do you believe postgraduate engineers actually do bring to a position?
- Are you ever surprised by what a postgraduate is or is not able to do?

- If you had the opportunity to provide feedback to a university about their postgraduates' abilities, what would you say?
- If you had the opportunity to provide feedback to postgraduate candidates about their value to employers, what would you say?

In every interview, participants were encouraged to consider the questions as a general guide for discussion, but to comment on anything they believed was relevant to the topic. While several of the participants experienced initial difficulties speaking beyond the guiding questions, all participants appeared to relax and speak extemporaneously over the course of the interview.

The recorded interviews were transcribed by a professional transcription service. Table 5.1 provides an overview of participant details, in chronological order of the interviews conducted.

**Table 5.1: Employer descriptive details, organisation type and size, interview location and sampling phase. Employer identifiers that include letters indicate that more than one employer from an organisation was interviewed; employers identified with the same letter were in the same organisation**

Participant	Eng/ Sci/ other	HDR grad	Main organisation activity	Size of org. Small ≤ 200 Large > 200	Private/ public org	Location of interview	Analysis stage
EmpP 1	Eng	Yes	Professional organisation representative, former employer	Large	Private	Emp office	Scoping
Discussions with EHDR students, engineering academics including former supervisors of EHDRGs, practicing engineers. Preliminary Focus Group Study, EmpP1							
Emp 2A	Eng	Yes	Engineering consulting	Small	Private	Lunch	Theoretical sampling
EmpP 3B	Eng	Yes	Engineering consulting	Small	Private	Lunch	
Emp 4	Eng	No	Industrial design, systems integration, maintenance	Large	Private	Lunch	
Emp 5A	Sci	Yes	Engineering consulting	Small	Private	Lunch	
Emp 6B	Eng	No	Engineering consulting	Small	Private	Emp meeting room	
Emp 7	Eng	No	Private utility provider	Large	Private	Emp meeting room	
Emp 8	Eng	Yes	Engineering consulting, engineering academic	Small	Private	Lunch	
Emp 9C	Eng	No	Utility and infrastructure provider	Large	Public	Emp office	
Emp 10D	Sci	Yes	Industrial design, systems integration and maintenance	Large	Public	My office	
Emp 11C	Sci	Yes	Utility and infrastructure provider	Large	Public	Lunch/Emp office	



<b>Participant</b>	<b>Eng/ Sci/ other</b>	<b>HDR grad</b>	<b>Main organisation activity</b>	<b>Size of org. Small ≤ 200 Large &gt; 200</b>	<b>Private/ public org</b>	<b>Location of interview</b>	<b>Analysis stage</b>
Emp 12	Other	No	Manufacturer	Small	Private	Emp meeting room	Theoretical sampling
EmpHR 13D	Other	No	Industrial design, systems integration and maintenance	Large	Public	Lunch	
Emp 14D	Sci	Yes	Industrial design, systems integration and maintenance	Large	Public	Emp office	
Emp 15D	Sci	No	Industrial design, systems integration and maintenance	Large	Public	Emp office	
EmpP 16	Eng	Yes	Industrial design, manufacturing, systems integration	Large	Public	Lunch	
Emp 17	Eng	No	Engineering consulting	Small	Private	Lunch	
Emp 18E	Sci	No	Mineral exploration and processing	Large	Private	Emp meeting room	
EmpP 19	Eng	Yes	Engineering consulting	Large	Private	Emp office	
EmpP 20	Sci	Yes	Public research organisation	Large	Public	Lunch	
EmpHR 21E	Other	No	Mineral exploration and processing	Large	Private	Emp meeting room	
EmpHR 22C	Other	No	Utility and infrastructure provider	Large	Public	Emp meeting room	

## 5.6 Analysis

A detailed description of the process of analysis for this study was provided in Chapter 3. The present chapter describes the practical steps taken to analyse the recorded data.

I reviewed my notes as soon as practicable after each interview and carefully revisited each interview recording several times, because much nuanced information was revealed in the tone, inflection and pace of delivery. Each transcript was read several times and its key ideas were summarised and sent to the participant for confirmation, correction and clarification. Emp 2A, Emp 9C and EmpHR 13D did not return responses to this request. Seventeen participants confirmed that the summary accurately reflected their views. One made grammatical changes to the summary that did not alter the main content meaning, and another changed a somewhat critical statement about academics into a less critical comment.

With respect to written transcripts, Chase (2003) argues that they give little indication to the reader of the full meaning conveyed by speech acts such as the pauses, stumbles, delivery speed and intonation present in oral delivery. I found this to be the case in the current study. The employers drifted away from their topic and then returned and occasionally hesitated and stumbled over speech as they gathered their thoughts to form a response. One employer was not a native speaker of English.

Mischler (2003) suggests that by repeated listening to the recordings for speech features, we ultimately deepen our understanding of what was meant in an oral exchange, and I found this to be so. However, it is difficult to convey the meaning of oral expression in written transcription. Mischler (2003, p. 300) argues that transcription of oral text is always interpretive, that decisions about textual presentation display an author's assumptions about meaning, but that 'there is no way not to make such decisions' (Mischler, 2003, p. 317).

In quoting participants in this thesis, I make use of several techniques described by Chase (2003, p. 293). Bold format signifies emphasis, and capital letters signify greater emphasis; dashes indicate a break or interruption in speech; laughter, long

pauses and other non-lexical events are placed in brackets [ ], as are words and phrases that I have added to clarify the participants' comments; quotation marks indicate that the speaker is quoting someone else or her/himself; ellipses indicate that several words have been omitted; and ellipses in brackets [...] indicate that a substantial amount of wording has been omitted. Such omissions occur when the intervening text was irrelevant to the point under discussion and distracting or confusing for the reader.

Transcript texts were formatted with a wide left side margin for my coding and comments. Following open coding directly onto the transcription document, codes were entered into a database using NVivo 7 software (QSR, 2006), with links made to the transcript text. These codes were subsequently grouped into 'tree nodes', or categories, and then printed. I used the printed versions to compare and contrast the codes, and later the categories; I was more comfortable working with hard copies of the emerging categories than using the software for further analysis. While the software program worked very well for linking text to codes and, particularly early on, allowing me easily to revisit and search coded text, I found it interfered with my ability to intuitively manipulate the concepts and it worked less well for maintaining the myriad conceptualisations of the categories. Thus, I worked with paper and pencil, and simple word processing, to create conceptual diagrams, charts and lists of ideas as they emerged from the data. Fortunately, one of my supervisors had extensive experience working with the methodology and assured me that grounded theory analysis can be a messy process.

## **5.7 Summary of chapter**

This chapter presents an explanation of the sampling and recruitment methods used in the study of employers of EHDR graduates. Convenience and snowball sampling techniques proved to be highly successful for gaining access to employers of EHDR graduates, who shared characteristics similar to elite participants as described in the social science research methodology literature.

A description of the participant identifier coding system is provided and the immediate post-interview analytic procedure described. The chapter also presents a brief description of my observations and experiences encountered during the

interviews. These concur with descriptions of confounding issues described in the literature. Details of the transcription analysis and display are outlined and my use of software and non-computerised coding systems is explained.

The next chapter presents an overview of the theory's emergence. This introduces the main themes that emerged from the interview data during the constant comparison of concepts and categories, as well as the process of final theory construction. Chapters 7, 8 and 9 then provide detailed elaboration of each main theme.

## **Chapter 6: Overview of the theory's emergence**

The purpose of this chapter is to orientate the reader for the subsequent three chapters. This chapter presents an overview, in general terms, of the way that concepts emerged in this study to reveal three themes, and which culminated in the development of the core idea that employers' decisions about the employment of EHDR graduates were a matter of 'Reconciling image with innovative need'. The overview is presented in the form of a chronological progression of ideas that emerged during the simultaneous process of interviewing and analysis. The chapter also includes, in Section 6.3, a number of observations from the interviews that provide peripheral, useful background information to the findings of the study. This chapter is not an attempt to elaborate and explain the complexity of the emergent themes and their concepts. That detailed explanation and elaboration occurs in Chapters 7, 8 and 9, where the participants' perceptions are presented in depth.

This study set out to explore the beliefs held by employers of EHDR graduates about their value to the industrial workplace. It ultimately reveals that each employer undertook a 'decision to engage' process that hinged on the image he or she entertained of EHDRGs in general. This image influenced what an employer believed the EHDRG could contribute to workplace outcomes, and how each employer anticipated an EHDRG might impact on the workplace environment. The process by which the employer reached a conclusion about the potential value of an individual EHDRG involved three stages (the original three emergent themes) which the employer used to determine if the EHDRG would 'fit' in the particular workplace. Chapter 7 provides elaboration of the first stage of 'Contextualising EHDRG innovative outcomes' and Chapter 8 covers the stage of 'Invoking personal theories'. Chapter 9 revisits several concepts introduced in Chapters 7 and 8 and describes differences between the employers' preferences for the problem-solving approaches they believed necessary to achieve the type of innovative outcome they sought. Chapter 9 also brings these three stages together to form a decision pathway, or selection process, through which the employers determined EHDRG workplace suitability. This takes the form of a reconciliation between beliefs about desired workplace innovative outcome, and how it is best achieved, and an idiosyncratic

image of an EHDR graduate. All three stages reveal employers’ concerns that combine to provide the most accurate picture of the employers’ perceptions of the nature and value of the HDR experience and its potential for contribution to their engineering workplaces.

**6.1 Phases of the theory’s emergence**

This section provides a brief summary of the process through which main themes emerged in this study and how they developed through the concurrent data collection and analysis. Because the detailed elaboration and explanation of these themes are presented in Chapters 7, 8 and 9, specific references to and quotes from employers’ comments are avoided here.

The theory of ‘Reconciling image with innovative need’ emerged in roughly three phases. As expected with GTM, these phases were not pre-planned in the research design and were not always distinctly noticeable at the time of initial analysis. Instead, during the process of reviewing, comparing and contrasting earlier data, I became aware of emerging patterns and sensed undercurrents that could not be ignored. Phase change occurred at significant points of conjecture and resolution, as illustrated in Table 6.1.

**Table 6.1: Phases of theoretical sampling reflecting conceptual emergence**

Phase 1	Interviews 1–7	Types of work roles and knowledge desired for roles emerge and are defined by the originality of work outcomes. Notion of personal image is suggested.
Phase 2	Interviews 8–16	Extent of originality of outcome sought is expanded and importance confirmed. Influence becomes evident of employers’ personal biases toward EHDRGs’ personal characteristics and problem-solving approaches.
	Interviews 16–17	Imaging for oddness in EHDRGs is revealed. Main concern identified: balancing/reconciling image with need for originality.
Phase 3	Interviews 17–22	Theoretical sampling, including in another geographic region, confirms the main concern and elaborates category properties. No disaffirming samples are found. Saturation is reached.

Appendix 10 provides a detailed listing of the categories, along with the concepts that formed them. It also illustrates the ways in which categories were re-envisaged and realigned as new data contributed to theory development.

### **6.1.1 Phase 1: Emergence of originality of outcome sought**

From the focus group study and the interview with EmpP 1, the following early and somewhat pessimistic picture emerged of employers' views of EHDR graduates:

- Industry does not generally value EHDR qualifications.
- Large companies are not interested in EHDR graduates.
- Some small companies value in-depth technical knowledge found in EHDRGs.
- Most employers value workplace experience over advanced qualifications.
- Research graduates are often viewed by employers as having failed previously in the workplace.

I was intrigued by the second suggestion because I was aware from my own work with engineering academics and HDR students that large organisation did, at least occasionally, employ EHDRGs. I persisted by exploring what known employers of EHDR graduates sought and valued in them and whether they viewed these graduates as having something 'more' to offer than engineers with undergraduate qualifications, or whether the students and EmpP 1 were correct in their perception that their HDR experience was not valued in industry.

Following the fourth interview with employers, a clear distinction emerged among the employers concerning their expectations of EHDRGs in workplace roles. The distinction initially appeared to be related to company size, but by the seventh interview revealed itself to be related to the extent of originality sought in the outcomes of engineering work. This distinction eventually formed the basis for 'Establishing context', which is elaborated in detail in Chapter 7.

The concepts and categories that emerged in Phase 1 are illustrated in Appendix 10, Figure A. The concepts were described as attributable to the knowledge and skill level (Knowledge-Skill) achieved by EHDRGs and to personal and social (Personal-Social) characteristics that the employers associated with EHDRGs. This dichotomy in underlying attributes was to become fundamental to the emergent theory. It related to the work and work outcomes expected by the employers, as elucidated in Chapter

7, and to the images constructed of EHDRGs by the participants, as elucidated in Chapter 8.

At the end of Phase 1, the following had appeared evident, although eventually all but the last point proved to be inaccurate in associating uniqueness and knowledge-skill sought with organisational size.

- Some employers engaged EHDRGs for their ability to use their advanced knowledge and skill to find, explain and adapt existing products or processes developed elsewhere. I referred to this type of work as innovative adaptation and expand on this in Section 7.2.1. At this stage in the interview process, I considered, erroneously, that these employers only worked in large organisations.
- Some employers valued EHDRGs for their ability to use their advanced knowledge and skills to develop unique products or achieve novel problem solutions. I referred to this type of work as niche innovation and expand on this in Section 7.2.2. At this stage in the interview process, I considered, erroneously, that these employers only worked in small organisations.
- Some employers of EHDRGs in small organisations had HDR qualifications and some did not. The employers of EHDRGs in large organisations did not have HDR qualifications. There did not appear to be a strong relationship between an employer's HDR status and employer valuing of EHDRGs in the workplace. This was subsequently shown to be the case throughout the interviews.
- None of the organisations had an official position regarding the employment of EHDRGs; they were neither officially sought nor discouraged. This was subsequently shown to be the case throughout the interviews.

The first two conclusions, although incorrectly assuming a link with organisational size, were of most interest. They revealed distinctions in the type of outcome the employers sought from advanced engineering work: some sought unique products and other employers sought products developed elsewhere and applied, or adapted



and applied, to the workplace context. This distinction is illustrated more fully in Chapter 7, Section 7.3.

By the end of Phase 1, the employers had also mentioned an extraordinary number of other important considerations, particularly related to personal-social characteristics of the EHDRGs. I undertook to explore these concerns during subsequent interviewing.

### **6.1.2 Phase 2: Emergence of personal bias and selectivity**

Three themes emerged and began to be clarified during Phase 2. The employers frequently commented on what they believed were the preferred work practices, personal characteristics and motivations of EHDR graduates.

(1) Employers' beliefs about EHDRGs' work practices included references to their approaches to problem solving, and these beliefs appeared linked to the outcomes sought by the employers. Thus, I concluded that the originality of outcome sought formed a context in which the 'imaged' characteristics of an EHDRG were judged as valuable or not. This reinforced an emerging theme that I had titled, 'Specifying EHDRG workplace roles', but which developed into 'Contextualising innovative workplace outcomes', as discussed in Chapter 7.

(2) Often, the employers expressed considerable concern that EHDRGs would display awkward personal characteristics, despite the employers' claims that they were impressed with the particular EHDRGs they had engaged. Exploration of these observations eventually led to the emergence, in Phase 2, of the stage 'Invoking personal theories', which is elaborated in Chapter 8. Their concerns led the employers to engage in strategies, frequently referred to as 'weeding', that helped identify the presence in an EHDRG of desirable and undesirable personal characteristics.

(3) 'Weeding' led to a final balancing, or reconciliation, of desirable characteristics and approaches to problems against undesirable characteristics and approaches. This reconciliation is a process of 'Selecting for workplace fit', which along with 'weeding' is explored in Chapter 9.

The transition from Phase 1 categories to Phase 2 categories is illustrated in Figure B in Appendix 10. At the close of Phase 2, I had concluded the following.

- The employers maintained idiosyncratic images of an EHDRG against which they tested applicants.
- These images were informed by employers' personal perspectives gained through their educational, career and general life experiences.
- The images based on personal characteristics of EHDRGs played a central role in the employers' views about their value.
- The employers displayed varied degrees of tolerance toward personal characteristics of EHDRGs that they deemed to be problematic.
- The process of determining a particular EHDRG's suitability entailed the identification, through testing, of desirable and undesirable characteristics.

Concurrently, during Phase 2, my research emphasis shifted from the employers' descriptions of workplace roles to the innovative outcomes that they sought. The hypothesised variability in workplace outcomes sought by employers of EHDRGs was expanded and confirmed, leading to the following additional conclusions:

- The employers sought innovative outcomes that ranged in originality from 'adapted from elsewhere' to 'visionary'.
- The extent of originality in workplace outcomes sought by employers varied from one employer to another, irrespective of the official stance of the organisation in which they worked.

### **6.1.3 Phase 3: Moving to saturation**

This final phase of interviewing and analysis clarified and confirmed the utility of the findings that were emerging and led to saturation. At the start of this phase, I identified questions that added depth to the information I sought about the employers' personal experiences, their thought processes during their consideration of a potential EHDRG worker and their beliefs about impacts on the business and

workplace climate. Although some employers had offered this information spontaneously in previous interviews, I determined to explore these issues with the next participants. I was mindful of the difficulties, mentioned in Section 5.1.1, that arose by posing direct questions about their beliefs concerning EHDRGs' personal characteristics. The additional questions I sought to address were as follows:

- Do you have a research qualification? Why or why not? Did you make a decision not to pursue one?
- What are your views about a PhD's value, or lack of value, to the business?
- What things do you consider when you interview an applicant with a PhD in engineering? What are you expecting or hoping to find, what do you do to find it and how do you know when you have found it?
- Are you wary or looking out for anything? How do you explore/determine/consider this during the application process?
- Have you had problems with a PhD employee that you think are related to PhD study? If so, please elaborate.

Phase 3 interviews included site spreading to another industrial centre in Australia where I interviewed employers in large and small, public and private organisations. These interviews yielded no disaffirming information. All the interviews revealed the employers' concerns about the originality of engineering outcomes and the problem approach taken to achieve the outcome, and all also revealed personal theories about the personal characteristics of EHDRGs and about their potential impact on the workplace.

Phase 3 clarified the relationship between the image that an employer entertained of an EHDRG and the belief the employer maintained about the ability of an EHDRG to produce an original outcome. Appendix 10, Figure C illustrates the realignment of categories to reflect the central position of imaging in the employers' determination of EHDRG value and suitability for a workplace.

For some employers who sought original outcomes, the ability of EHDRGs to resolve challenging and unique problems and to achieve imaginative and original

outcomes tended to be associated with certain unusual and potentially troublesome personal characteristics that they expected EHDRGs to exhibit. For others who sought original outcomes, EHDRGs' abilities and these characteristics were not understood to be linked. This difference in understanding was shown to explain differences in the value employers placed on EHDRGs in the workplace. For the employers who did not seek original outcomes, this linkage was irrelevant; there was no need to consider engaging a person with troublesome characteristics, even if the employer believed they were associated with the ability to produce an original outcome. Explanation and elaboration of this finding is detailed in Chapter 9, where the process of reconciliation is displayed as a flow chart of the decision pathway (Figure 9.2) taken by employers when contemplating the engagement of an EHDRG in their workplaces. The three emergent themes are presented as three stages of the process.

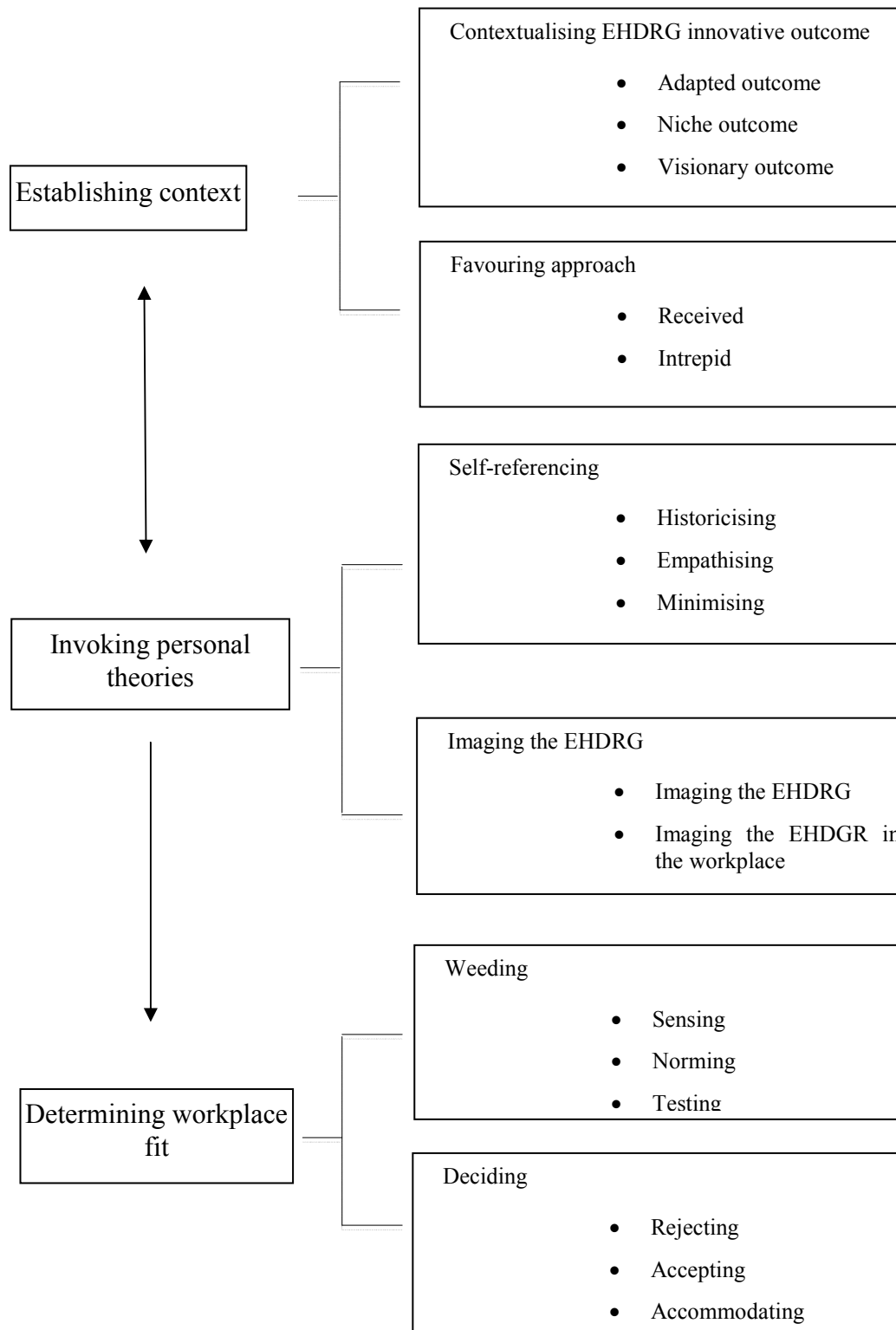
## **6.2 Final theory construction**

The implicit personal theories evoked by the employers in this study were fundamental to their ultimate valuing of EHDRGs for their workplaces. These personal theories influenced the employers' expectations of contextually appropriate, innovative outcomes achievable by EHDRGs, as well as the means used by employers to determine an EHDRG's suitability to workplace social climate and work practices.

The emergent theory is best explained as a process that reconciles the employer's image of a hypothetical EHDRG with the employer's beliefs about the innovative needs of the workplace and how they can best be achieved. This process has three stages: invoking implicit personal theories, establishing innovative context and determining workplace fit. The term 'reconcile' encapsulates the employer's concern that once any imaged desirable or troublesome characteristics are revealed in an EHDRG applicant during the weeding process, they are balanced against the characteristics believed necessary for the innovative outcome sought by the employer. The reconciliation process may result in acceptance or rejection of an EHDRG, but the term 'reconcile' recognises the accommodation by some employers

of troublesome characteristics in order to gain co-existent desirable characteristics in an EHDRG (see Chapter 9, Section 9.3).

Figure 6.1 illustrates the stages, and their categories and concepts, that combine to form the process of ‘Reconciling image with workplace need’.



**Figure 6.1: The three stages and six categories with component concepts that form the process of 'reconciling image with innovative need'**

## **6.3 Peripheral matters**

My observations regarding three matters, which I consider peripheral to my findings, but important to the context of this research, are presented in the following sections. Section 6.3.1 provides a description of the issues that emerged during the interview process and impacted on the development of the theory, followed by a description of how these were dealt with. The other two matters, which are the distinctions the employers made between undergraduate and HDR graduate engineers and the significance of R&D units, are discussed in Sections 6.3.2 and 6.3.3 respectively; although these matters emerged from the interviews, they are not directly relevant to the elaborations presented in the subsequent three chapters. They are presented here to avoid subsequent reader confusion and to pre-empt questions that might arise later about the focus of the interviews. Because these issues will not be revisited later, the following three sections provide more specific detail and employers' comments than can be found in the earlier part of this chapter.

### **6.3.1 The interview experience**

The grounded theory that explains the ways in which employers reconcile their images of EHDRGs with the needs of their workplaces unfolded gradually and, like most grounded theories, after the negotiation of a number of false starts and blind alleys. The stages of the theory revealed themselves sporadically from the data analysis, each appearing for a time as the main concern of the participants then retreating, only to re-emerge later during subsequent sampling, analysis and review.

One reason for these challenges related to the interview process. Despite her principle that excellent qualitative research data requires 'excellent' participants, Morse (2007) acknowledges that, even with the use of ideal sampling methods, some interviewees will offer less than others and that this is inevitable particularly as saturation is reached and little more useful data is being gleaned. My experience was as Morse (2007) described: some interviews were highly informative milestones in the analysis process and gradually pushed the main themes to the surface. Some interviewees ostensibly fit the bill perfectly at the recruitment stage but provided little personal insight into their own beliefs or decisions. Other interviewees rightly

identified that they had something of significance to say and provided stories and information that greatly enhanced the developing research picture. This occurred with interviews 7, 8, 10, 15 and 17, in which employers presented challenging ideas and new concepts that caused me to review and reflect on previous data and see it in a new light. These insights led to further hypothesising and testing in subsequent interviews.

Another challenge I faced was in accessing suitable participants to meet the demands of theoretical sampling at the times when I needed particular perspectives. Interview times had to be scheduled around the employers' busy agendas and work demands; this was frequently done through communication with their administrative assistants. This meant that some interviews were scheduled in a less than ideal sequence for sampling. For example, Emp 4 suggested that I interview a particular group of engineers. I would have recognised more readily the variation of certain properties of the desired problem-solving styles of HDR engineers had I been able to interview Emp 10D, Emp 14D and Emp 15D shortly after interviewing Emp 4; however, Emp 10D, Emp 14D and Emp 15D were difficult to locate and contact. This likely resulted in the delayed emergence of a main concern. However, by engaging in constant revision of early data as new concepts were revealed, a persistent concern eventually emerged.

As noted in Section 5.1.1, I found certain modes of questioning more fruitful than others. Most of the participants were familiar only with experimental, positivistic research design and this influenced their responses. If queried too closely about their beliefs, preconceptions or feelings, they tended to want to adjust their statements to render them suitable for generalisation, and this muffled the sharpness and intensity of their comments. Some participants were at pains to ensure I would not rely on their sole personal views, and this afforded the opportunity to assure them that their personal views were precisely the material important to the study.

I eventually found the best strategy to encourage open discussion was to refrain from direct questioning about personal notions and to allow the participant to control much of the conversation. This required a delicate dance of careful interjections on my part to keep the interview focused on content relevant to the emerging theory. I also made use of the insights offered by Chase (2003) in her description of her



development from a controlling to an enabling interviewer. I discovered that by asking the employers how they set about appraising the suitability of an EHDRG for the workplace, they were most likely to express informative, complex views replete with beliefs, values and personal experiences. I gradually improved this technique and found that later interviews yielded richer data than had the earlier ones.

### **6.3.2 Merged views about undergraduates and HDR graduates**

The interviewees typically merged their views of engineering bachelor degree graduates with their views of EHDRGs. This was particularly the case when they spoke of the characteristics, as distinct from knowledge and skills, that they sought from engineers in their employ. For example, EmpP 1 was interviewed in his capacity as a representative of a professional organisation of engineers as well as his direct workplace experience as an employer of engineers. His perspective was also founded on his discussions with many hundreds of employers of engineers in Australia. In response to my inquiry about what employers sought in EHDRGs, he answered in terms of engineering graduates in general when he commented thus:

Look I have asked employers this [*what they seek*] so often, I am not sure if it is me answering or them. They all say they want somebody who can fit in, who can communicate, who knows the role, who can write good letters or memos or whatever, who can speak at presentations, who can you know, well be a good communicator. Usually that is the first thing that they talk about and then the second one that they usually bring up is that they have an understanding of the financial atmosphere in which they are working because they say they've got to understand that, you know, if they're going to spend a month working on something that has got very little chance of an outcome, then somebody has got to pay them for that month. They have to have their feet on the ground financially. They have got to have a good understanding of finance and returns on investment and things like that.  
(EmpP 1)

The expectations listed by EmpP 1 were voiced to some extent by most of the participants in the present study. They echo demands in the literature exploring the employability attributes and skills of engineering graduates in general (for example, DETYA, 2000; Hager et al., 2002). However, my task in both interviews and analysis was to extract that which was pertinent to EHDRGs.

### **6.3.3 Distinction between research and development and other roles**

The employers made less of a distinction than the literature suggests (for example, Mann et al., 1994) between the characteristics valued in R&D engineers and those working in general, advanced engineering roles within the same organisation. A surprising finding from the data is that only one employer, EmpHR 21E, stated that HDR qualifications were necessary for employment in the roles he identified as most suitable for these graduates; these positions were in the R&D facility of Organisation E. EmpHR 21E also noted that the section of his organisation devoted to R&D activity was ‘shrinking in size’. Employers 11C and 22C implied that a HDR qualification would be most likely sought for employment in the R&D unit within their organisation, which maintained a single specialised scientific focus and where only a very few engineers were employed at times. In both organisations, EHDRGs were employed for both R&D and general engineering work. Several employers in other organisations suggested a HDR qualification might be an advantage in certain employment situations, but such qualifications were not formally demanded in any positions within their workplaces.

Organisations C and E were the only ones identified by the participants as operating discrete R&D facilities. EmpP 16 described his perceptions of a R&D unit in an organisation for which he worked previously, but his comments did not relate to current employment of EHDRGs. As noted in Chapter 5, at its commencement the study did not distinguish between the views of employers of HDR graduates who worked in R&D units of large organisations and those in general units and divisions. As the interviews unfolded, and apart from the aforementioned comment by EmpHR 21E, surprisingly little distinction was made by the participants in these organisations with R&D sections between those sections and areas of the organisations not identified as specifically focused on R&D.

Further, the responses of the employers in these organisations indicated that they understood research and development activities to be directed almost exclusively toward meeting the ongoing and specific needs and general goals of the organisation. None, other than EmpP 16, described a situation where research engineers were required to work as isolated ‘boffins’ without the scrutiny and practical demands of

current organisational goals such as was the situation described by Bruner (1962) of researchers in an R&D unit in a large engineering organisation:

They work apart from the rest of the firm, physically and intellectually. It is the leader of the Group, not the personnel office, that hires the members. ... Behind the main building, chastely modern in design, there is a rather scuffed building that earlier served as a shop and drafting center. It is here that the Group works. Its quarters, a suite of rather ramshackle offices letting on to the beautifully equipped shop, have the air of a boys' club. There are models around, a half-finished sculpture, a large, barn-like room with old bookcases and redone couches, the walls hung with cellulose soundproofing that reminds one of attic space under the rafters on rainy afternoons in childhood. The windows give out upon a parking lot. The dress of the members is studiously casual, from tweeds to turtlenecks. ... The members of the Group are in no conventional sense engineers. (Bruner, 1962, p. 19)

In the current study, Emp18E and EmpHR 21E both worked for a large organisation that specifically seeks EHDRGs to work in a research and development consulting capacity where the company acts as its own client. EmpHR 21E made it clear that the research work performed is applied problem solving that requires relevance to organisational activities and needs:

So the engineers in our R&D function will actually have ... to try and work out 'Well what is the problem here, what's causing the bottleneck, what can we do to change this process to make it achieve the goals that were originally set?'. So there are business issue responses where they're almost having a process improvement type role. ... de-bottlenecking type research assignments ... a lot of the work they do is in response to an asset or an operation encountering a problem. They then need to be able to go out to that asset and in their investigation to try and work out all the variables that they need to consider. The people that they need to communicate with are not just fellow engineers. They often have to communicate with the people that operate the plant... [*they need*] the attributes in terms of technical expertise, in discussing communication skills, that sort of sense of being team spirited, there is a cliché or a stereotype that a research boffin is someone who works away on their own, I can't think of any of our R&D guys that operate like that, they all operate as part of a team and they do need to interact and communicate with the others. (*EmpHR 21E*)

Employer 18E, in the same organisation, held a management position of a large division. He hired EHDRGs for work both within and outside a defined technical research group. It is clear from his comments, however, that, for either situation, he

aimed to hire a person with particular skills and ‘quite often you’ll end up with someone that has got either a PhD or a masters’:

Sometimes we just go to the market hiring kind of the best person for the job and it turns out to be someone that’s got postgraduate qualifications. Some other times we go looking for the depth of kind of technical expertise in a specific area, which generally lends itself towards someone that has got specialisation, which often goes with postgraduate qualification. Now to give you a feel for that, I have a, which I didn’t mention before, that I have a technical research group of about fifteen or so people that are doing, I guess, applied research, mostly into *[identified topic]*. So within that group there will be chemical engineers, there will be metallurgists, there will be, could be mechanical and electrical engineers, and process engineers in that group as well. And often those people may have come out of a more traditional research background, having worked within universities, or with the CSIRO, or the like, coming to that kind of group. So when we are hiring into that group we’ll often go out looking for a specialist that might have, for example, might have expertise in working with *[identified topic]* or whatever, from that perspective. So quite often you’ll end up with someone that has got either a PhD or a masters, and so what we’re looking for is someone that’s capable of, has got a deep understanding of the technical challenge we’re trying to overcome, and hence we might be hiring someone out of that position. (*Emp 18E*)

Furthermore, these employers’ comments revealed a perception that most of the work HDR engineers perform within the research and development area of the organisation is directed toward practical engineering problems that require immediate attention.

Several other employers mentioned ‘R&D type’ work as part of an engineering role in their organisations, but this was not viewed as separate, either physically or intellectually, from the daily work of the organisation.

#### *6.3.3.1 The research-engineer dichotomy*

Three employers, Emp 9C, Emp 11C and EmpHR 22C worked for the same large public utility which maintained a separate research unit focused on one area of scientific endeavour of relevance to the overall operation of the organisation: Emp 9C as a manager of an engineering division, Emp 11C as the head of the special research unit, and EmpHR 22C as a HR manager responsible for hiring engineers. The views of these three employers revealed irreconcilable ‘facts’ about the work performed by engineers in the organisation. EmpHR 22C seems to have

dichotomised scientists as researchers and engineers as non-researchers, and highlighted the shift of scientists into engineering work when they had something of practical value to offer the organisation:

The only areas that it [*hiring an EHDRG*] might be would be in the more scientific areas in our laboratories and they certainly do take more notice of academic qualifications. They're more research scientists based and they publish papers and that kind of thing... whereas in the engineering field we tend not to. But there are some people... that have moved from that scientific area across into engineering because they've seen the link, in this organisation at least, between the research that they're doing with [*special topic*] from a scientific point of view moving into quite clearly into the engineering area. (*EmpHR 22C*)

Employers 9C and 11C, in contrast, were clear that EHDRGs worked in both the special research unit and in general engineering of organisation C:

**Emp 9C:** Work qualifications, industry experience, maybe a PhD we have gone and hired them too, I've had a few in the last...

**Karen:** A few PhD's?

**Emp 9C:** Yeah a few do, we fortunately have people who have done a PhD. ... [*our company*] is that way very progressive at senior management level. If we can see talent that is out there that we don't have that we could do with or if somebody just 'wow', comes out of nowhere, ... [*Our company*] has a flexibility to create a good position and say we will go out and hire this person because we need that person in the future, maybe two years time, everybody start doing some development work in this field, so very, very flexible organisation. (*Emp 9C*)

Well I can speak probably across the corporation; for instance we, I can think of one engineer we employed here who had a postgraduate degree, would have originally come from [*named university*] and then did his PhD in the US actually and came back and worked in the [*specialised facility*] area here for a while, he's now with the Engineering Projects Group in the city. ...So a lot of what our engineers do, especially ones that are you know postgraduate qualified, would be special investigations like that, special capital works projects we call them. (*Emp 11C*)

The view that engineers are not 'real' researchers was expressed also by some employers in large, research-focused organisations. For example, Emp 15D makes and explicit distinction between researcher and engineer:

...and to have a research engineer is to have a bit of an oxymoron. [...] In terms of engineer—'planned', 'organised structure'; [*whereas*]

researcher—more esoterically, more you know, ‘follow your dream’, ‘blue sky research’. (*Emp 15D*)

It [*engineering approach*] is very much a concrete approach if you will [...] It is something that does rather get instilled at the undergraduate level I think and is then quite commonly carried through to later. But there tend not to be that many research engineers. (*EmpP 20*)

The methodology used in this research explores a phenomenon from the viewpoint of participants to reveal a common or main concern, problem or theme (Glaser, 1978)<sup>8</sup> that explains the individuals’ actions within a particular context. As noted in Section 6.3.3, it was important to avoid the imposition prior to interviewing of a presupposed distinction between employers in organisations with R&D units and those without. This decision was vindicated, as the data revealed that employers’ beliefs, understandings and expectations of EHDRGs’ roles in their organisations were not wholly, or even substantially, influenced by a graduate’s placement in a particular workplace context. Subtler and more personal beliefs about EHDRGs emerged—beliefs that have not been clearly elucidated in previous research.

## 6.4 Summary and conclusion of chapter

The aim of this chapter is to provide a brief, general overview of the gradual emergence of key ideas that formed a grounded theory of ‘Reconciling EHDRG image with innovative workplace need’. The implicit personal theories of the participants emerged as important factors in the value the employers placed on EHDRGs and their willingness to accommodate them. The elaboration and refinement of my interpretation, hypotheses formation and testing that occurred during Phases 2 and 3 of data collection and results of analysis are discussed in detail in the following three chapters, each of which focuses on factors that influence the decision pathway undertaken by the participants in this study. This pathway was used to determine an EHDRG’s fitness for a workplace and culminated in reconciling the EHDRG image with workplace innovative need.

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<sup>8</sup> Glaser (1978, p. 94) states that ‘He [the researcher] is constantly looking for the “main theme,” for what – in their view – is the main concern or problem for people in the setting, for what sums up in a pattern of behavior the substance of the [*sic*] what is going on in the data, for what is the essence of relevance reflected in the data, for gerunds which bring out process and change...’

Grounded theory analysis provided the means to disentangle underlying beliefs and understandings that informed employers' decisions to accommodate EHDRGs in the workplace. Chapter 10 of this thesis relates the grounded theory of 'Reconciling image with innovative workplace need' to previously developed theories that explain the relationship between worker's personality and managers' attitudes to innovative performance (for example, Kirton, 1976), the influence of implicit theories on beliefs and behaviour (for example, Sternberg, 1985), the components of creative performance in organisations (for example, Amabile, 1983) and beliefs about intelligence and creativity in popular culture (for example, Becker, 1992).

## **Chapter 7: Establishing Context**

This chapter explores in depth the first of three key conceptual themes associated with the grounded theory of ‘Reconciling image with innovative need’. The other two key themes, ‘Invoking implicit theories’ and ‘Determining workplace fit’ are examined in Chapters 8 and 9, respectively.

The present chapter focuses on the employers’ expectations of the type of work they considered appropriate for EHDRGs within their organisations or organisational units. A common response in the interviews to the question ‘Why do you decide to employ an engineering HDR graduate?’ was a variation of ‘We don’t’, meaning the HDR qualification was not a critical determinant for selecting engineering employees for most advanced engineering positions. This did not mean the qualification was considered useless but, with a minor exception, was not considered a requirement to gain employment. In every case in this study, the hypothesised EHDRG work applicant was seen as competing for a position against bachelor-level graduate engineers with workplace experience or who could be trained ‘on the job’. Nevertheless, the employers’ comments revealed beliefs about the potential for EHDR graduates’ knowledge and skills to enhance the quality of engineering outcomes for the organisation.

A description of the type of work expected of EHDRGs tended to be the initial information revealed by the study participants. All the engineering workplace roles described were considered by the employers to be innovative in intent, but they are distinguishable by the level of novelty or originality in the products or outcomes expected of the engineering innovator. For this reason, a third of the way into the analysis of interview data, my focus shifted from the employers’ descriptions of work roles to their identification of work performance outcomes. This shift commenced in the transition from Phase 1 to Phase 2, and thus the focus on performance outcomes gradually sharpened as the study progressed.



## 7.1 HDR engineers in innovator roles

The Macquarie Dictionary (Delbridge et al., 1997) defines 'role' as 'proper or customary function'. Mitchell (1982, p. 57) defines 'role' within an organisation as a position that 'carries with it a number of duties, responsibilities, rules, regulations and generally expected behavior patterns' and notes that often the expectations of roles can be ambiguous and/or lack explicitness, which makes the learning of a role more difficult. In reference to professional work, Alvesson (2004, p. 189) defines role as 'external expectations' of what to do. In this study, the term 'role' refers to the individual employers' expectations of EHDRGs' activities and behaviours in the performance of their duties. In other words, the individual employer's expectations are considered independently of organisational descriptors of specific positions. In response to the question 'Why do you decide to employ an engineering HDR graduate?', the employers generally mentioned the tasks they expected to be performed by a person with particular abilities and characteristics in order to achieve a certain quality of outcome. The tasks made use of technical and theoretical knowledge and skills, some of which the employers believed to be developed or enhanced through EHDR study. The particular characteristics the employers associated with the performance of these tasks to achieve the outcomes they sought were a blend of personal and social abilities.

The participants in this study often presented inexplicit, and even enigmatic, descriptions of what they understood to be the appropriate functions, duties and responsibilities that would be expected of an EHDRG in their organisation. This lack of clarity was caused mainly by the employers' tendencies to merge the attributes they associated with graduate and postgraduate qualified engineers. Additionally, the participants frequently conflated their expectations of EHDRGs' work activities with their notions of EHDRGs' personal characteristics. This conflation was idiosyncratic, with employers working in the same organisation expressing different expectations of EHDRGs for the same work roles, as illustrated later in this chapter. The first cause of the employers' inexplicitness is elaborated in Chapter 6, Section 6.3; the second cause in part supports the hypothesis presented in Chapter 8.

## 7.2 Initial concepts

Early interviews, up to and including the interview with Emp 10D, were coded for roles the participants specified as suitable for EHDRGs in their workplaces, under the category ‘Specifying EHDR graduate work’. Although the roles were only broadly described by the participants with respect to specific activities and tasks, each role emphasised demand for either interpersonal ability or knowledge of engineering theory and the practical means for its application. The roles were labelled as personal-social or knowledge-skills based. Figure 7.1 divides the employers’ role expectations of EHDRGs in their workplaces into activities that require substantial personal and social engagement and those primarily requiring knowledge and skills related to engineering or research practice.

**Table 7.1: Employer expectations categorised as 'Specifying EHDRG workplace roles' with personal-social or knowledge-skills emphasis**

Personal-Social emphasis	Knowledge-Skills emphasis
Perform in teams	Search for, identify and assess ready-made products
Lead teams	Prepare documents and review subordinates’ documents
Manage and persuade people	Adapt existing products to organisational needs
Liaise with external providers	Fill gaps in technical knowledge to assist engineering subordinates
Liaise with clients	Devise and develop new to world products
Provide technical mentorship	Develop one-off products or problem solutions
	Adapt and maintain newly developed products
	Anticipate future development scenarios
	Build knowledge base for predicted future

Tasks with a personal-social emphasis involved performance as a technical negotiator and translator, who interfaces with outside consulting firms and clients, as well as expert leadership performance, including team leadership, documentation checks, management and mentorship. Performance in teams is a general requirement of most professional engineers, since they are required to work in teams as a matter of course (EngineersAustralia, 2011, Table 3); this is an example of comments that illustrate the employers’ conflation of graduate and HDR roles. The tasks that emphasised knowledge and skills included some or all of the following: the use of general search skills, problem identification and solution achievement, problem prediction, and imaginative conceptualisation of potential scientific and technical

problems and situations. Some EHDRGs were expected to perform most or all of these tasks, but most graduates would only be expected to perform a few.

Early in Phase 2 of the interviews, it became evident that three discrete types of roles consistently distinguished the employers' expectations. Three corresponding role sub-categories were devised: those that used knowledge and skills to adapt existing products or processes, those that used knowledge and skills to create unique or niche products or processes, and those that used knowledge and skills to predict future products or processes. I labelled these roles 'innovative adapter', 'niche innovator' and 'visionary', respectively (Adams, Mullins & Zander, 2008).

### **7.2.1 Innovative adapter role**

The fundamental activity that distinguishes this role is the adaptation of existing procedures, products or processes. Employers of innovative adapters valued EHDRGs' information search skills and advanced knowledge to assist in locating existing 'off the shelf' products, created elsewhere, and to assess product suitability for development into improved company products and services. Research skills are used to test the adaptability of the product to the organisation, and skills are required in negotiation and persuasion to put forth a convincing argument for company commitment to the product or process implementation. Negotiation and persuasion skills were described by these employers as the ability to present complex technical information to a non-technical audience such as management and to identify the information required by an audience to reach a sound conclusion. These abilities of negotiation and persuasion require personal-social qualities and are generally considered as essential skills for all graduate engineers (Engineers Australia, 2010). However, the employers believed that the level of complexity of the products and testing processes involved requires a high level of engineering knowledge as well:

We just keep monitoring the landscape, so that's an activity or we then decide to focus on an area. If we decided to focus on an area then we'd want someone who is much more than capable of research into who the parties might be that we could collaborate with, you know, other businesses or who has technologies that are available off the shelf that could be factored onto some other technology that you can buy, perhaps off the shelf, that sort of thinking and then possibly you know, running a small development project or something like that if we could convince our senior management and the board that that's an appropriate place for us to put our

funding...In terms of moving that technology fast to market you'd take a licensed technology. (*Emp 7*)

Within a technical context, EHDRGs were valued for their knowledge and ability to access complex information and render it useful for co-workers in the adaptation process:

Well, with a graduate engineer, we'd expect them to be able to use standard techniques of analysis and to solve what I would call general problems. Like for instance we are doing some [*equipment*] structures work at the moment and the graduate engineers have been doing quite good analysis activity on the [*equipment identified*] structure, but we have a postgrad engineer working amongst that team and he's been working on filling in the gaps in missing data we've got so that he's able to actually create an engineering baseline that the others can then work from. So what he's doing is more novel, using different tools to create structural analysis that the graduate engineers then use to, as a basis for their design. (*Emp 4*)

### **7.2.2 Niche innovator role**

Niche innovators perform the same functions as innovative adapters; in addition, niche innovators were expected to apply the knowledge and skills acquired during their research study to the creation of products or processes that have market value by dint of their uniqueness or because they solve unique problems for clients. Their work is knowledge intensive and requires the ability to conceptualise a problem from a unique set of circumstances, to determine a solution pathway, and to devise and oversee a project management plan to achieve the solution:

We have and continue to develop a number of products in our company, within our company across Australia but also primarily in the [*city named*] office and so these products obviously have, before they evolved to the product or manufacture stage, we obviously had to invest significant amounts into research and development funds, not only monetary funds, dollars, but a lot of time and effort by individuals and of course that sort of work does require the input of a range of people before it gets to that sort of product stage and I suppose someone with postgraduate experience is quite needed in that sort of case. I suppose, these products are niche products, they are often technically complex systems that need to be developed and I suppose in that sense we need people with obviously diverse as well as extensive technical knowledge and background in research. (*Emp 5A*)

However, niche innovator functions extend beyond conception and development of a product or solution. Since these outcomes are complex and unique, niche innovators

were expected to oversee installation, development, improvement and ongoing problem solving and troubleshooting.

### 7.2.3 Visionary role

Visionaries may perform some or all of the functions of both innovative adapters and niche innovators. The visionary role is expanded to include the investigation of new knowledge and techniques relevant to workplace interests, as well as proposing future development that can make use of the new theoretical and technical knowledge. The role includes working in groups to explore potential areas of future development, to predict future problems and to propose imaginative solutions:

That is their job. People between 22 and 35, full of ideas, so it is their job to put together proposals and ideas with, I mean it is not totally unhinged from the needs of the division of course. ... And it is my job to do that, but I am not leading the research and saying, 'I have got a great idea. Go do that'. These are things that they might look at. I don't know, just to give you a feel for it, like instead of putting the fuel on the inside of [*vehicle type defined*], put it on the outside. ... And you think, 'how could that be?' Well you know, with forces and fields and things, you could do it. Now I wouldn't want to particularly [*operate*] it ... So I mean we are not saying we are going to build these things, but at least carry it through to like a business case and articulate it, this is how this might fit into [*our*] needs of the future. (*Emp 15D*)

HDR engineers in niche innovator or visionary innovator roles were also expected to engage in some innovative adapter work. However, employers who emphatically sought innovative adapters placed little or no value on the other innovative role types in their workplaces. Despite individual variations in tasks between the role types, such as more or less demand for client liaison or mentoring, every participant, with the exception of EmpP 16<sup>9</sup>, emphasised a preference for one of these innovator types when referring to EHDRGs' roles.

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<sup>9</sup> EmpP 16 was interviewed for his pertinent experiences and views on employers' motivations when hiring and supporting engineers in general.

### 7.3 Shift from innovative roles to innovative outcomes

‘Specifying EHDRG work’ was the initial category to emerge from the interviews and specified what the employers believed to be suitable work for an EHDRG to perform. The employers’ descriptions of these roles, such as ‘search for, identify and assess ready-made products’, ‘fill gaps in technical knowledge to assist engineering subordinates’, ‘adapt and maintain newly developed products’ and ‘build knowledge base for predicted future’, did not provide much evidence of distinction between the employers’ expectations, especially since some or all of the adapter roles were included in the work of visionaries. They also failed to capture much of what the employers’ comments revealed about their expectations of the engineers they envision working in these roles.

I used a strategy to enhance theoretical sensitivity, offered by Strauss and Corbin (1990), who suggested applying the basic questions ‘Who?’, ‘When?’, ‘Where?’, ‘What?’, ‘How?’, ‘How much?’ and ‘Why?’ during analysis of the data. My change of focus from roles and tasks to purpose resulted from the answer to the question ‘Why?’ or in this case ‘To what purpose were the roles that the employers described?’ The answer to this appeared to be in a quality of the outcome the employers sought: adapted (Emp 7) or unique (Emp 8):

I take the example of some of the other postgraduates we’ve got, we’ve got, one of them has been doing some research or I guess monitoring what’s going on in the industry in certain areas, ... If we decided to focus on an area, then we’d want someone who is much more than capable of research into who the parties might be that we could collaborate with, you know, other businesses or who has technologies that are available off the shelf that could be factored onto some other technology that you can buy, perhaps off the shelf... (Emp 7)

We were a company pushing the boundaries of the way things were done. ... ‘cause most of the problems we were dealing with we hadn’t seen before. (Emp 8)

I had been focusing on what employers expected EHDRGs to *do*; however, the participants tended to explain their expectations in terms of what they expected EHDRGs to achieve, and to what purpose. My attempts to categorise the engineering workplace tasks that required postgraduate education and training were not revealing

graduate characteristics that the employers believed appropriate for workplace environments and necessary to achieve workplace goals. This prompted me to change the focus away from role to outcome.

This shift was also prompted by another insight. One marker of the transition to the second phase of interviewing was my gaining insights from the interviews with Emp 8 and Emp 10D, whose comments follow and relate to the personal attributes of EHDRGs that emphasised their beliefs that uniqueness of products or solutions was dependent on the nature of the person who produced them:

Probably the ‘can do’ and ‘not afraid to try’ aspects of a person [*are important*]. We were a company pushing the boundaries of the way things were done. So we didn’t want someone who was steeped in tradition. We didn’t want someone whose views were ‘this is the only way to do something’. I always was looking for good communication, which of course also came out of the chat over lunch. So those were the main aspects I was looking for. But certainly in attitude it was preparedness to attack problems that they’d not seen before, ‘cause most of the problems we were dealing with we hadn’t seen before. Willingness to learn, an open-minded approach, ability to think, preparedness to think. My own experience is that a lot of high scoring students are high scorers because they work very hard but often they have really no ability. And the translation, real ability to think, analyse a problem is really what I was looking for. [...] I couldn’t get that out of an interview really, their ability to analyse a problem, but I certainly could get out of the interview their attitude and their approach to a problem. And usually if the approach is right I found the abilities followed from that. (*Emp 8*)

Well [*organisation name*] is charged with pushing back the frontiers to a significant extent, it is not routine engineering in the sense of using existing knowledge, it is about generating new knowledge in particular areas that are relevant to [*organisation’s focus*]. So whether we employ engineers or scientists is often a secondary consideration and the primary consideration is whether this is a person who, usually demonstrated through a postgraduate degree programme, has shown that he or she can exhibit the sort of skills and attributes that we’re looking for which includes primarily a rampant curiosity and an ability to go where others haven’t gone, if you can use that language. (*Emp 10D*)

This finding further increased my awareness that differences between the employers could be more easily understood by considering the differences in what EHDRG workers were expected to produce. It was clear that the outcomes expected from the different roles were distinguished by more or less need for originality, thus answering another basic question suggested by Strauss and Corbin (1998): ‘How

much?'. Adapted innovation did not produce an outcome that was as original as a niche innovation. Visionary innovation provided for prediction and construction of hypothetical situations beyond what was presently achievable and thus could be seen as opening the workplace to even more original or unique ideas.

The distinctions between these three role types, outlined in Table 7.1, illustrate this increasing demand for newness or originality of outcome to achieve the purposes mentioned and describes, in general terms, the tasks associated with each role.

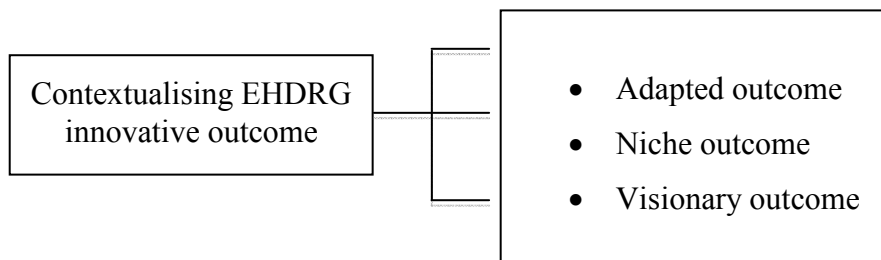


**Table 7.2: Key innovative advanced engineering role types and associated activities as identified from employers' comments**

Role type	Purpose	Engineering HDR graduate roles
Innovative adapters	Maintain product or service relevance	<p>Search for, identify and assess ready-made products</p> <p>Adapt existing products to organisational needs</p> <p>Technical knowledge 'gap filler' for other workers</p> <p>'Intelligent clients' who liaise with external providers on the organisation's behalf</p> <p>Liaise with clients, sell products</p> <p>Technical mentor</p>
Niche innovators	<p>May include the above, plus...</p> <p>Provide competitive or social advantage in the marketplace through the use of extensive technical knowledge</p>	<p>Devise and develop new-to-world products</p> <p>Develop one-off products or problem solutions</p> <p>Adapt and maintain new products</p>
Visionary innovators	<p>Some or all of above, plus...</p> <p>Prepare the organisation for future response to technological developments in the field of interest</p>	<p>Some or all of above, plus...</p> <p>Anticipate future development scenarios</p> <p>Build knowledge base of relevant recent and potential technological developments</p>

Increasing demand for originality in innovative outcome

As a result of this reflection, I reframed the previous category of 'Specifying EHDRG workplace roles' as 'Contextualising EHDRG innovative outcomes', with the sub-categories renamed to reflect outcomes, as shown in Figure 7.2.



**Figure 7.1: 'Contextualising EHDRG innovative outcomes' and sub-categories**

Although this was a subtle change, it helped to separate the function and purpose of EHDRG work from the participants' theorisations about the personal and social functioning of EHDRGs. This was important because the outcomes were concrete and could be categorised, while the role descriptions provided by participants tended to be vague and not amenable to categorisation. The three innovative outcomes and their value to the employers' workplaces are outlined in the following sections.

### **7.3.1 Adapted innovation outcomes**

Employers of innovative adapters occasionally identified the possibility of new product development, but strongly downplayed the value of this occurring within the organisation or the opportunity for this to occur in the workplace. Rather, they emphasised the need for engineers who had the necessary knowledge and skills to assist in gaining access to products, evaluating their usefulness and developing an argument for their implementation. The valued outcome was the successful identification and alteration of products created elsewhere, with the altered product rendered suitable for application:

My experience in terms of the *[PhD]* chemical engineers that we've had and mechanical engineers that we've had has been that ..., they've had to largely feed into an existing project on not necessarily new technology that's been developed but maybe adapted technology. And or ironing out work as you've stated before. [...] So it's very applied in the sense that the science that they're doing has been kind of researched, it's just new applications. (*EmpHR 13D*)

... in a lot of areas you're executing if you like, applied work and if they *[EHDRGs]* are going to help to do that then they have to be aligned with those goals which includes ... liaising with people, cost and schedule, all those things as well. (*Emp 4*)

### **7.3.2 Niche innovation outcomes**

Niche innovators are valued for their ability to improve existing products and services and to conceive and create novel ones, thus providing the company with a commercial advantage in the marketplace. This strategy was described by Employer 6B, the director of a small, specialised engineering firm, as a commercial imperative for company survival:

...we do have a stated objective to be a leading edge company in the fields that we work in.... And that to us is a survival strategy. We kind of see that manufacturing is under pressure as such because of cheaper labour countries becoming more prevalent, so anything that doesn't have some degree of difficulty incorporated in it isn't going to survive very long. So education and knowledge are things that are not easily copied and so we base our business on knowing how to do things and developing new and better products and services. (*Emp 6B*)

### **7.3.3 Visionary innovation outcomes**

Visionary innovators work to prepare organisations for potential future developments or to dictate future developments. In this study, visionary innovators were sought mostly by government or semi-government institutions, where a proportion of funding is available for what is commonly referred to as 'blue sky' research. Employers of visionary innovators were clear about their preference for unconventional approaches to problem-solving and several viewed an HDR qualification as suggestive of an appropriate sort of engineer.

The employers' descriptions indicated that visionary innovator roles share characteristics of niche innovator roles, but a key difference is that niche innovator roles are kept more stringently under check by budgetary and time pressures within the organisation. However, consistent with my observation that these roles are on a continuum with respect to their demand for novel outcomes, it was clear from the descriptions that follow, and the enthusiastic and dynamic way these descriptions were delivered, that several niche innovator employers perceived niche innovator roles as demanding, like visionary roles, a strong drive to perform that pushes people into uncharted intellectual territory. EmpP 3B, a niche innovation seeker, described developing a large entertainment installation of original design that was required by an internationally renowned client within a short timeframe:

Yeah, it's less than 100 days! It's 97 days and they're saying 'Okay, it's a half a metre pond of water, there's a grate in the middle of it, all your gear has to be underneath that grate, you can't have anything penetrating above that because water will drain away, [*people*] have to go on top of that, there will be no trip hazards and you can't have, if you have anything that comes up, it has to be go away and it has to light in this particular sequence, dah, dah, dah, do it.' That's it! All hands on deck from all aspects of getting the gas in there, making it work, lighting it, and stuff like that. So the creativity of going 'So, it's a research problem again'. Okay make gas burn on top of water. We knew we could do it but doing it the best way of okay, what factors we have to consider here. You've got wind, you've got, something

could go wrong here. So it's problem solving. We're putting up a huge amount of gas there. So okay, do we look at LPG versus natural gas? LPG is brighter but then it will pool on the surface of the water so if that doesn't light initially and you light it, it will just go whooph, a big fire ball. Natural gas goes, is lighter than air so that will rise. If it doesn't light then you might get a vertical flash but it'll be safe. LPG, you've got to have tanks there. That's a security risk. You have massive, massive tanks there that terrorists could target. Natural gas you've got pipelines buried. (*EmpP 3B*)

Similar to employers of visionaries, the employers of niche innovators seek imaginative and original outcomes. However, there are key differences between the employers' needs and these are discussed in Section 7.6.

#### **7.3.4 Outcome preference and individual employer**

The engineering positions requiring any of the three levels of innovative outcomes described in Sections 7.3.1, 7.3.2 and 7.3.3 are not exclusively available to EHDRG engineers. From the employers' viewpoints, any graduate with the appropriate expertise would be considered for these roles. However, they are the roles and outcomes the employers associated with the level of knowledge and expertise that they believed HDR graduates would be more likely to possess than engineers holding only an undergraduate qualification.

These levels of innovation required in outcomes reflected the expectations of interviewees, rather than formal organisational role descriptions. This is illustrated by my observation that employers in the same organisation, describing identical employees, revealed different expectations of originality, or placed emphasis on tasks and attributes associated with different expectations of originality. In other words, in some instances employers in the same organisation, and referring to the same engineering positions, favoured different innovative role outcomes or emphasised the importance of different tasks. For example, the following two employers were commenting on the same positions when they stated the following:

We have experts in each field. For example we've got somebody with Geotechnical ability ... he's got a PhD; .... and have [*been*] tending to hire people with a lot of knowledge so that we can be intelligent clients, so we can understand what the consultants are saying [...] We also need people, specialists in the area of [*topic named*], you know, like people that understand, PhD by research, on the new types of emerging problems out there with [*problem area identified*]. (*Emp 9C*)

But we're not necessarily looking for that extension, for the PhD type things, because we're thinking well they're [*bachelor-level graduates*] useful now, they're useful at that level. We've got a whole lot of practical stuff that we'll give them. (*EmpHR 22C*)

#### **7.4 Linking knowledge and skills to outcomes**

The sub-categories of workplace outcomes appear to suggest that each employer fell neatly into a particular sub-category. This was not the case. Each employer maintained an outcome preference, but the participants peppered their views with elaborations that emphasised certain notions that were at variance with those of other employers who had a similar outcome preference. Continued exploration of the variety of employers' ideas within a clear framework of desired outcomes provided me with an opportunity to unearth much subtler notions and preferences that influenced the employment of EHDRGs in industry.

Knowledge, skills and approaches to solving problems are discussed in this section only with respect to their direct link to the roles and outcomes described previously. Knowledge and skills were also linked by the participants to personal and social characteristics of EHDRGs, as well as to academic culture, and this forms the basis of discussion in Chapters 8 and 9.

The employers did not explicitly distinguish between the meanings of knowledge and skill, although they used both terms. From their comments, I identified the following distinctions. Knowledge was the enhanced understanding gained by study of an engineering field of interest and included relevant knowledge of theoretical concepts related to physics, chemistry and mathematics. Specialised knowledge was concentrated in an engineering area of interest, sometimes referred to as the 'thesis topic'; it included awareness of other experts and important developments in the field. General engineering knowledge was seen as the understanding of the fundamental concepts and principles of engineering practice, as acquired in undergraduate engineering study. Participants also dimensionalised knowledge with expressions such as 'deep', 'narrow' or 'broad', and I interpreted their comments to mean either a sophisticated understanding of a narrow topic, or a surface-level understanding of a wide range of related concepts. Specialised knowledge was deep,

general engineering knowledge was broad, as was general knowledge related to understanding gained from experience of the world at large.

Skill was an ability to *do* something and was related either to cognition, such as to ‘drill deep into a problem’; or to concrete practicality such as ‘bolt[ing] together the pipes and stuff’; or to specialised or general engineering-relevant procedures or protocols such as, for example ‘doing [*sic*] Microsoft Project’; or to the performance of a professional activity such as ‘skills in being able to alter their presentation communication to suit the audience’. References to skills appeared dimensionalised at either expert level or non-expert level. A glossary of terms describing these distinctions is provided in Appendix 11.

Participants held one of two perceptions of the specialised and general engineering knowledge achieved in HDR study. They believed that either EHDRGs’ knowledge was deeply grasped, narrow in scope and limited in applicability, or that it was deeply grasped, broad in scope and broadly applicable. Those participants who perceived EHDR knowledge to be limited in applicability expressed the view that the achieved knowledge was only useful if it was directly relevant to workplace needs and therefore applicable; otherwise it was deemed irrelevant to the organisation. Participants who perceived that EHDR knowledge was broadly applicable expressed the view that the achieved knowledge was either directly relevant to workplace needs, and therefore applicable, or that the ‘deep’ fundamental understanding of principles and concepts that graduates acquired during EHDR study was transferable to conceptualisation of other engineering situations and problems, thus providing the graduate with the tools necessary to address a broad range of highly complex problem scenarios. Therefore, depth and breadth of knowledge were important qualities in the employers’ estimation of EHDRGs’ value to the workplace:

... postgraduate experience gives you a much greater depth in particular niche areas and hopefully greater breadth as well by virtue of having to deal with a whole range of issues in getting deeper and deeper into one particular niche area. ... So by depth I use the analogy of a past professor in the [*university named*] Mechanical Engineering Department who was, is very good with mechanical systems but he also used that mechanical knowledge and the analogies to apply it to the design of electronic circuits and solving the design of data acquisitions problems. And I think he got that through that experience doing postgraduate work, so you don't have the time when you're doing normal engineering as a graduate employee to

develop a broad enough perspective to be able to take the knowledge in one field and being able to flop it across to another. Yeah, and also to be able to dig down deeper. The undergraduate course for example in engineering dynamics or acoustics barely deals with a differential equation but a differential equation might be fundamental to understanding how to make the next step to apply say, to understand a CFD, a computational fluid dynamics program sufficiently to be able to apply it to a new situation or to understand the limitations or to maybe, to do some hand sums to check whether the answers are correct. So I think you get that from postgraduate work, certainly that which is well supervised and well framed and you don't have the luxury of that in a...in a job. (*Emp 2A*)

The dimensions of depth and breadth are discussed further in relation to the personal and social characteristics of EHDRGs in Chapter 8, Section 8.2.2.1.

#### **7.4.1 Linking knowledge and skills to innovative adaptation**

Innovative adapters were valued for their broad general engineering expertise, as well as general knowledge and skills for the performance of basic research and socially-based functions, such as team management and mentoring. Claims of this nature about innovative adapters were made directly by the employers and were also reflected in their statements that dismissed the relevance of the graduates' thesis topics. While they viewed a highly relevant thesis as a bonus, they tended to be less concerned with specialised knowledge and more concerned with a HDR graduate's ability to adapt to the broader knowledge requirements required in the adapter role:

‘We’re not generally using the knowledge that they would have acquired in their PhD thesis in the business...the PhD is sort of nice to have but we won’t then directly use it.’ (*Emp 7*)

Employers seeking innovative adapters particularly emphasised general knowledge and skills related to the area of commercial operation:

And so what you’re looking for there is you know, kind of the right balance between the technical specialisation or generalisation, to some extent, in that area, plus the work experience, the leadership skills, the commercial nous. So you’re really looking for a fully rounded individual of which the technical piece, and whether or not they have a PhD or a masters is just one factor in the decision-making about 'are they the best candidate for the job?' (*Emp 18E*)

This strong emphasis distinguished them from employers seeking the other innovative outcomes.

#### **7.4.2 Linking knowledge and skills to niche innovation**

Niche innovators were sought for all the knowledge levels and skills associated with EHDRGs. Their specialised knowledge honed in their research area, and usually reflected in their thesis topic, was particularly valued. Of the three outcome types, the employer focus on thesis topic and specialised knowledge was greatest for those who sought niche innovation:

The people we have employed have done their postgraduate studies in an area of interest to us, which is mainly in the area of *[named specialist topic]*, although we have one *[PhD graduate]* that's in a different part of the company that's unrelated to *[named specialist topic]*, so it's really just the people that we employed some portion of those have been PhDs because they have the right background, skills, knowledge, experience.  
(Emp 6B)

However, niche innovators were also expected to make use of broader general engineering expertise and skills as the niche product moves through the manufacturing and application stages. This additional breadth was viewed as necessary to enable the EHDRG to negotiate change and alterations with other workers and clients. The following two quotes illustrate how, due to the uniqueness and specialisation of products created in niche firms, and at times also because of lower staff numbers, an advanced engineer is expected to play an integral role throughout the product development lifecycle, including product conception, production, maintenance and ongoing development:

However, I suppose you know, having said that we like people with PhD's to come into the organisation to assist with our R&D work primarily, we expect people to perhaps expand their horizons and not only focus on that. You know, the bottom line with a tight running consultancy business is that we have got to generate dollars and so if, you know when the products end up being optimised and ready for production and manufacture, then those people who have developed the R&D if you like there, would be expected to perhaps move on, maybe onto another R&D project if we had one or into perhaps the other side of our business which is consulting and that is where, I suppose we believe some people might not have the experience necessarily to offer as much, perhaps compared to someone who has a number of years of consulting experience under their belt. Okay, so a



graduate for example that has come out and has been trained up within the organisation to run various projects within the consultancy business, after a few years experience there, they would almost be ahead of a PhD graduate, postgraduate, in that sense. In being perhaps someone with a bigger picture view of what our business is about and understanding the process of those more pure consultancy types of projects. (*Emp 5A*)

In all the stuff we do, you've got to get in there and you've got to be able to know [*how to use*] a screwdriver bolting something up... it's not really anything too technical, it's not something like welding or anything like that where you have to be a bit more specialised but just the commonsense of 'We've got to plumb something up so we've got to get some hose'...the ultimate postgrad for us would be someone who was qualified as a plumber and as an engineer. (*EmpP 3B*)

Niche innovators were also seen to need general knowledge gained through life experience to perform adequately in diverse environments:

They [*workplace experienced engineers*] bring some life experience into the company that's fairly important because we're continually dealing with, you know most of our engineers deal with customers and travel and work on, you know, remote factory sites in all different countries and there's a certain amount of life experience needed I guess to effectively do that which undergraduates typically won't have. (*Emp 6B*)

#### **7.4.3 Linking knowledge to visionary innovation**

Specialised knowledge was valued in visionary innovators because it was seen to enhance the depth of EHDRGs' ability to engage with other challenging problems in related areas; this ability was essential to the achievement of useful prediction. Depth of knowledge was considered a pre-requisite for the ability to transfer across to related, or even distant, knowledge domains:

***Emp 10D:*** It is not just roles it is actually fields, someone whose skills are in electrodynamics and they may end up doing optics or something which is probably the same equations but it seems a bit away.

***Karen:*** So how do people suddenly go from electrodynamics to optics and deal with that or is this where you end up knowing less and less about more and more?

***Emp 10D:*** It is part of that but also I think and it is one of the attributes I suppose, 'Can you see the wood for the trees? Can you see that the same set of physical equations apply in this field as apply here?'

Employers of niche innovators and visionary innovators expected advanced engineering workers, such as those with HDR experience, to broaden their

specialised knowledge in response to workplace problems and predicted future developments. In the passages that follow, Emp 17 favoured niche innovators with specialist knowledge, broadened general engineering knowledge, and general knowledge for ‘dealing with clients’:

And I think, having worked for a number of different firms, the last firm that I was at, they wanted everyone to be generalists. So they have an expertise but not only to be expert but to be general across most things, which I think Jack-of-all-trades—good at none—in a way. Some of the books I’ve been reading and things like that, I like the generalist aspect in a particular field. Like acoustics – there’s so many avenues in acoustics, but being able to do all of them and what this book that I’ve been reading recently talks about deep generalists, those that have an expertise but they understand general things but more deeply, not just on the surface type stuff. And perhaps deep generalist goes beyond just other disciplines. It’s drawing knowledge of just life in general. And there’s certain things though obviously that you can’t teach anybody and that’s just life experience. In terms of dealing with clients, developing empathy, you need to have a few hard knocks yourself and relate to what they’re going through. (*Emp 17*)

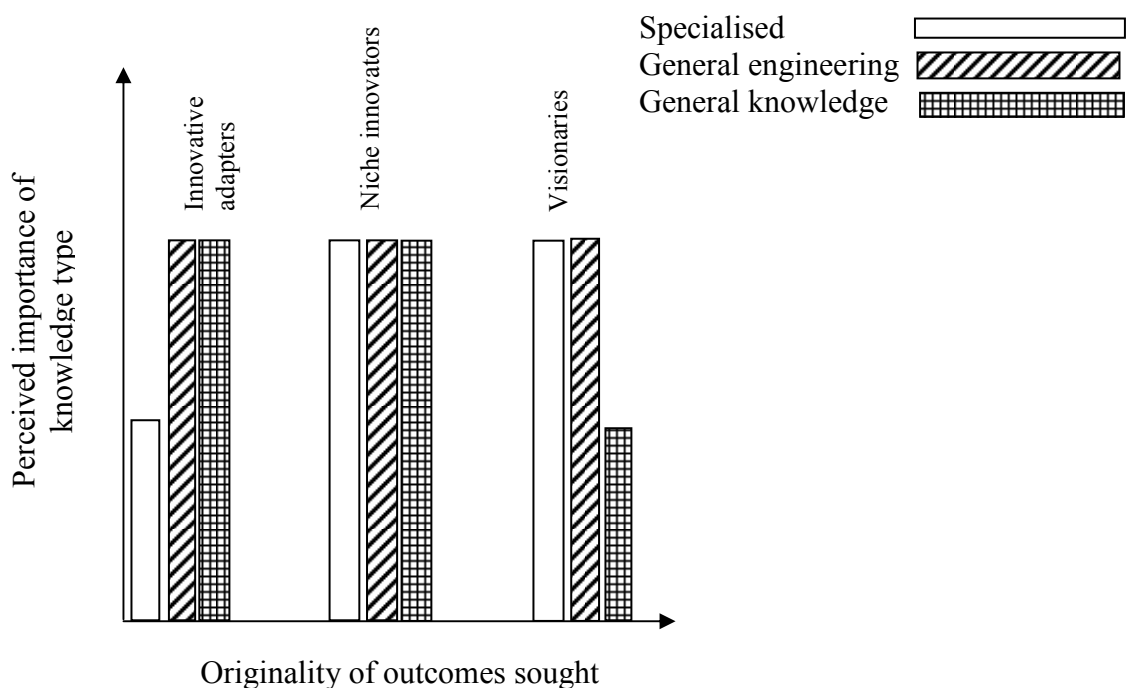
Emp 14D, whose interview was not recorded, favoured visionary innovators and identified their need to broaden their specialist knowledge to include the highly specialised work required in the organisation. Emp 14D noted that no postgraduate students are taught the specific knowledge about the specialist area in which his unit operates, and that during their first five years with his organisation, HDR graduate engineers and other research graduates develop a depth of workplace-relevant specialist knowledge by ‘enmeshing’ their existing knowledge with the core capabilities required for the specialist workplace area. Employers seeking visionary adaptors never stated they did not seek general knowledge, but they did not emphasise a need for it.

#### **7.4.4 Summary of knowledge, skills and outcomes link**

Employers who sought innovative adaptors tended to value basic, general research skills, general engineering skills and knowledge, and general knowledge and skills for tasks that emphasise personal and social engagement. They tended to devalue specialised knowledge associated with EHDRGs. Employers who sought niche innovators and visionary innovators tended to value EHDRGs’ specialised knowledge and general engineering knowledge, as well as a capacity for continued

development and adaptation to new knowledge demands. Seekers of niche innovators shared with seekers of innovative adapters an interest in general knowledge and its use in tasks requiring personal and social engagement, with an emphasis on client interaction. The employers who sought niche innovators were the most demanding of EHDRGs' knowledge and skill: they required high levels of all three knowledge and skill types.

These findings suggest that employers make an association between a need for originality of outcome and a need for specialist knowledge and skills as well as strong general engineering knowledge and skills. Figure 7.3 illustrates the relationship between the relevance of specialised knowledge, general engineering knowledge, and general knowledge at EHDRG work entry and the expectation of originality of work outcomes.

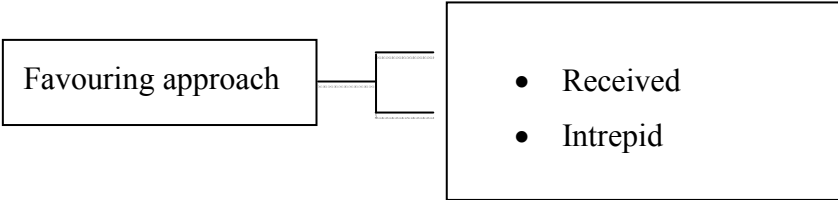


**Figure 7.2: The relationship between employers' expectations of original outcomes (x) and the value they place on each knowledge type (y) when considering the suitability of an EHDRG for the workplace.**

I noted that the employers frequently described the personal characteristics of a hypothetical engineer who they believed would be most likely to create the desired innovative outcome. Thus, the employers' beliefs about role, person and outcome were routinely conflated in their comments.

## 7.5 Linking problem-solving approach to outcome

The employers in this study described the processes by which they believed innovative outcomes in their workplaces are achieved. Two problem-solving approaches were identified within the theme of ‘Establishing context’: the received (or conventional) approach and the intrepid approach (Figure 7.3).



**Figure 7.3: Favouring approach: received and intrepid**

Like outcomes, these approaches are distinguished by the extent of their originality or uniqueness. The employers’ descriptions of problem solving approaches were closely linked to their images of engineers described in Chapter 8, Section 8.2.2.2 under the heading ‘Imaging the EHDR problem solver’.

### 7.5.1 Received problem-solving approach

The received problem-solving approach was described as adherence to a conventional or standard engineering approach to solving problems. This entails using pre-determined techniques to evaluate different design solutions for machinery, devices, systems or processes and determining the best solution for a situation, taking constraints into account. The best solution, frequently a compromise, is chosen from a pool of potential solutions, and is judged the one that best meets relevant criteria including safety, cost, time, comfort and constraints on usability:

I know that for example one of the major divisions that hires probably more of the mechanical engineers, far more than the chemical, would be our *[Name]* division which looks at things like, you know, basically for keeping airplanes in the sky for longer, for less money, adapting foreign technology, should we purchase this, should we purchase that, that kind of work. So it's very applied in the sense that the science that they're doing has been kind of researched, it's just new applications. (*EmpHR 13D*)

The received approach was favoured by employers who sought adapted outcomes.

### 7.5.2 Intrepid problem-solving approach

Intrepid problem-solving was seen as intuitive and imaginative, and was associated with thinking something ‘crazy’, ‘pushing boundaries’, exploring ‘unknown territory’ and ‘thinking laterally’. These expressions represented endeavours that break from accepted or conventional wisdom, have an unknown likelihood of success and demand intellectual, professional and social risk-taking:

A lot of the times there’s a lot of sensible things but a lot of the time you do need to think a little bit left of field and maybe try for a while and it doesn’t work out, you know it’s not really going to be, you might learn something else in the process. So that’s part of the thing with combustion as well. It’s not really a clear science. There’s a lot of theory of how to get something that burns and stuff like that but getting something that works most effectively, it’s a little bit of a black art. You’ve got to sort of, and aerodynamics and, that sort of, aerodynamics and combustion are all along the same sort of line. You’ve got to be able to think a little bit laterally.  
(EmpP 3B)

Employers who advocated the intrepid problem-solving approach were keen to avoid engineers who worked exclusively by conventional engineering problem-solving strategies:

So we didn’t want someone who was steeped in tradition. We didn’t want someone whose views were ‘this is the only way to do something’. (Emp 8)

The intrepid approach was valued by employers who sought niche innovator and visionary outcomes, because it was seen as the means to create new things:

Well what we're actually doing is growing the business into the future and there are different skills required for that, one is the entrepreneurial characteristics and the other is the technical excellence which can give birth to these new products. And when it comes down to it, you've got to be able to keep going deeper and deeper and deeper into the solution to give something which is a discriminator in the market. And I think the post graduate in principle can do that better than the industry trained graduate.  
(Emp 2A)

It’s to get people with some thinking ability to perceive risks and do some future scenario planning. So I think the PhD is, you know, the good ones look for solutions where there is a situation [and] where people just can’t get a right solution and there is a range of options. (Emp 9C)

Some of the employers interviewed believed that EHDR study required an intrepid approach to engineering problems, and viewed EHDR graduates as likely to have this approach.

## **7.6 Linking personal-social characteristics to outcomes**

Personal characteristics refer to interests and attitudes, while social characteristics refer to manner and preferences for engagement with other people. These two characteristics formed the basis for skilled performance in a number of roles identified by the participants as essential to EHDRG-suitable work, in that they were either the means to achieving innovative outcomes such as through team work and team leadership for problem solving, or they were essential for the continued functioning of the organisation, such as through client interaction, and could not realistically be removed from an EHDRG's work.

The employers' descriptions of EHDRG-suitable work tasks and outcomes reflected what they understood to be necessary to meet their organisations' goals. EHDRG-suitable work outcomes at the theoretical extremes of the outcome continuum, completely 'adapted' or completely 'visionary', would be the result of the following two organisational conditions. For completely 'adapted', no encouragement or resourcing would be available for the development of unique products or solutions for adaptation outcomes. For completely 'visionary', only unique outcomes would be encouraged and resourced. No participants' comments reflected the theoretical extremes, but several participants expressed views placed near one or other of the extremes.

Employers who sought niche innovators occupied a tense position in this regard. Much like visionary seekers, they sought engineers with a strong knowledge-skill base and an intrepid approach to produce originality of outcomes, but they were greatly constrained by temporal and financial considerations. Additionally, similar to employers who sought adapters, those who sought niche innovators emphasised the importance to their workplaces of socially based tasks such as team problem solving and client liaison, which in the case of niche innovator seekers are related

particularly to product lifecycle<sup>10</sup> demands. Put simply, specialist and generalist knowledge and skills, as well as skilled interpersonal performance, were equally and highly important to niche innovation seekers.

The combination of these needs within a temporally and financially constrained work environment created particular challenges for employers of EHDRGs for niche innovation. EHDRGs were seen to have the particular knowledge, skills and intrepid approach to meet the originality imperative. However, these employers believed that the type of person who is driven to undertake HDR study, and especially PhD study, would be unlikely to have the capacity to perform personal-social based tasks adequately. They also believed that such a person would be unlikely to perform well within the financial constraints imposed upon them. To meet both their task and outcome objectives, the employers who sought niche innovators displayed individual variation in their preferences for engineering capabilities. Some employers focused on constraining originality, others on approach, and others on personal-social characteristics. The beliefs and preferences emphasised initially by employers who sought niche innovators emerged as fundamental factors in the value all the employers placed on EHDRGs in their workplaces. They are discussed in subsequent chapters.

## **7.7 Summary and discussion of chapter**

This chapter discusses ‘Contextualising innovative outcomes’, the first theme to emerge from the interview data. The participants valued EHDRG work within the context of their workplaces for its contribution to innovative performance outcomes in the form of either adapted or novel products or problem solutions. Three work roles were identified by the employers as suitable for EHDRGs: innovative adapter, niche innovator and visionary. The roles are distinguished by a respectively increasing requirement for uniqueness of outcome, where the term ‘unique’ refers to the originality of the outcome, whether new to the context or new to the world. Innovative adapters use generic research skills and knowledge of the field to locate and adapt to workplace need products created elsewhere. Niche innovators and

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<sup>10</sup> Product lifecycle means the conception, design and production of a product, as well as marketing and service provision.

visionaries are expected to create new-to-world products, and visionaries are further expected to use their engineering knowledge to inform imaginative predictions of potential innovative developments relevant to their organisations. In this chapter, these differences in outcomes are viewed in a continuum of novelty, with innovative adaption the least novel and visionary outcomes the most novel.

The outcome expectations of the employers were associated with a number of factors. These include the beliefs of the employers about the nature of the knowledge and skills that students develop during EHDR study, including specialised knowledge restricted to or closely related to the thesis topic. Other factors were the employer's beliefs about the specialist procedural skills, general engineering knowledge and skills, and problem-solving approach needed to achieve the desired outcomes. Lastly, they were associated with the employer's beliefs about the need for general research knowledge and skills such as document production, desktop research skills, knowledge of experts in the field of interest, and general knowledge and skills that ranged from common technical or craft skills to knowledge of common social experiences.

However, the linking of EHDR experience and knowledge to the work tasks and outcomes required in their workplaces reveals only one component of the employers' views of the workplace suitability of EHDRGs. Evidence of ambivalence emerged initially in the comments of employers situated in specialised workplaces that, for survival, required engineers to produce novel outcomes whilst exhibiting temporal-financial constraint and social engagement. Chapters 8 and 9 reveal the complexity of employers' attitudes to and expectations of EHDRGs. These chapters draw a link between the importance to the employer of an original work outcome; the employer's tolerance, in the form of personal theories, for knowledge-skills and personal-social characteristics; and the ultimate value the employer places on EHDR experience.



## Chapter 8: Invoking Personal Theories

This chapter explores in depth the second of three main themes associated with the employers' reconciling of image with innovative need. This theme draws on the employers' personal beliefs about EHDRGs that gave rise to ambivalence in their attitudes toward these graduates.

Evidence of the employers' ambivalence toward EHDRGs surfaced from the earliest interviews. Although employers expressed satisfaction with the EHDRGs they had hired or managed, I was surprised to hear that many harboured reservations about EHDRGs' personal suitability for their workplaces. This appeared to contradict their own experiences of satisfaction, and their critical comments were often directed toward behaviours and attitudes that would be unsuitable for any worker, regardless of qualification attained. The employers' ambivalence, along with the finding that a research qualification was not a requirement for employment in the roles discussed in the preceding chapter, are compatible with the perception by EHDR candidates, noted in Chapter 4, that they are not valued by industry employers.

The employers' comments about the personal suitability of EHDRGs for industry-based work revealed that the employers' held idiosyncratic understandings and opinions about EHDR candidates' personal attributes, knowledge focus, the academic environment to which EHDRGs have been exposed and the HDR experience as a whole. These influenced the value they placed on graduates and the subsequent decisions they made about accommodating EHDRGs. For brevity, these idiosyncratic understandings and opinions will be called 'beliefs' in this thesis. While these beliefs were indeed idiosyncratic, there were patterns of similar beliefs that were entertained by different employers and held with different degrees of intensity. Thus, 'idiosyncratic' here means a belief, cluster of beliefs, or strength of belief unique to a particular employer.

In determining an EHDRGs' suitability for a workplace, the employers used a three-part process: they invoked their personal theories of beliefs about EHDRGs, they made inferences based on those beliefs and they acted on those inferences. The initial part of the process, establishing and inferring from beliefs, is explained here as the

employers' invocation of personal theories that varied idiosyncratically with the employer.

My realisation that the employers were revealing and acting on their personal, often unflattering judgements, based on idiosyncratic beliefs about EHDRGs, came slowly and was not one with which I initially felt comfortable. I had expected to discover the reasons for their valuing of EHDRGs, because these were employers who had worked successfully with EHDRGs and who were considered, by the scoping interviewees, to be positive and supportive toward them. I encouraged the participants to speak freely but, in the early interviews, I tended to focus on their elaborations concerning the work tasks they expected of these graduates and how they expected EHDRGs' knowledge and generic skills to be used in the industrial context. As noted in Section 7.3, the transition to Phase 2 was, in part, the point where I became sensitised to the personal nature of the comments expressed by the participants and commenced to explore this category.

Eventually, I discovered that by asking the employers to describe how they personally went about determining the suitability of EHDRGs who apply for work with them, they revealed a great deal about their thoughts and personal interpretations as they made their determinations about the suitability of a candidate for a workplace position. It was obvious to me from their responses to this question that most of the employers had not previously reflected on the nature of their personal decision making. Many were quite open in their subsequent discussion about the process in which they engaged.

Invoking personal theories is a process that consists of four sub-processes, three of which are detailed in this chapter and illustrated in Figure 8.1: 'Self-referencing', 'Imaging an EHDRG', and 'Hypothesising impact of an EHDRG in the workplace'. The fourth sub-process, 'Weeding', is described in Chapter 9.

The terms 'imaging' and 'weeding' are *in vivo* expressions, which means they are specific words or phrases used by one or more participant and work well at capturing the meaning of a category or sub-category (Strauss & Corbin, 1990). Although the four conceptual categories that form the sub-processes are presented here as sequential stages that explain the employers' decision-making process, it was evident

in the interview transcripts that, as noted earlier, notions about image, impact and selection procedures were presented by the employers as a single idea into which other ideas were embedded and blurred.

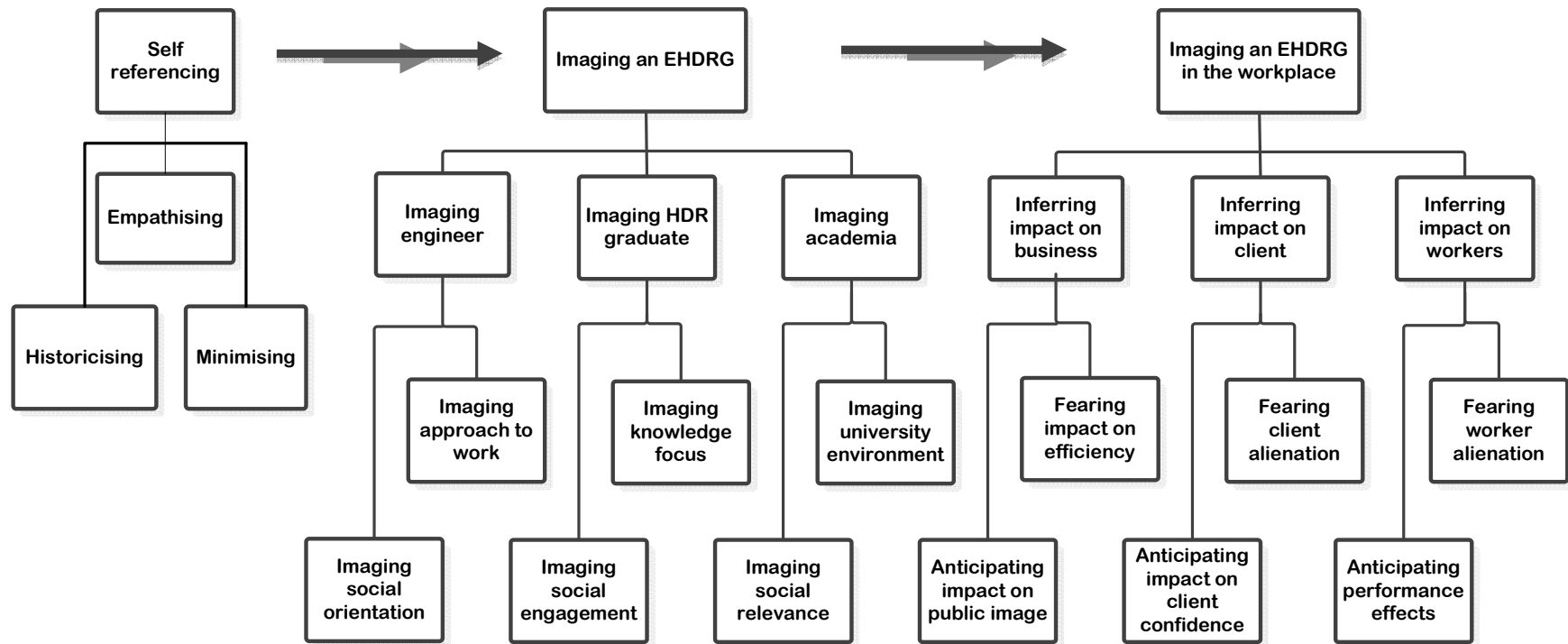


Figure 8.1: Invoking implicit personal theories. Factors in the employers' process of invoking personal theories of EHDRGs.

In the employability literature, employers' criticisms are usually presented as generalised and thematised lists of employee attributes and skills, such as presented in Fallows and Steven (2000). In this thesis, I argue that each employer maintained a unique picture of the ideal engineer as a worker in the employer's workplace, made up in part by the employer's expectations of all workers but further coloured by notions of engineers in general and their potential impact on fellow workers, clients and management. However, importantly to the context of this research, each employer also entertained mental images of ways that knowledge and skills are developed in the research process, the nature of the HDR experience, and the type of person who chooses to undertake HDR training. Inferences made from these images shaped the personal theories that the employers used to predict the impact of a hypothetical EHDRG in the workplace. Comments made by the employers supporting this contention that their views are personally constructed theories and inferences include the following:

I have a somewhat of a theory around that... (*Emp 18E*);

The engineers can't pull the wool over his [*the manager's*] eyes... (*EmpHR 22C*);

You know, if you did have a preconceived view of things, engineers, you know, well organised, well planned. (*Emp 15D*);

It's like a marriage I think... That's all, I don't know what the professionals do [*HR managers*]. We're talking about my experience. (*EmpP 19*);

That was the mental image that crossed in my head. (*EmpP 16*);

It's a bit of intuition... I think at the end of the day it's a bit of gut feel... (*Emp 17*);

You start making inferences about their attention to detail, their motivation in coming to the organisation and things like that (*EmpHR 13D*);

It's [PhD] character building! (*Emp 8*)

The images may be formed from personal experience of undergraduate study or HDR candidature, personal experience of work, anecdotes from others, or personal life experiences and philosophies. Regardless of origin, these images inform an inferential process that leads the employer to engage in strategies to identify attributes hypothesised to be valuable or troublesome, which in turn informs a

decision about the individual EHDRG's suitability in a particular workplace. This study does not seek to identify how an employer creates these images. However, many participants engaged in 'Self-referencing', involving comparisons and contrasts between their career biographies and those they considered likely of EHDRGs, and these frequently included self-identified links with candidate selection.

## **8.1 Self-referencing**

From the earliest interviews, the participants offered stories about their personal experiences and reflections on their own study and work choices. These self-referential stories focused largely on the influence of their personal, educational and work experiences on subsequent professional work practices and behaviours and were offered as explanations for their inferences about the type of person who chooses to pursue a HDR in engineering. The stories involved, for example, careers forged with or without a HDR, what they had done in their personal lives instead of pursuing a HDR and reflections on the way engineering work, the workplace or business in general had changed, or remained the same. Self-referencing served three purposes for the employers: historicising, empathising and minimising.

It is important to note that historicising, empathising and minimising were idiosyncratic to individual employers. Not all HDR qualified employers empathised with EHDRGs; some tended to minimise either directly or indirectly. Not all non-HDR qualified employers minimised the value of HDR experience; some were very empathetic.

### **8.1.1 Historicising**

Many employers told stories to explain their personal life decisions and how they affected their career trajectories, and how these decisions coloured their views of EHDRGs. Historicising uses autobiographical information to illustrate and explain the path to professional maturity. For some, the decision to engage in further study, including HDR study, was considered a time to consolidate engineering knowledge and develop greater depth in an area of interest. Employers who were themselves EHDRGs believed that the experience of HDR study ultimately contributed to their

success and saved them from what they feared could have been a career of intellectually uninteresting engineering work:

I guess from my own perspective doing postgraduate work gave me actually time to think about what I was interested in and develop skills which I wouldn't have developed in industry and gave me much greater opportunities, work opportunities, business opportunities, gave me opportunity to work overseas which would have been hard otherwise unless I was in a different type of environment like making cars or you know, oil industry which I wasn't interested in. (*Emp 2A*)

Others pointed to the confidence and character building that develops from tackling the challenging problems of PhD research:

I was actually working as a serious engineer, the company was being rebuilt, but we had 25 fulltime staff and the place was riven by politics. 'Cause they were all enthusiasts wanting to do it their way. And there I started to learn the skills of dealing with people. [*Karen: Do you think your PhD helped you to learn any of those skills?*] I didn't think so at the time but in retrospect it probably did. I think it gave me a degree of confidence that I could tackle a tough problem and come out the other end in one piece. Because I had a huge crisis in the middle of mine and really 6 weeks couldn't do anything, and I didn't know what I was going to do, I couldn't see a way forward. And I used to walk the streets of [*city name*] trying to think because I couldn't sit at my desk thinking...And eventually I just thought I've just got to go and do something. I went in and I took a few photographs of this oil scrap and in these photographs was inspiration. (*Emp 8*)

This quoted passage also reveals Emp 8's experience of problem-solving in a novel situation and the value he placed on his recognition of the 'inspiration' that emerges from doing something different to address an intractable situation.

Other employers, whose stories revealed a career pathway without EHDR study, were equally content with their decision. They described an early decision to make a living and make their way in the world, for example by assuming responsibility for a home and family. From the start of their careers, these participants grappled with the demands of working with others and negotiating the social and commercial constraints of industry. The following quote contrasts an employer's experience of undergraduate part-time study to that of fulltime undergraduate study, but mirrors similar views expressed less eloquently by employers referring to EHDRGs. Emp 18E offers a good illustration of a view, elaborated later in this chapter, that

exclusive exposure to the academic environment retards personal and social development:

I have somewhat of a theory around that, and some of it's because of my own experience. I did a significant part of my undergraduate degree part time, because that's just the way it was done in these kind of fields, in the, from the mid-1970s onwards. You know a day a week plus two nights a week university and then working as an undergraduate, in a kind of technical *[role]*. So all of the issues around leadership, and almost an extra maturity as a student, came from the fact that I was out there in the workplace. And it was very starkly illustrated and it's going way back now, but in the, so I graduated in the early 1980s, and around about that time there was a shortage of technical graduates, just before the early 1980s recession actually, and we went to hire some engineering and metallurgical and chemical engineering graduates from overseas, but they'd all just done their straight full time degrees, and the maturity level difference *[was evident]*. Now part of it was age, because we were all a couple of years older than they were. But there was also this kind of immaturity, but also a view that, kind of world owed them something, as opposed to having kind of worked through the hard slog. And that was, so I think we've kind of lost something with the demise of kind of part time study, in terms of getting extra maturity. (*Emp 18E*)

Both employers' views expressed belief that their chosen career path fostered the maturity necessary to deal with problems and people. One believed maturity was fostered by undertaking a PhD and in so doing gaining broad opportunities, learning the social-personal qualities of discipline and perseverance, imaginatively overcoming intellectual challenges, and learning to remain steadfast and confident in one's understanding and problem solving. The other believed maturity was fostered by developing social independence and connection through practical experience and by learning how to navigate through the practical demands of the 'real world'. Both viewpoints expressed employers' beliefs that their personal life decisions and experiences strengthened their ability to do meaningful engineering work.

### **8.1.2 Empathising**

Some employers' stories displayed empathy for EHDRGs. For example, Emp 2A revealed that he had had difficulty finishing tasks on time during his PhD candidature, and acknowledged that the engineering industry likes timely task completers:



It's good to finish on time, yes. I was not a good finisher on time. I don't think industry would value that **that** much, but we do value a very good output from a PhD. [...] and maybe post grads don't necessarily, are not necessarily that practical, at least initially. And personally that doesn't worry me because you know, you learn plenty out in industry quickly as long as you just get involved. (*Emp 2A*)

The key point in this quote is the employer's belief that his difficulty with meeting deadlines did not prevent his success, because many of these skills can be developed in the workplace. Interestingly, this view echoes a comment by participant B1 in the preliminary focus group study, who was one of only a few students who had pre-candidature engineering workplace experience. Other employers empathised with the limited funds available to HDR candidates, the temptation they battle to give up their studies, and their ultimate determination to finish what they started.

Despite the demand of some employers for commercial acumen in EHDRGs, many employers empathised with EHDRGs about the pressures placed on them to be competent in many arenas, and defended them against accusations that EHDRGs lack commercial acumen by comparing current expectations of knowledge and skill with their own career histories:

I think there's a big difference to what sort of happened over my life cycle in work, compared to what is expected of younger people these days because, just citing the person we've got here, [*he*] is production manager, he's 30 I think and you know certainly there is a lot more expected of people with, with degrees and things like that to be able to pick up things very quickly. So I think this person, you know probably six months is you know is where I was probably at after about ten years, when it comes to you know responsibilities and things like that. So I think we're expecting a lot more of people in the terms of how quickly they have to apply themselves to things. (*Emp 12*)

### **8.1.3 Minimising**

In contrast to empathising, personal stories could also serve to illustrate a diminished value of EHDR experience by employers who had not undertaken EHDR study themselves. The value of EHDR experience was minimised by their view that they could have completed a PhD if they had wanted to, but that the pursuit did not appeal to them at the time and the lack of PhD had not interfered with their success. They

emphasised that they were just as successful, and possibly more successful, than colleagues who chose further study. The employers also pointed out that they had PhDs working under them in their organisations. These self-referential stories served to minimise the suggestion that EHDR experience is evidence of greater intelligence or ability, knowledge or skill in engineering work than the absence of such experience. They also hinted that HDR experience might be detrimental to career success in that it exposed the candidate to the detrimental knowledge-skill and personal-social effects of the HDR and academic environment noted later in this chapter in Section 8.2.

Initially, I was hesitant about my interpretation of minimising in self-referential stories, especially since minimising did not seem to result in an employer rejecting EHDRGs as workers. I considered it likely that minimising created a minor, but not a major, hurdle to accepting an EHDRG during the weeding process. However, it was at this stage of analysis that I had a fortuitous conversation with an engineering academic who had worked as an engineer at management level in private industry for a number of years. Upon my mentioning my tentative hypothesis, he offered to share the views he developed through his workplace experiences and agreed to a formal research interview. While his experiences did not include decision to hire an EHDRG, they reveal one engineer's considered perceptions of the influence of minimising to serve personal interest in the workplace accommodation process:

Some people see if they keep people down around them, then they keep themselves on top of the position. [...] Well I can only sort of talk I suppose on the observations I've made. I mean it's, if I try and talk on any more than that, it's pure speculation but I've seen evidence, I suppose of people's personal situations and the professional situations that they're in, directly affecting who they recruit. ... I think you know, my last boss who had this chip on his shoulder, I wonder if he was more influential in whether I was employed or not.... I think the guy that was above him perhaps had a little bit more vision and, well that sounds like I'm blowing my own trumpet but you know, I think there's a big effect on ... people looking at how it's going to affect them. And every employer, you know no matter how posh he looks in his IBM suit and his slick back hair, is a person with emotions and you know, they're going to have human needs, that survival, they're going to want to look after themselves. Some are perhaps a bit more, what's the word, I suppose that they're perhaps you know, looking for the greater good, maybe the good of the company or you know, maybe sort of is out looking for the greater good of mankind, I don't

know. But I think yeah, if it boils down to it, we're all humans and we all love to see what's going to put us in the best position. (*EmpP 16*)

The experiences and reflections of EmpP 16 added weight to my interpretation that minimising was, at least in part, an attempt by some employers to maintain professional self-esteem by highlighting their career success despite their subordinates having gained higher academic qualifications. In this study, no suggestion was found that minimising influenced the employers' decisions to accommodate EHDRGs, and exploring this was not within the scope of the study. Nevertheless, EmpP 16's story supports both the notion of a strong personal component to employers' perceptions and images of EHDRGs and a likelihood that minimising could be significant to an employer's decision-making process.

## **8.2 'Just from the image of them'**

The conversational style of the interviews provided opportunities for the employers to explain or elaborate on their ideas and this often took the form of colourful descriptions that revealed much about the employers' perceptions of the EHDR experience and the people who undertake it. The employers' explanations and descriptions consistently made use of mental images that portrayed EHDRGs as potentially attractive or problematic. Employer 7's comments, from which the *in vivo* code 'imaging' was taken, inferred that he had reservations about HDR graduates because he viewed the academic research in which they are trained as painstakingly detailed and impractical:

The researchers, just from the image of them, you know... one of the researchers was picking up the little sliver cells in this case and putting them on a glass or whatever. And you know, if you're creating, if you're in a business where you have to create area fast you know, picking them [*slivers*] up with tweezers in a laboratory is sort of academic. (*Emp 7*)

The use of mental imagery of a researcher and PhD holder was strongly echoed by EmpP 16, who had employed many graduate engineers and who then completed a PhD in engineering. He described his earliest perception of PhD graduates he encountered in a previous workplace R&D unit:

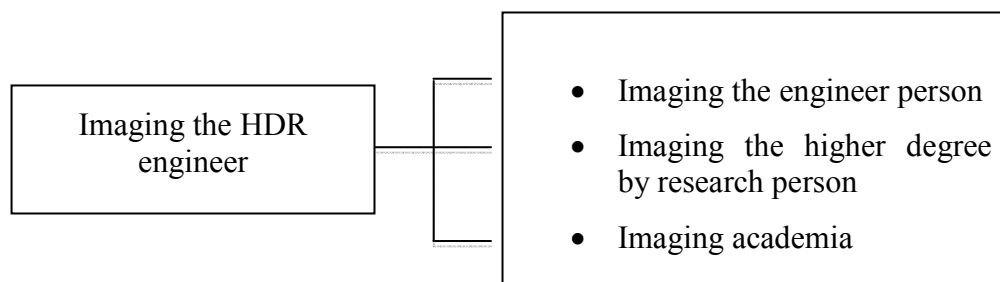
What was going through my mind was that it was for the boffins. At that point in my career, I directly associated someone with a PhD as a boffin, as a rocket scientist. [...] You know, it was just this 'odour' around this particular area where the very advanced research was done. ... I mean it was a terrible stereotypical view. I didn't think about them too much, I'll be honest with you, but you know, when somebody with a PhD or a topic of a doctor someone or someone with a PhD came up, that was the mental image that crossed in my head. (*EmpP 16*)

At times, an employer's use of an image was implied in the way a comment was presented. For example, the following comment suggests an image of childlike, naivety in certain engineers who displayed attributes EmpP 1 associated with EHDRGs in the workplace:

They would never become the chief engineer or his manager or something like that. They would have their own little areas that they would manage, and I don't know if they were ever particularly unhappy with that. You know, they were much happier tinkering around with their transformers and insulators and that kind of stuff, than they would have been working through spread sheets and budgets and personnel management. (*EmpP 1*)

Many such comments reflected doubt about the maturity of EHDRGs.

The explicit or implicit reference to images of this nature was an important, persistent theme that surfaced throughout the data, which I identified as a conceptual category with three sub-categories, as shown in Figure 8.2.



**Figure 8.2: The three sub-categories of 'imaging the HDR engineer'**

The images presented in the sub-categories are characterised by knowledge-skills and social-personal properties. Knowledge and skills were imaged as either broad or narrow in focus, and intrepid or received in approach to engineering problems. Broadly focused knowledge and skills can be applied to a range of engineering situations; they move beyond a specialist field to be available for use in other areas

of endeavour. Narrowly focused knowledge and skills are confined to an area of special interest.

Personal and social characteristics were imaged as connected or disconnected. Connected personal and social characteristics are those that allow smooth interaction between the engineer and others. Disconnected characteristics favour solitary activity and lead to avoiding interaction with others. The images are also explained by trends in the employers' interpretations. These trends weigh the image in favourable and unfavourable terms, because individual participants displayed positive or negative attitudes toward the conjured image. In theory, an employer could entertain an image that is characterised in one of the eight ways in which these properties can combine. However, in this study, certain combinations of image properties prevailed: narrow-received-disconnected, narrow-intrepid-disconnected, broad-received-connected and broad-intrepid-disconnected. These combinations are elaborated in the following sections.

### **8.2.1 Imaging the engineer person**

This sub-category refers to impressions held by several employers about the nature of a person who studies and practices in the field of engineering. Engineers were characterised as displaying broad, received and connected, or narrow, received and disconnected characteristics. The contrast in employers' views was striking.

In their work approach, engineers were characterised as either absent-minded and obsessively focused or highly organised, efficient and able to think broadly across an engineering project. Engineers were also viewed as conventional and procedural (received) in their approach to problems. Engineering was viewed as a discipline that promotes a cautious culture that honours accepted wisdom and traditional or conventional ways of thinking and solving problems.

Socially, the employers imaged engineers as either loners, who preferred technology and ideas to people, or team players who had developed collaborative problem-solving skills within their undergraduate course. The following quotes from Employers 17 and 15D illustrate these contrasting views:

**Emp 17:** I mean coming from an engineer as myself, and my wife often calling me a ‘mad professor’, you know—a little bit autistic, you know *[laughing]*...So I think we naturally have those tendencies, perhaps... Tendencies to zoom in on things in great detail—perhaps put the blinkers on and drill into a problem. I like to solve problems. I suspect, it depends whether you’ve got a research bias or not, but if you’ve got a research bias with those natural tendencies anyway, you might want to push the envelope a little bit more in terms of the research side. And that mad professor part comes from getting too caught up in a particular topic, and to the detriment of everything else.

**Karen:** When you say a particular topic, are you thinking acoustics or one narrow part or a problem?

**Emp 17:** One narrow part of acoustics or a problem, yes. And often you can be zooming into it, a tendency to go into it and solve it and understand what makes up the problem in its intricate detail, you can neglect other things. Like for example if you have a budget to do a project, and you put the blinkers on, there’s the problem, ignore the financial implications of putting the blinkers on and zooming in, spending vast amounts of time blowing the budget and you probably end up producing a, for example, in an engineering sense may produce a report on why it produced some sort of output. These are either innovative which is a good side, or very technical and you may actually miss what the client really wants in some instances.

And our engineers are more our procedural sort of guys who are very good at teamwork, project management and working in teams and working to a deadline. You know, if you did have a preconceived view of things, engineers, you know, well organised, well planned...Flip charts, the Gantt charts. (*Emp 15D*)

## 8.2.2 Imaging the HDR graduate

The influence of research degree training was characterised by contrasting descriptors related to HDR graduates’ knowledge focus and opportunity for social engagement. A HDR, and especially a PhD, was seen as personally narrowing or expanding of the HDR candidate. The image of a HDR graduate was of a person who is narrow, intrepid and disconnected or broad, intrepid and disconnected.

### 8.2.2.1 Imaging knowledge focus

Knowledge focus was viewed in one of two ways. Several employers viewed the HDR experience as an opportunity to develop the capacity for deep thought and the ability to transfer knowledge from one problem domain to another, to build a substantial body of specialised and general engineering knowledge and expert skills in the graduate, to enhance search and knowledge-networking skills, and to develop personal attributes of persistence, tolerance for ambiguity, and patience.

I think he got that through that experience doing postgraduate work so you don't have the time when you're doing normal engineering as a graduate employee to develop a broad enough perspective to be able to take the knowledge in one field and being able to flop it across to another...and also to be able to dig down deeper (*Emp 2A*).

Deep, transferable knowledge and imaginative problem-solving were specifically associated with HDR experience, as detailed in Section 7.4, and were seen as the result of specialised and general engineering knowledge and skill combined with inherent personal characteristics. This capacity, when recognised, was highly valued in the workplace.

Other participants viewed the HDR experience as an intellectually isolating and knowledge-limiting experience. In their eyes, research study ultimately results in a graduate who knows a great deal about a very narrow topic; thus, graduates were seen as possessing limited and bounded technical and theoretical knowledge. While they possessed the same broad general engineering knowledge of graduate engineers, their time spent in academia was interpreted by these employers as depriving them of the development of general engineering knowledge and skills in a practical workplace context.

The employers who associated the HDR experience with narrowness saw research as the acquisition of deep knowledge in a narrow, highly specialised field. These participants did not consider the knowledge and skills gained as a resource for innovation in the organisation and some considered the research experience as remote from and irrelevant to the day to day operation of their business. The employers who maintained this viewpoint did not consider the depth of knowledge as evidence of either the inclination or ability to develop broad knowledge through deep understanding, or did not value the ability:

... people who have done a postgraduate qualification, once they've come into the organisation will actually start to jump up and down and say that they only want to work in an area that is relevant to their area of study, so they actually become somewhat inflexible ... Yeah so they join the organisation and start working for us and you know they're okay, they may not be outstanding but they get the job done, they're productive, they form relationships in the organisations. But then they see that the work that they're doing is not their ideal so what's happening is that they're starting to do work that the business demands because of business pressures and it's taking them away from their preferred area. And so they'll jump up and

down and say ‘Well this is what I really want to do’, and our response to them is ‘We understand this is what you really want to do but this is what needs to be done, and you know this is what we expect you to.’ So there’s a degree of inflexibility on the part of some of them. ... there are some people that are very, they almost have tunnel vision. (*EmpHR 21E*)

The view of HDR completion as a narrow and confining endeavour was often compounded with the view that universities are themselves narrow or ‘cloistered’ institutions, as discussed in Section 8.2.3, and occasionally that engineering is a discipline that discourages different problem-solving approaches in favour of traditional or conventional thinking.

#### *8.2.2.2 Imaging social engagement*

The image of a solitary research student, colourfully described by one employer as ‘sitting in a back room somewhere for five years under a 40 watt light bulb’ (*Emp 18E*), extended this view of limitation and narrowness to the area of social behaviours. The HDR experience was seen as encouraging a non-collaborative approach to problem-solving and an attitude of secrecy and individual ownership of knowledge and problem solutions. The persistence and determination needed to pursue isolated study on a narrow topic served as evidence that HDR graduates were driven by perfectionism and self-interest. This underpinned the employers’ concern that the extended commitment to HDR study deprived an engineer of valuable workplace perspective:

I suppose the important point there too is that, one, well in the consulting arena, you don't have time necessarily to develop the most perfect, Rolls Royce solution and so you have to take into account the client's expectations and what their real needs and requirements are and I suppose, you perhaps come up with a solution that essentially solves the problem but is not necessarily perfect. ... That is one area that is common, where a PhD or post graduate will want to take the problem to its end point and without sort of initially maybe looking at the problem from that big picture view point and then working out a reasonable solution in a reasonable amount of time. And so I suppose, that we have had experience in the past where some people have not been a perfect match with our business and that they will tend to want to research something ad infinitum and not know when to stop perhaps. (*Emp 5A*)



The solitary nature of HDR study, as imaged by the employers, also resulted in their belief that EHDRGs claim ownership of their work, avoid sharing their work with others and do not trust work performed by other workers:

They might also be inclined to just sit at a desk and try to nut something else out themselves and essentially waste time on it rather than going to the broader group of people working on the project and just asking them a question ... You're used to, 'it's my thing, no one else will understand it, I've got to solve it'. (*EmpP 3B*)

If someone has done a PhD at a university, has been very used to working on their own. and [they] think they are going to do the whole lot on their own. ... And [*organisation projects*] are very complex. There is a bit from here, a bit from there and ... you want a person that is prepared to grab someone else's stuff, be confident that that is done. ... But if the person has to do it all for themselves, they are not sure. 'I don't trust that bit, because I didn't do it.' (*Emp 15D*)

#### 8.2.2.2.1 Imaging the EHDR problem solver

Received and intrepid approaches to problem solving were defined in Section 7.5 and linked to the production of adapted or visionary outcomes. As graduate engineers, EHDRGs were considered well-grounded in received, or conventional, approaches to the solution of engineering problems. They were also understood by the participants to be capable of producing an original outcome during their research study; many of the employers believed this was evidence of their ability for an unusual or imaginative approach to problems.

Intrepid problem solvers were described in terms of their personal characteristics:

***EmpP 19:*** What we're talking about is coming up with a novel idea or a different approach to a problem which is not the norm and that's different.

***Karen:*** Say you're interviewing someone or you have to consider whether someone is going to be able to do these things, what do you look for?

***EmpP 19:*** In terms of 'will they be able to provide novel solutions?'

***Karen:*** How will you know that?

***EmpP 19:*** I don't think you can. That would be probably more to do with their character

The characteristics included courage, curiosity and imagination:

Well [*organisation name*] is charged with pushing back the frontiers to a significant extent, it is not routine engineering in the sense of using existing

knowledge, it is about generating new knowledge in particular areas that are relevant to *[organisation's focus]*. So whether we employ engineers or scientists is often a secondary consideration and the primary consideration is whether this is a person who, usually demonstrated through a postgraduate degree programme, has shown that he or she can exhibit the sort of skills and attributes that we're looking for which includes primarily a rampant curiosity and an ability to go where others haven't gone, if you can use that language. (*Emp 10D*)

Two advocates of intrepid problem-solving, EmpP 3B, quoted in Section 7.5.2, and Emp 8 referred to this type of engineering approach as an 'art' :

In fact I think women make really good engineers because it's a subject where you use both sides of the brain. I say engineering is an art, it isn't a science at all, it's not a science and if you go back to the Victorian era we were taught about the art of engineering. We use science as tools to assist us in our decision making, but at the end of the day we make decisions often on intuition, with evidence that backs it up. (*Emp 8*)

Employers who advocated the intrepid problem-solving approach were keen to avoid engineers who worked 'by the handbook', a reference to well-known undergraduate texts such as Perry & Green (2007):

Going back to chemical engineering, there was always the view that the answers were all in the Chemical Engineers' Handbook, Perry, and if presented with a problem the first thing you would do is go to Perry, see who had looked at the problem before, modify the parameters and come up with the answer...I think there is too much of that received wisdom. You're simply told how things are, and you keep going on and on and on doing things the way, how things are. (*EmpP 20*)

So we didn't want someone who was steeped in tradition. We didn't want someone whose views were 'this is the only way to do something'. (*Emp 8*)

Intrepid problem solvers were seen as people with the personality or natural inclination to consider situations in different ways. This was described as a passion, curiosity, drive and determination. Successful completion of EHDR training provided employers with evidence of this inclination and the possibility that the inclination was developed and informed by specialised knowledge and skill, along with experience of successful struggling with the uncertainty of an unknown outcome:

... [W]hen we do employ people, whether they are postgraduates or not, we employ them because they have an ability to analyse situations, analyse what we're trying to do, the objectives of a project, and apply the most appropriate and best solutions to arrive at either a design or an answer. ... so the people we employ ... come with a certain amount of pre-existing knowledge, a certain attitude to try to find the best ways to do things and a certain hunger to learn and do better. (*Emp 6B*)

But certainly in attitude it was preparedness to attack problems that they'd not seen before, cause most of the problems we were dealing with we hadn't seen before. Willingness to learn, an open-minded approach, ability to think, preparedness to think. My own experience is that a lot of high scoring students are high scorers because they work very hard but often they have really no ability. And the translation, real ability to think, analyse a problem is really what I was looking for. [...] I couldn't get that out of an interview really, their ability to analyse a problem, but I certainly could get out of the interview their attitude and their approach to a problem. And usually if the approach is right I found the abilities followed from that. (*Emp 8*)

EHDRGs, as intrepid problem solvers, were believed to be curious and motivated to use their knowledge and skills productively to contribute to areas of workplace need:

They'll have initiative to do things and they're particularly useful people to work on any special projects that come up. Doesn't necessarily have to be research, it could be special investigations. (*Emp 11C*)

The employers considered these processes as likely inherent to a graduate's personal character, or in the case of Emp 14D, biology: 'their heads are just wired-up this way' (Emp 14D). Those who strongly favoured highly original thinkers and intrepid problem solvers tended to explain imaginative problem solving as inherent to an individual, and usually viewed a PhD as evidence of a person's possession of these attributes.

#### 8.2.2.2.2 Imaging the HDR engineer

Some participants conjured an image of the type of person likely to hold an EHDR; this image was a conflation of attributes associated with the two previous sub-categories, resulting in both positively and negatively viewed images. At best, the originality required in research conceptualisation, with its associated need for courageous and imaginative problem solving, was viewed as mitigating the cognitive strictures of conventional undergraduate engineering training:

Well the assumption I think is that the person has a better range of qualities in terms of being able to analyse problems and follow through with a research approach I guess.[...] Also part of the PhD process you're basically looking at researching what's out there, what's been done before, coming up with an area that's new within that and developing something so there's also developing, and perseverance in developing an idea and taking it through to fruition. [...] As engineers we're all trained to think one way and that's not necessarily appropriate for thinking outside the box. (*EmpP 19*)

At worst, research training was viewed as further narrowing and strengthening the obsessive, disconnected nature of someone who chooses to undertake engineering study in the first place, such as the views expressed by Emp 17, quoted in Section 8.2.1:

I suspect, it depends whether you've got a research bias or not, but if you've got a research bias with those natural tendencies anyway, you might want to push the envelope a little bit more in terms of the research side. And that mad professor part comes from getting too caught up in a particular topic and to the detriment of everything else. (*Emp 17*)

At times, some employers went to pains to emphasise that the attributes to which they referred were independent of any education or exposure but rather reflected an individual's personality. Several suggested that EHDRGs complete a personality profile, such as the Myers Briggs test, to determine the work situation to which they would be best suited. However, I interpret the nature of their responses and the juxtaposition of personal-social characteristics with discussion about the suitability of HDR graduates to their workplaces as strongly suggestive of the employers' belief that the characteristics are pertinent to EHDRGs. For example, EmpHR 13D ostensibly stated that a workplace problem was caused by an individual's personality, but then implied suspicion that the worker's research training was relevant to the problem:

There have been some reports of the individual not necessarily communicating well with others in terms of where the status of the project is, or communicating problems and trying to handle everything by themselves. So there's a variety of different issues that can come into play there but I think that can on the whole be personality driven not just necessarily you know, the product of someone having worked on a PhD by themselves for three years with little or no contact with others in a team.' (*EmpHR 13D*)

As noted earlier, other participants explicitly identified beliefs that positive and negative personal characteristics were associated with engineers and HDR graduates.

### **8.2.3 Imaging academia**

This sub-category refers to employers' conceptions of the nature of academic work, the academic work environment, and the type of person who chooses academic life. As part of the process of self-referencing, some participants noted with admiration the intellectual abilities of their former professors. However, when considering the preparation of EHDRGs for work in their organisation, the employers made distinct contrasts between university-based and industry-based engineering work, which appeared harshly unfavourable to the former and are dichotomised here as relevant/irrelevant, large/small, and strong/vulnerable. Academic engineers were imaged as narrow, intrepid and disconnected. The employers contrasted the social and practical relevance of these worlds, academia and industry, as well as their perceptions of personal strength and weakness of the people who work in them. Inference from these beliefs suggested that troublesome characteristics were likely in a person mentored in the academic environment and who chose to remain in that environment.

#### *8.2.3.1 Imaging social relevance*

The engineering topics viewed as important to engineering academics were considered by the employers to be either obscure and irrelevant to industry, or more positively as fundamental to the progress of engineering knowledge and thus intrepid in nature, but contextually undeveloped for industry needs. Academic engineering work, including research, was perceived as narrowly focused and detailed, remotely theoretical rather than practically applicable, and with markers of success that the employers considered irrelevant to industry:

The only areas that it might be [*useful*] would be in the more scientific areas in our laboratories and they certainly do take more, I was going to say more, notice of academic qualifications. They're more research scientists based and they publish papers and that kind of thing, it seems to be viewed by the rest of the organisation with a deal of amusement I guess that they are so focused on the academia and papers published and when they have any presentations or whatever they put letters after their names whereas in the engineering field we tend not to. (*EmpHR 22C*)

Academic writing was seen as unnecessarily obscure, aimed at a small, academic audience and produced with the goal of publishing papers rather than disseminating knowledge and achieving practical outcomes to the larger audience of engineering practitioners:

Yeah, their theses are too big, too thick and most people will have no attention span to read them, even the professors don't read them. That's my strong belief. If they read the stuff in it, they read the crap in it, they would never have given them a PhD. [...] No I don't have one, but I've seen lots of them out of interest to see these guys have done their physics, you know, PhD in this and you read it more than 99% of human beings cannot understand where they are going. So it doesn't tell them what it is going to tell them really, [*what it is*] they want to research about. And there will be a long-winded sentence that doesn't tell you what it is you want to get out of this when you finish it. And sometimes I wonder how they even set the thesis topics because [*if*] they will research enough to see the value of that information in real life, in application and I think they will keep questioning 'What is the value of that?', 'Why are we doing it?', 'What is it going to benefit?'. Is there a benefit at some point? Is it just theoretical concepts or is that concept ever going to be applied in real life somewhere? And you've got to start thinking of that, at least put some theories up there and say 'Maybe it will never be applied, but I just want to do it as a research topic'. That's fine, then state that, alright? (*Emp 9C*)

It was interesting to hear several employers comment that replicability was important in industry but not important in the academic research context, although this appeared to be related to either fast replication in a production run or numerous repetitions of an experiment to meet standards accreditation. The employers viewed knowledge focus and work practices as very different in the two environments, with university research requirements appearing to them to be less rigorous (smaller) than industry requirements:

...have to do ten, twenty times or more and sometimes we've had people who don't like that because they like to do one little bit of thing and move on to something else ... also some issues that we have had with people who have come here is the, sometimes people like to play. I call it playing. They, you know in a postgraduate degree you might only do an experiment as many times as you need to do it to satisfy being published or you might repeat something two or three times, you might even not repeat it at all. Something that has to be impressed on people certainly that have come out here to the centre to work is the importance of when you're doing applied science and especially say developing new methods for analysis or something like that, that you need to have the repetition and they need to have the understanding and maturity of thought that these things need to be

locked down because we have to produce enough data so we can get accreditation for a new test for instance. That's a little bit different sometimes to doing postgraduate research where you, as I say, might repeat something two or three times. (*Emp 11C*)

Therefore, EHDRGs were not seen as adequately prepared, or mature enough, for the rigours of industry research and thus were seen as vulnerable. Academics were painted as being out of touch with developments and issues occurring in the engineering industry:

I get a bit worried about people who get a bit cloistered, where they enter university at the end of Year 12, they go, they, well they don't have a gap there, they go straight through their under grad, they become a tutor and post-doctoral or not post-doctoral, basically a PhD student helper around the university while they are doing their PhD, I think there needs to be a time where they go and spend some time doing something else. [...] Engineering is about if you like helping the community and to help the community, you've got to understand what the community needs and particularly if the people that are lecturing and providing guidance to the students have themselves not spent much time in industry [*voice pause*] and I know that Engineers Australia has been trying to get a situation where academics have a certain mandated number of hours of industry time. (*Emp 4*)

There was a sense of personal strength associated with industry workers, reflected in the image of engineering academics as refugees from industry, who fled the pressures and challenges of the non-academic workplace to the relative safety of the academic environment:

I think probably in chemical engineering most academics have got a small amount of industrial experience but equally I suspect most of that experience is not good for them or wasn't a good experience, which is why they return to academia. So I think the great majority would be biased against industry and would attempt to keep the students in academia. (*Emp 8*)

This notion was further reflected in the employers' perceptions of the university work environment.

### *8.2.3.2 Imaging the university environment*

EHDRGs have spent more time in the university environment than have undergraduate engineers and the participants' beliefs about them were largely

influenced by this fact. The employers' perceptions of university work environments and work focus dichotomised them as 'small' compared with the 'large' industrial arena. In contrast to the engineering industry-based workplace, the university environment appeared impoverished to these employers; their perceptions of those who work in universities were formed in part on the basis that academics choose to work in such impoverished conditions. University budgets were viewed as small and resources limited. The participants believed that little pressure exists in universities to achieve results quickly, and thus there is little overall pressure to perform at the pace and risk level demanded in industry. The participants judged the focus of those who work in such impoverished circumstances to be limited and irrelevant to the 'real world' at large. In contrast, industry was seen as engaged with society because it was forced to be relevant in order to survive: budgets are bigger, time scales are compressed and thus pressure to achieve useful outcomes is greater, as are financial risks. Only intellectual risk is restrained in the workplace, as a result of the other pressures, but this is seen by the participants as the adherence to greater practicality in response to real world constraints.

The importance of the contrast between the academic and industrial environments was in the employers' interpretation of it. Those engineers, academics and EHDR candidates who sought to work in such a small and irrelevant atmosphere as academia were suspected of deliberately hiding from pressure. Even if an individual was not hiding, HDR experience was seen to provide no indication that the graduate could cope with the pressures and rigours of industry work. Thus, for some employers, an EHDRG was seen as potentially unsuited to industry engineering work by reason of temperament and/or training. University was not considered the place to develop engineering work practices suitable for industry, and greater time spent at university was seen, at best, as a delay in exposure to suitable training:

I would not say that spending four to five years of your life at a time when you can learn fast, and perhaps have less other things to worry about, like home and mortgage and kids and all the rest of it, in a university environment is not the time, is not a place to learn commercial acumen. I think it's probably, in my experience and it's only limited at universities, but I've had a little bit, it's probably about as far away from any place you could learn commercial acumen because they just don't seem to have it there in my view. (*Emp 7*)



So leading to the postgrads, if someone's done an undergraduate degree, gone straight into a masters program and then come out, so they've got their, what, six years of academic learning, they might have done some vacation work, we would still much prefer to hire the undergrad whose got then two years of full time work. [...] They [*managers*] would have concerns that, I mean, they were all at university themselves these managers, so they would probably have a concern that you know they're not used to the same time deadlines that you're required to function in a business environment. They don't have the same cost pressures that they have to work with in a business environment and so because they don't have those, they haven't been tested in that environment. As I said, there's a greater risk that they're not going to perform. (*EmpHR 21E*)

However, for other employers, the lack of commercially relevant training was noted but considered irrelevant to university education. They viewed commercial preparation as something that occurs through exposure to the workplace, and therefore not cause for concern when considering the suitability of an EHDRG:

Yeah I would say that probably from a commercial acumen point of view that she's not, she's not there yet but I mean I, personally I wouldn't really expect that in the first year or so out of Uni, I think that's something that, that comes more with experience. I mean, I guess my opinion is that you can't expect everything at once; some of these things just come with experience. [...] we've gotta be able to produce a product that's cost competitive and, and things like that and I think that, to me that comes with experience, so I don't know that that's necessarily something that you can, can really teach too much in university, I think, I think that's more of a business thing, so I wouldn't be critical of that myself. (*Emp 12*)

Maybe postgrads don't necessarily, are not necessarily that practical, and at least initially and personally that doesn't worry me because you know, you learn plenty out in industry quickly as long as you just get involved. (*Emp 2A*)

For these latter employers, EHDRGs might be potentially unsuited to the commercial workplace by reason of temperament, but not training. Capacity for commercial work was viewed as a quality that emerged, or failed to do so, on the job.

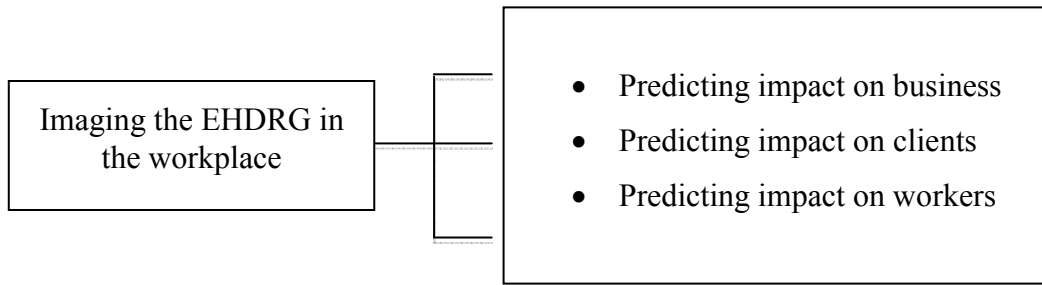
### **8.3 Hypothesising impact: Imaging an EHDRG in the workplace**

The participant employers' perceptions of the value to the workplace of EHDRGs were both influenced by, and led to, their predicting of the effect of the imaged EHDRG on a work unit's operation. The predictions influenced decisions to consider

the inclusion of an EHDRG in the workplace. Frequently, the prediction was embedded in a description of attributes or an explanation of the innovative work the employer associated with an EHDRG, or the statement of two or more mutually contradicting ideas. For example, the following quote from Emp 7 suggests that a PhD qualification is not necessarily going to place an applicant ahead of others, but also implies that a PhD might be problematic, despite Emp 7's claim that it is the person and not the qualification that interests the company. The comment reflects a belief that an EHDRG is disconnected:

Being able to deal with people is a good thing and in that respect perhaps someone who's done an undergraduate degree and wants to come out into the workforce because they want to get into the real world perhaps, it might actually be at an advantage or might have some attributes that are, that someone who is comfortable with staying in a laboratory for four to five years and perhaps, depending on what happens in their workplace, but if they're dealing with a relatively smaller number of people in a fairly protected academic environment, that's a different environment to one that's out in a workplace I would suggest. So in that case, and again it depends on the individual, we've got some postgraduates that are very good in terms of some of those skills that I've outlined so it's more I think driven by the nature of the individual, the maturity, the factors that will, the type of person you know, there's a range of things which perhaps guide that more than whether or not they've got a PhD. (*Emp 7*)

The employers hypothesised impact on three integral elements of the workplace: the business functioning, and particularly efficiency in response to pressure, their business clients, and the workers who would come into contact with the EHDRG, as shown in Figure 8.3.



**Figure 8.3: The three sub-categories of 'imaging the engineering HDR graduate'**

### **8.3.1 Predicting impact on business**

The employers described the inferences they made about the potential effects of an EHDRG's personal attributes, knowledge and qualifications on the overall functioning of a business or organisational unit. There existed a tension between promoting an image of business competence and prestige by employing, in particular, a PhD graduate, and protecting the business from the feared negative repercussions of HDR graduates' perceived threatening work practices. The employers predicted benefit to the organisation's reputation and prestige through the presence of an engineer with a PhD qualification, which was seen as conveying an image of expertise and authority to prospective clients and the public at large. The employers also predicted that the advanced level of general engineering knowledge, or appropriate specialised knowledge, grasped by HDR graduates advantaged the company in negotiations with external parties. Thus, in this way broad, and possibly narrow, engineering knowledge and skill was valued.

In contrast to these predicted potential benefits from the presence of EHDR graduates, the data consistently revealed fear of threats to business efficiency inferred by the participants as resulting from EHDRGs' impracticality due to their disinterest in anything not related to the narrowly focused topic of research. Efficiency was also threatened by perfectionism, which was believed to lead to a lack of attention to constraints on time and finances.

It was interesting to note the variety of meanings applied to the descriptor 'impractical'. The term was used to mean a lack of skill or knowledge with everyday mechanical procedures such as plumbing, an inability to understand a client's needs during a problem-solving effort, or a lack of appreciation for business-related

constraints when negotiating an agreement on behalf of the organisation. It was not associated with intelligence and disinterest. The following comment from EmpHR 22C illustrates the belief that a person with an excellent brain might not be very practical, but that, remarkably, ‘Dr Death’ was both intelligent and practical:

We call him Dr Death who comes in and gives us reports about the [*named dire situation*]... somebody used to say he's got such a brain he's an excellent thinker **but very, very practical** and knows all about us and this company. (*EmpHR 22C*)

With the exception of the first definition, the term ‘practical’ referred to a willingness or ability to act with restraint. Such inconsistency between participants in their personal definitions of common terms was prevalent, and illustrates the need for caution in devising global descriptors of employability attributes.

I interpreted the employers’ predictions that a PhD qualified engineer simultaneously enhances a company’s public image of expertise and threatens business functioning and efficiency were interpreted as evidence of ambivalent attitudes entertained by employers toward EHDR graduates. This ambivalence is particularly evident in the employers’ predictions of impact on clients.

### **8.3.2 Predicting impact on clients**

The employers invoked a social image of both engineers and HDR graduates, that was particularly concerning to the employers of engineers in organisations that cater to external clients. Perceived concerns were manifest as ‘Fearing client alienation’, which resulted from the employers’ imaging of HDR graduates and research focused engineers and the notion that EHDRGs maintained less interest in people and less ability to relate well on a social level than non-research focused engineers. Thus, the employers viewed the HDR qualification as evidence of disinterest in interpersonal engagement (disconnection) and suggestive that EHDRGs are potentially harmful in client interactions because they lack empathy with clients:

We have to justify our existence and ultimately our budget comes from, comes from the operating side of the business really, so we have to demonstrate to a broad range of people, our worth to the business. ... If they think we’re just smart arses and you know we’re trying to do what we want to do and get some money to do what we’re going to do, then they’re

not going to be particularly impressed. [...] We've had our instances of people [*PhDs*] who just give a very technical presentation. Obviously it's an exercise to show how clever they are, and you know they lose the audience so, you do have to learn those things sometimes. We have had some problems with that. I guess it's, yes, it's just skills in being able to alter their presentation, communication to suit the audience. Of course they wouldn't get much experience of that in university background. (*Emp 11C*)

This belief was at times compounded by the notion that EHDR graduates are disinterested in any aspect of life other than their work and would therefore be unable to relate to clients on an appropriate personal or casual basis in the type of social interaction considered valuable for the maintenance of relations:

...if you put them out of their comfort zone a little bit, they find in themselves that they may struggle and they think, 'I don't want to do it—not interested. I don't want to talk to clients; don't want to deal with them—they annoy me. I just want to do my work. I want to solve problems.' You can train—I've tried to, just to sort of educate them and they generally switch off; they just zone out and just think 'I'm not interested'. The relationship is all fluffy—they want to deal with the hard core engineering issues. (*Emp 17*)

A corollary of the belief that EHDRGs lack empathy and broader social skills is the prediction that client confidence in the HDR consulting engineer will be diminished due to misreading of cues on both the client's and engineer's part. Mitigating this fear was the contrasting prediction that client confidence and satisfaction will be enhanced by the EHDRG's knowledge and problem-solving competence:

So problem solving on different levels and even with the industrial stuff as well, we're still like that. When it comes to commissioning, when you're out there on site and your burner is not working for some reason, you know and you've got the plant manager over the top of your neck, 'Get this thing working, you know it's costing us a million dollars a day for this burner not to be working so you've got to'. You're under pressure, [*you've*] got to try and think logically through it, try and think of the problem, try this, try that and rely on your technical background as well as being able to problem solve logically which is probably the core engineering skills, logically working through a problem, so that's probably that stuff I think gets honed being a postgraduate, if you combine that with sort of experience and practicality, that's who we are interested in. (*EmpP 3B*)

**Karen:** Why do you think they wanted you as an employee?

**EmpP 19:** Because of the recognition of a PhD as being a status of some sort...It's a sales feature to the outside world... the area of specialty that I had with my research I built on and it's something I've been continuously

working in ever since and that's the area I'm recognised in. Also in terms of the outside world that's a marketing feature to say we've got so and so who's got this expertise.

EmpP 19's comment indicates both prediction of impact on business and on clients. It predicts a positive impact on business by predicting clients' social imaging of EHDR graduates as knowledgeable experts.

### **8.3.3 Predicting impact on workers**

In this instance, the workplace refers to fellow workers who have contact with the HDR graduate and, in particular, whose work intersects with the graduate. Co-workers include management, team members, administrative staff and those whose work involves undertaking the implementation of ideas developed by the graduate. Similar to the previous sub-categories, 'Predicting impact on workers' is characterised by contrasting perceived concerns and benefits. Concordant with the other sub-categories, the concerns are related to EHDRGs' perceived social attributes and their relationship to the graduates' work practices; the benefits are related to the knowledge and engineering skills gained during the HDR experience.

Concerns were manifest as 'Fearing worker alienation', and fed employers' predictions about the impact an EHDRG's imaged social disconnection might have on fellow workers in the work unit. Inadequacies in personal and social characteristics and work practices, including egoism, perfectionism, secretiveness and preference for isolation, were worrying for these employers because they interfered with the routine requirement for problem solving in teams. Employers predicted these inadequacies would lead to co-worker alienation:

If they come in thinking 'I've got a PhD so everybody is going to listen to what I say,' I think they've got a big surprise coming because sometimes a tradesperson has got more knowledge about how to lay bricks than a PhD student would ever dream of [...] but if they are just, you know because they are PhD's thinking 'Well I'm so good, people want to come and talk to me', I think people wouldn't bother. (*Emp 9C*)

Employers also feared that these inadequacies in character and work practices would severely undermine colleague morale:

Because it is day to day stuff very often, it is day to day. And as a manager of people, which is my job, you know, if you have got two or three people who are sort of prima donnas and stuff like that, oh gee. And for such a marginal, they might be brilliant, by such a marginal improvement to the job that we do, to the distraction and the lack of everything else that goes with it. It is just not worth it. The actual, if you integrate up that actual performance of the group, by having one or too many people like that, it actually lowers it, I reckon. (*Emp 15D*)

In contrast, an EHDRG who displayed a penchant for intrepid problem solving, rigour in work approach and ability to imagine future scenarios was perceived by employers seeking niche and visionary innovators as capable of exerting a strong positive influence in the workplace, as long as the EHDRG was also perceived as sociable and communicative:

The other area that [*named organisation*] really needs I think in specialists are thinkers is what I would call it, is in the areas of scenario of planning generally about climate change, about mixing and matching of the, you know source water ... helping management to think hard and you know, sort of put plans in place for contingencies or issues or a resource drying up for example. [...] [*It is good*] if somebody is just saying ‘Look, think about this, think about this, think about this,’ but bringing a lot of research based knowledge of what has been done before. (*Emp 9C*)

Nevertheless, despite the employers’ perceptions of potential benefits of an EHDRG worker to the workplace, an EHDRG’s imaged potential for personal-social disconnection was a pervasive troublesome characteristic maintained by the employers interviewed, along with the prediction of its negative impact in the workplace.

#### **8.4 Imaged desirable and troublesome attributes**

The previous sections of this chapter detailed the images employers maintained of EHDRGs, and the impact the employers inferred from their imaging. Images were constructed with beliefs about the knowledge and skills and the personal and social qualities attributed to EHDRGs by the employers: narrow or broad, received or intrepid, disconnected or connected.

The employers varied in their perceptions of the value of these properties to the achievement of their desired innovative outcomes, and included the importance of

the smooth and efficient operation of their businesses and workplaces to achieving these outcomes. They also varied in their perceptions of the quality of knowledge and skill (narrow or broad), and personal and social functioning (connected or disconnected) they believed likely of EHDRGs.

Desirable attributes of EHDRGs were those predicted by the employers to result in the desired innovative outcomes, as discussed in Chapter 7, and improved business or workplace functioning, as illustrated in the present chapter. Troublesome attributes were feared to pose an obstacle to the achievement of desired innovative outcomes and to cause commercial or social difficulties in the workplace, which would indirectly impede the achievement of outcomes. Desirable personal-social attributes imaged EHDRGs as collaborative, organised, persistent, curious and imaginative engineers; the latter two were linked to an EHDRG's intrepid approach to problem solving. Troublesome attributes included images of them as solitary, isolated, obsessive and vulnerable.

Beliefs about desirable and troublesome attributes, such as whether they are likely in an EHDRG, whether they are important and whether a particular attribute is desirable or not, were largely idiosyncratic to an employer. However, the perceived value or threat of an attribute was also dependent, in large part, on the innovative outcomes sought in the workplace.

## **8.5 Conclusion**

This chapter explains the participant employers' images of an EHDRG and their hypotheses of the impact of the imaged person in their workplaces. Employers formed personal theories on the basis of their beliefs about engineers, researchers and academic environments, in combination with the employers' personal experiences and rationalisations concerning their own life decisions.

The employers' views are argued here to be their personally constructed images of an individual who has undertaken EHDR study. The images reflect beliefs about the knowledge and skills, as well as personal and social qualities, of such a person. The genesis of the beliefs that contribute to image construction is argued here to be in



part related to the employers' constructions of self as they were presented in their self-referencing comments.

Graduate engineers were understood to emerge from their studies with broad knowledge of their engineering field. However, the focus of the knowledge and skill level of EHDRGs was perceived to be narrowed by extensive study within a limited, specialised research field; this narrow focus was considered rarely to be useful in industry workplaces. The depth of theoretical knowledge achieved by narrow, extensive study was considered useful, however, if it was used by the EHDRG to inform the graduate's responses to other challenging engineering situations not directly related to the graduate's EHDR study topic.

EHDRGs are exposed extensively to the academic engineering environment, which was imaged by the employers as narrow and disconnected from industry work. Thus, the imaged EHDRG was a person who had spent considerable time in a culture not itself imaged as conducive to the development of valued attributes. This contributed to suspicion about the EHDRG's personal motivation for choosing such exposure. The motivation was interpreted as possibly a personal vulnerability in face of the rigour and challenges of industry engineering work.

An employer's imaged EHDRG displayed certain knowledge-skills and personal-social attributes that were viewed positively and valued for the employer's workplace context and others that were viewed negatively and devalued for the workplace context. The perceptions of positive or negative impact were revealed in the inferences the employers made when imaging the EHDRG in the workplace. Impact was inferred on business functioning and client and worker satisfaction; the imaged EHDRG raised both concerns and anticipations of benefit.

However, as elucidated in Chapter 7, the employers also viewed the abilities of EHDRGs as potentially valuable to the achievement of desired innovative outcomes in their workplaces, which ranged from little to a great deal of originality in product or problem outcome. This led every employer to a decision about the relative merits and disadvantages of the various knowledge-skills and personal-social attributes of the imaged EHDRG worker to the ultimate achievement of workplace goals.

Chapter 9 extends the ideas elaborated in the present chapter. It first details the weeding process, in which strategies used by the employers determine whether imaged EHDRG attributes are evident in an actual EHDRG who seeks work with the employer. It then presents a hypothesised process which combines the findings of the weeding process with the employer's favoured innovative workplace outcomes, and with the employers' preferred problem-solving approach to achieve that outcome, in order to determine the value placed on the EHDR experience by the employer.

## Chapter 9: Determining Workplace Fit

This chapter explores in depth the third of the three main themes, ‘Determining workplace fit’, that are associated with ‘Reconciling image with innovative need’. It begins with an elaboration of the category ‘weeding’, which tests for the presence of troublesome characteristics in an EHDRG. The chapter continues by linking the outcome of the weeding process with the innovative outcomes sought by the employer. It concludes with a hypothesised decision pathway used by employers to determine the suitability of an EHDRG for an industry workplace. The outcome of ‘weeding’ combines with the employers’ conceptualisations of the expected innovative role of an EHDRG in the workplace, detailed in Chapter 7, to form a more elaborate picture of employers’ decision making processes.

### 9.1 Weeding

In this chapter, the category of ‘weeding’ is named with an *in vivo* code and describes an action taken by employers to determine the accuracy of their imaging of a theoretical EHDRG, as well as their predictions of the impact of various perceived attributes, by testing for the imaged attributes in a presenting EHDRG work applicant. It concludes with an impression of the EHDRG applicant’s likelihood to ‘fit’ into the workplace.

Similar to the three categories involved in ‘Invoking personal theories’, the insights that led to the category of ‘weeding’ resulted from my asking respondents to explain how they went about deciding on the suitability of an EHDR applicant for their workplaces. In particular, participants were asked what they were thinking during the process and how they would come to know what a candidate was like. As was the case with the ‘Imaging’ categories, the employers’ ideas about ‘weeding’ were blurred with comments concerning images and other processes.

‘Weeding’ is noteworthy in two respects. It is a highly personal and intuitive reflection by each employer, rather than a formalised assessment process. It is also each employer’s interpretations of the personal and social characteristics of an actual

EHDRG who presents for employment: her or his motives for pursuing research study, the ideas that captivate the EHDRG, the social environment in which the EHDRG is comfortable, and the ways in which the EHDRG engages with others.

The response from Emp 4 revealed the personal nature of the process in the comment that provided the *in vivo* code. This passage identifies the nature of the work expected of an EHDRG, in this case an innovative adapter role that includes considerable management interest, and indicates the employer's judgement based on reference to the applicant's 'caring' or interest, as well as his vulnerability to pressure:

**Emp 4:** Well you try and weed it out [*troublesome characteristics*] ... For instance I did an interview yesterday where we interviewed a guy with a PhD and we determined that he was not fit for the project work. He was not, but we identified there might be a couple of areas where he may in fact be able to work as a technical specialist assisting areas that could use his expertise [...] What I'm saying, what we, if you're going to put someone in that role, we wouldn't expect them to necessarily to have it [*ability to cope with demands*] but we have to make a judgement about whether we think they would cope with it.

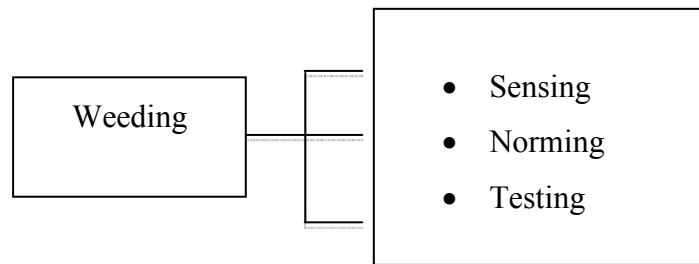
**Karen:** So how do you make that judgement? What are you looking for? What sort of characteristics are you looking for?

**Emp 4:** There's several issues. There's people who (a) they've got to give you the indication that they actually care about it and that often you'll get an attitude that all that stuff is an encumbrance getting in the way of my real work and [*b?*]you've got to try and pick someone who's got attention to detail, not only in the technical work but, if you like, the management work which includes statusing what they are doing, planning what is going to happen but also what we call changing the future. I mean, one of the jobs of a manager is to make a difference such that, if they weren't there, things would go worse. So the way that you make a difference is by removing roadblocks, adding resources, assisting the team to get over problems and you've got to make a judgement whether they care about that sort of work as well as the actual technical work.

Subsequent interviews revealed that 'weeding' involves more than 'weeding out'. Much like in gardening, it is an act of identifying and retaining what is wanted and identifying and eliminating what is considered problematic due to a potential to damage or weaken the environment for growth. Thus, when an EHDRG was viewed positively, the employer was delighted:

Fairly early on in the piece I could see that...she was a stand out. I mean I had some, internally I had a perhaps, there was a bit of doubt from some people that she was the right person, but in my mind she was going to be the right person. (*Emp 12*)

The conceptual category ‘weeding’ encompasses a three sub-processes, as indicated in Figure 9.1.



**Figure 9.1: The three sub-processes of 'weeding'**

‘Weeding’ is an act of discovery by the employer and is informed by the employer’s personal theories of an EHDRG. In the early data, it was difficult to recognise the weeding process as an independent process following personal theory invocation. This was partly because the participants blurred the process with their notions about the personal characteristics and knowledge focus of EHDRGs. Another factor that camouflaged the weeding process is that, in a sense, decisions about suitability are made by all people who engage in the recruitment or assessment of workers, so it did not seem a unique process. However, the separation of invoking and weeding became evident once I became aware of the role of personal imaging and began questioning in more depth the ways that the participants arrived at their decisions regarding EHDRG suitability. Further, during the interviews and subsequent analysis, I became aware of the employers’ sense of urgency to identify certain character attributes or lack thereof, such as caring, curiosity, obsessiveness, disinterest in people, or courage, which they believed likely of EHDRGs. These were attributes that they hoped or feared lay hidden, but from which they predicted the business and workplace would either benefit substantially or must be protected. The process used by the employers to identify character attributes was largely intuitive and grounded in the employers’ personal theories.

### 9.1.1 Sensing

This sub-process, another *in vivo* reference, refers to a subtle sensing by employers that an EHDRG may possess certain personal characteristics or problem-solving approaches. It is a ‘gut feeling’ or early general sense that the EHDRG is ‘right’ or ‘wrong’ for the workplace. This sub-category particularly reveals the intuitive nature of much of the weeding process used by the employers. Many of the expressions used described a visceral response to EHDRGs, such as ‘the right vibes’, ‘there isn’t any chemistry’ and ‘get a feel for the person’. ‘Sensing’ is deliberate openness to comfort or discomfort due to subtle evidence of personal characteristics or problem-solving approaches that employers associated with EHDRGs. In later interviews, it became clear how difficult it was for employers to determine the potential value of workers:

**EmpP 19:** *[You]* talk to them, you'd be asking questions that relate to the sorts of things that you do and you'd be listening to what they have to say, and estimating what your gut feel is... if you're asking questions how you'd respond to this, that and the other and trying to get a feel for how they would react to those situation and then gut feel. [...] You don't know if any employee is going to be successful in the end. You think after you've spoken to them *[engineering applicants]* that you have some idea of how they'll...it's like a marriage I think. Often people say we'll get married and then it falls apart for whatever reasons.

**Karen:** But there are some people you won't marry in the first place because you just know it's not right.

**EmpP 19:** Because you don't get the right vibes [...] It's very hard to put your finger on, very hard.

Sensing was used to detect enthusiasm or disinterest of the EHDRG for certain aspects of engineering work, such as working with people, engaging in conventional or imaginative problem-solving approaches, intellectual curiosity and motivation.

### 9.1.2 Norming

‘Norming’ occurred when an employer made use of self-reflection to judge EHDRGs in the light of the employer’s own life experiences and what she or he considered to be ‘normal’. In this way, the employer’s experience became a benchmark for normalcy against which an EHDRG could be judged as ‘unusual’. This activity made use of the participant’s own sense of what constituted a usual or ‘normal’ range of healthy activities and attitudes to test for evidence that an EHDRG

was able to interact socially with others because she or he had a set of interests common to most people. The implication of these comments is that an EHDRG might not share common interests with average, ‘normal’, connected people:

I guess one of the things I try and push is you need to be able to understand about the client, in terms of their family and kids, what car they drive, all the details about them and get to know them as a person. There’s a fine line, but that’s quite important because once you get beyond work and start drifting into personal lives, then you immediately have more of a bond. You remember that person you talked to because you talked about football or that person’s three kids being a similar age to yours or whatever. (*Emp 17*)

... see what their interest is in the community and see what other, you know, if they are interested in footy and then their reading and philosophy ...And then you look at their marks and they are at least 75% and you say, well that is a pretty rounded sort of person [...] and you want to get on with people. I mean, when you are working with people, it is really important to get on with them as well. So you know, if they have got the normal set of life interests, it is really great. [...] Because if they have got a life, they play sport or they do something, really it is like we are a cultural fit. ... And the cultural fit means, do they get drunk occasionally, go to barbeques, have they been overseas, have they been mountain climbing, is there something in their life that drives them, other than just the work. And it tends to be, they are more involved with life and people and stuff....And they tend to fit in beautifully...But if they are just, ‘my life is my research’, well you can run into that problem...That everything is about their own work ... And then so, you are a real person type of thing, you have got a bit of a life with you and you are not too egocentric that you think you have to know everything. (*Emp 15D*)

What is interesting about these comments is that they describe a testing process that conveys the employer’s personal assumptions about what constitutes a ‘normal’ life. Emp 15D reveals suspicion that an EHDR graduate is potentially socially abnormal, infers EHDR egotistical workplace behaviour as egocentric and arrogant, and then infers that a person who leads a normal life is not egotistical and will therefore work collaboratively with colleagues—an inference made from his observations about social behaviour.

### **9.1.3 Testing**

The employers devised tests for evidence of characteristics considered beneficial or problematic in EHDRGs. These often took the form of conventional situational

interview questions, where an applicant is asked to describe her or his response to a hypothetical work situation (Maurer, 2006), or engaging an EHDR candidate or graduate to work on a project temporarily, referred to as ‘try before we buy’. This testing strategy was used to determine an EHDRG’s personal characteristics of initiative, independence, motivation, approach to problems and social connectedness:

You go ‘well that one’s really not going to fit in and the other one’s good, they can get the stuff done’ [...] We get to work closely with them and that’s probably the real process where we’ve seen some people, postgraduates and gone ‘Yeah, they’re really good, they can work when they’ve got [to].’ (*EmpP 3B*)

However, testing frequently occurred in contrived social situations, where the employer believed attributes would likely be revealed. For example, some employers described using a covert strategy, such as having a chat over coffee or visiting a pub to find out more about an EHDR graduate’s personal characteristics that confirm or refute the employers’ invoked theories of social orientation and social engagement:

In fact, when we interview, I have told the guys and they have started to do it now. ‘Find out if these people, if they have got a life.’ (*Emp 15D*)

I used to do an interview essentially by inviting perspective employees down to the premises, talking to them a little bit about the company and then taking them around, I’d interview a few of the people on the methodology we use for doing things and then take them out for a long lazy lunch in a historic pub which had reasonably inexpensive lunches but good food and continue in the conversation with two or three other senior people in the company and the main thing that I was looking for during that period was the person’s attitude to life as well as work. (*Emp 8*)

The outcomes of testing provided the employers with what they believed to be a truthful or genuine picture of the personal and social characteristics of the applicant. It was as much an attempt to identify desirable characteristics as troublesome ones. Employers conveyed enthusiasm when they described working with someone they believed displayed characteristics they valued, such as invoked theories of an approach to problem-solving and knowledge focus:

But I got such a thrill out of somebody working for me coming up with something really creative and clever. I got as much as if I did it, more probably, because I knew I couldn’t do it myself anyway. (*EmpP 1*)



Employers used the weeding process to assist a decision to engage an EHDRG in the workplace. The notions of immediately rejecting or welcoming are the extremes of this decision making process. Much of what the employers appeared to do was to accept an EHDRG as a package of desirable and potentially problematic attributes, in order to benefit from something an HDR can offer.

## **9.2 Linking weeded EHDRG to outcomes**

The weeding process allowed employers to determine the extent to which an actual EHDRG applicant displayed the imaged knowledge and skills, problem-solving approach, and personal and social characteristics they feared or anticipated during the personal theory invocation stage. The results of this process revealed desirable or troublesome attributes that were then balanced against the employer's beliefs about the innovative needs of the organisation. It is obvious that no employer valued troublesome attributes in an EHDRG; however, there appeared to be circumstances where an employer was prepared to tolerate some difficulties for the sake of gaining valued benefits.

'Weeding' is not the final stage in the process of a decision to employ, however. While knowledge and skill type were important for achievement of outcome, it was concern about personal and social characteristics that stood out in the employers' comments. The employers tended to associate EHDRGs with particular personal-social characteristics and approached any consideration of EHDRGs as engineering workers with an expectation of the presence of these characteristics. They believed an HDR qualification was evidence of likelihood of these characteristics.

The presence of deep, specialised knowledge was not of itself viewed as problematic in the absence of obsession and desire to pursue what Emp 5A referred to as a 'Rolls Royce solution'. However, the assumption made by the employers was that the presence of one meant the likely presence of the other. An EHDRG's intrepid problem-solving ability was not inherently problematic, even if the ability was not perceived to be needed. EHDRGs were well trained, in their undergraduate education, in the received approach to problem situations. What was problematic was the notion that problem-solving ability was evidence of an unusual person or

different thinker who was not able to remain constrained by ‘real world’ approaches to problems and who wanted to pursue:

... understanding the you know, the theoretical mechanism that lies behind the da, dadah, dadah, dadah, that makes the thing either work or not work.  
(Emp 7)

Added to these concerns were the employers’ images of academic and university life that were believed to have likely fostered narrowness, isolationism, unwillingness to collaborate and irrelevance to the needs of industry. This was compounded by the view that the type of person who would choose to undertake EHDR study was inclined to be comfortable in such an environment. This view of differentness, or even oddness, was confidently asserted by Emp 10D:

After all, going into a PhD program is a selection process in a sense. A lot of those who are hard driving commercial people won’t do it and they go and do something else. So we’re already down selected and you get more in that population that you recruit with PhDs are more of the nerd variety and socialising them is sometimes a challenge. But it goes with the territory, and there was a time I suppose when eccentricity was seen as almost a badge of honour that you expected people to be like that, the absent-minded professor model. It isn’t now. People are expected to shape up and be human beings and do normal things and that sort of stuff gets pushed down. But there’s still a bit of it around in the process that determines that someone comes out at the end of the PhD pipe and yeah they’re not an average. They’re unusual. (Emp 10D)

### **9.2.1 Tolerance of troublesome attributes**

If it was important to an employer to ensure an engineering worker displayed deep, specialised, transferable knowledge and intrepid problem-solving ability, there would need to be an attitude at the imaging stage much like the one displayed by Emp 10D. Since employers seeking original outcomes required these abilities, they were the most likely to show tolerance when considering EHDRGs:

**Emp 15D:** And you want to get on with people. I mean, when you are working with people, it is really important to get on with them as well. So you know, if they have got the normal set of life interests, it is really great...But that is not to say that if someone came along and was absolutely brilliant and there was just a few little funnies about them, you might make, you would say, ‘gee you know, they really are brilliant and you could probably accommodate one or two unusualls per 25....But you know, you wouldn’t want a whole team of them...But you are really

looking, sometimes you do get someone who is quite brilliant, who is a bit unusual and you say, 'well yeah, we will take a risk here' and it ends up that they are probably going to be okay... You don't want...

**Karen:** A whole room full of them?

**Emp 15D:** No

If, as in the case of niche innovator seekers, there was the additional tension of meeting the need for originality and the need for commercial constraint, such tolerance would be tempered:

We're very careful when we're interviewing a PhD. It's largely personality driven and we're really careful with questions we ask them and determine whether they are going to be happy in the role and whether they can actually think a little bit more broadly about things and if they are good to get on with. We wouldn't entertain the idea of employing an absolute brilliant genius backroom boffin; we just wouldn't do it. (*Emp 17*)

The employers imaged a person who displays an intrepid approach to engineering problems as likely to display troublesome, even odd, personal characteristics. A corollary to this view is that a person who is likely to display troublesome attributes of the type identified by the employers would be likely to produce original outcomes. No employer interviewed admitted to actively seeking a person with these troublesome attributes. Mild tolerance for unusualness was the most any employer was prepared to consider.

Adapter seekers, having no need for intrepid problem-solving skills, would be unlikely to consider employing an EHDRG who displayed troublesome attributes:

Some of the questions that we ask on the application form are about how they've dealt with interpersonal conflict or problems, And then there's a lot of prompting around that because that's probably the one area where we lose people, that's where they don't make it through their probation. It's hardly ever on their scientific or technical skills; it's these other skills that really let them down. [...] The two things that I'd like to give them feedback about is to understand that they are more than their PhD, that they are more than their collective scientific and technical knowledge, and the organisations will be demanding of them that they are more well-rounded individuals I guess. ... no matter how good your PhD is, it is getting harder and harder to get your foot in the door with organisations like [*organisation name*]. In the past they could have written a really horrible application and if their PhD was suitable, they would have got a job but that's not the case anymore. (*EmpHR 13D*)

**EmpHR 21E:** Our managers don't contemplate them [*Masters and PhD graduates*] at all in the operations. They don't believe that they would add any extra value.

**Karen:** When you say 'they don't contemplate them', do you think they might have some concern about them?

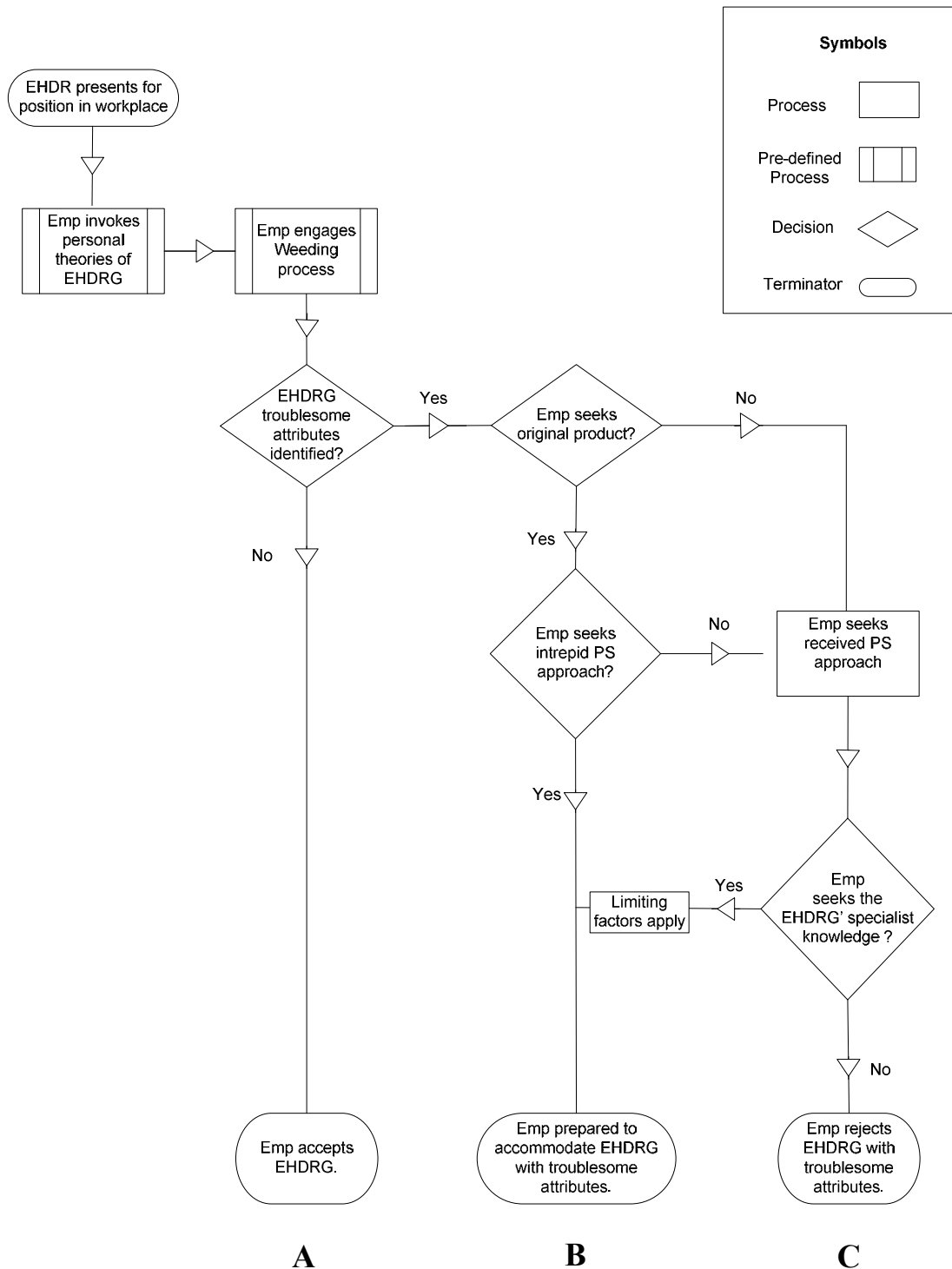
**EmpHR 21E:** Yes they probably would. They would have concerns that I mean they were all at university themselves these managers, so they would probably have a concern that you know they're not used to the same time deadlines that you're required to function in a business environment, they don't have the same cost pressures that they have to work with in a business environment and so because they don't have those, they haven't been tested in that environment as I said there's a greater risk that they're not going to perform. [...] There isn't a view though that the person necessarily with the masters or a PhD qualification in engineering is going to have better insight into how to solve a problem. The likelihood is that the person with real world experience who's dealt with the issues that our engineers are encountering on a day to day basis, they're more likely to be out there at another operation where they have encountered the problem and have said okay, this is something that we addressed twelve months ago, this is the solution that we implemented, you know we find that works really well, this knowledge network. ... I don't think that someone that because they have a masters degree or a PhD is necessarily a more innovative problem-solver than someone who's got an undergraduate degree. ... Real world applications that can be implemented cost effectively benefit the business.

### **9.3 Hypothesised decision-making pathway to determine fit**

The final stage in the process of 'Reconciling image with innovative need' is 'Determining workplace fit', whereby an employer reaches a conclusion about the suitability of an EHDRG. The employers in this study viewed this as a decision to reject, accept, or accommodate the EHDRG. The factors that determined an employer's decision to employ an EHDRG were 1) the type of innovative product sought (original or adapted); 2) the employer's invoked personal theories about EHDRGs; 3) the result of the weeding process undertaken, and particularly the identification of troublesome attributes; 4) the type of creative problem-solving approach sought (received or intrepid); and 5) whether or not the employer was seeking specific specialist knowledge. Listed separately, these factors present a fracturing of the employers' approach to the valuing of EHDRGs in their workplaces. As already noted, the blending of ideas by the study participants did not convey a definite stepwise decision-making process; however, by fracturing the data and reassembling them in this manner, a useful and sophisticated picture became evident of the important factors in employers' valuing of EHDRGs. This more complex view

of the process adds a significant dimension to current understanding of how engineering HDR graduates are engaged (or not) by industry.

Figure 9.2 illustrates hypothesised decision pathways followed by the employers of EHDRGs in this study, which reassemble the separate processes to reveal what is important and why in the employment of EHDRGs in industry. Although in Figure 9.2 the outcome type is illustrated as a decision step after 'weeding' has occurred, the desired innovative outcome would be determined by the employer prior to the weeding process.



**Figure 9.2: Hypothesised employers' decision pathway when considering the suitability of an EHDRG for the workplace**

An employer's willingness to accommodate troublesome attributes occurs as part of a decision-making process that is determined by the employer's notion of a suitable engineering problem-solving approach to achieve a desired innovation goal. The

employer's approach preference then defines the type of person who would be regarded as most suitable. Problem-solving approaches are viewed here as either conventional engineering approaches (the received approach) or as unconventional approaches to problem scenarios (the intrepid approach).

Figure 9.2 presents theoretical pathways to three outcomes:

- Outcome A results from the pathway any employer follows if no troublesome attributes are identified in the weeding process;
- Outcome C results when troublesome attributes are noted by an employer searching for an engineering expert skilled in conventional problem visualisation and solution, and the employer is not searching for EHDR specialist knowledge;
- Outcome B results when troublesome attributes are noted by an employer searching for an engineering expert who displays ability and inclination for unconventionally imaginative problem visualisation and solutions, or the employer is searching for EHDR specialist knowledge.

The vertical pathways that result in outcomes B and C are archetypical (ideal). However, the interview data from this study indicates that employers of EHDRGs sometimes indicate a preferred innovative outcome and then veer into a pathway associated with the problem-solving process linked to an alternative innovative outcome. This may occur when the EHDRG has specialised knowledge required by an employer seeking the received approach for a particular engineering application.

More likely, the pathway leading to outcome B follows a process that selects for a visionary innovator. This candidate is sought for an intrepid approach to problem solving and his or her EHDR experience is valued because it is imaged as evidence of the likelihood of this approach and of deep, transferable knowledge. Selection of an engineering graduate with a flair for unusual problem solutions is of primary importance and therefore some tolerance is extended to a difficult or unusual person type, revealed in the weeding process. This makes the selection of an EHDRG of some benefit despite evidence of personal and social troublesome attributes.

Two pathways lead to outcome C. One selects an innovative adaptor who is required to use conventional problem-solving strategies to adapt existing products to the workplace context. An EHDRG is sought for adaptation skills, either broadly applicable or narrowly confined to a relevant engineering area, and socially cooperative attributes to ensure minimum inferred negative impact on business, clients or workers. No EHDR specialist knowledge is sought by the employer. The second pathway leading to outcome C is followed by an employer who seeks originality but who does not seek an intrepid problem-solving approach. There is no perceived benefit in selecting an EHDRG with socially difficult attributes in either of these circumstances, and thus an EHDRG who is perceived to display troublesome personal attributes is likely to be rejected for employment.

The influence of beliefs about problem-solving approaches and knowledge and skills bases, introduced in Chapter 8, on employers following these pathways is discussed in the following section.

### **9.3.1 Selecting an EHDRG for problem-solving approach**

The factors used at this level of the decision-making process are informed by prior imaging of the HDR graduate for their knowledge focus and their inherent or acquired problem-solving approaches. The participants showed preference for either conventional or intrepid approaches to problem-solving. Those who preferred an intrepid approach and saw evidence of the courageous, curious and imaginative qualities they previously imaged in EHDRGs would likely select an EHDRG applicant who displayed them. These employers were prepared to tolerate different approaches to problem definition and solution, and to welcome the introduction of new concepts or ideas for consideration at the problem definition level. Employers who sought EHDRGs with experience and expertise in the application of conventional approaches to resolve pre-determined problem scenarios using traditional, advanced engineering methods would likely view evidence of courageous, curious and imaginative personal characteristics as problematic. These characteristics were associated with an imaged EHDRG's desire to pursue persistently ideas that were impractical or irrelevant in the workplace.



### 9.3.2 Selecting an EHDRG for skills and knowledge type

At the skills and knowledge level, employers following a pathway to outcome C seek application of conventional skills, such as information search and retrieval, analysis for comprehension, identifying engineering principles at work, calculating and adjusting parameters, and assessing the suitability of existing products for new application. Those interviewed also sought engineers with expert skills to correct and enhance other engineers' technical work.

In the pathway to outcome C, knowledge is viewed as something that already exists, and knowledgeable people are those who have acquired existing knowledge through access and practice. This view of knowledge as a body of existing information was captured in EmpHR 22C's interview statement:

We want you to know what we want you to know ... if you've shown us that you can pass exams well, that you've got the high results, then we're happy to take you on from that. With the engineers that we are engaging now it certainly is more about what specific knowledge they have. [...] somebody who's come from a university with a PhD, we know you're intelligent, we know that you know a lot about this stuff but this is the bit that we need. (*EmpHR 22C*)

Imaging the impoverished university environment also exerted influence on the decision-making process in the perception that certain skills and experiences, such as in the use of communication technologies, sophisticated equipment, and various software programs used routinely in a particular workplace were not available during higher degree candidature.

In the pathway to outcome B, skills include the additional ability to hypothesise something new from extensive current knowledge and to identify links between such knowledge and potential new development. The skill includes an ability to envision potential scenarios for change and to bring the potential as close as possible to fruition:

Probably the 'can do' and 'not afraid to try aspects' person. We were a company pushing the boundaries of the way things were done. So we didn't want someone who was steeped in tradition. We didn't want someone whose views were 'this is the only way to do something'... But certainly in attitude it was preparedness to attack problems that they'd not seen before, cause most of the problems we were dealing with we hadn't seen before.

Willingness to learn, an open-minded approach, ability to think, preparedness to think. (*Emp 8*)

Having gone through and survived the process of having a problem defined for you where there are no clear answers. Where there are no handbooks...being obliged and forced to think creatively and in an open minded fashion, really goes some way to shaking you lose from some sense of 'this is the answer', 'this is what has been done before'. (*EmpP 20*)

The pathway to outcome B includes a requirement for knowledge that is characterised as deep and broadly applicable. Employers seeking creative problem-solvers sought both a specialist and generalist knowledge base in EHDRGs, but included in the skills acquired the ability to transfer expert knowledge to distant problem areas and contexts. They welcomed evidence of interest in new problems and the expansion of organisational knowledge that comes from workers' expertise, curiosity and motivation. EHDR experience was associated with the development of knowledge at a deep level that transcends the HDR research topic. It was also seen to involve skills that can be applied broadly and used to think about issues in different ways:

I know they have the skills and power to drill into those problems more so than others, and solve it. [*Named PhD employee*] because he's had research experience, his maths skills are honed to a greater detail and his use of a particular software or software types was actually more honed. [...] he can think outside the square and think about the broader issues. (*Emp 17*)

### *9.3.2.1 EHDRG as knowledge specialist*

Employers who sought adapted products and a received problem-solving approach, but identified troublesome attributes usually rejected the EHDRG. However, if such an employer also sought the specialist knowledge gained during HDR candidature because it was directly relevant to current work site need, then outcome B could result. One view, presented by the participants that specifically emphasised the limited value of narrowly focused specialised knowledge and skills, noted that such EHDRGs were useful for circumscribed exploratory or restricted troubleshooting work in a workplace:

Some other times we go looking for the depth of kind of technical expertise in a specific area, which generally lends itself towards someone that has got specialisation, which often goes with postgraduate qualification. ... So quite often you'll end up with someone that has got either a PhD or a masters, and so what we're looking for is someone that's capable of, has got a deep understanding of the technical challenge we're trying to overcome, and hence we might be hiring someone out of that position. ... and so sometimes we will be doing work, providing funding that would allow PhD research into that area, and then sometimes those individuals may end up getting a job with us ... , you know, we've funded them and the university to do some work for us, and then we might want to continue that beyond them completing their qualification and hence they would come on board. (*Emp 18E*)

EHDRGs in positions where their specialised knowledge is immediately and directly relevant may be engaged for this short-term exploratory work and then find that there is no further need for their expertise:

**Karen:** What happens if you've got great minds [*reference to a comment on EHDRGs in special projects*] working at doing very high quality work and at the end of a certain timeframe the results aren't workable?

**Emp 7:** It would be a tough call in that circumstance depending on how much money had been spent getting to that point, but that's a business call ... we either decide to give it a go for a bit longer or we just draw a line on it ... and that might be tough for those individuals because they may no longer have a job, at least with us. We might look to see whether we can redeploy some of them but if someone is a very, has skills in a very specific area and that's really their expertise, they're unlikely to go and want to work on [*different work identified*].

Specialist knowledge was also hired from universities or research institutes and used for short-term work without the subsequent retention of an EHDRG:

If you're really at that breakthrough part and you've got more of a generalist as a supervisor, and you want a specialist as being kind of driving the frontier work, then you need the eight or nine out of ten person to kind of drive you forward. [...] But what we would tend to do in those circumstances I think, is not necessarily hire that person, because if they, we'd be better off to get a commercial relationship with a research institute, whether that's a university, or a [*research institute*] or somebody, because then your relationship is with that kind of pool of knowledge and expertise ... as opposed to bringing one person inside and trying to assimilate them into our team. (*Emp 18E*)

In these cases, employers revealed little or no concern about personal and social qualities of an EHDRG working on the project, presumably because these qualities were not predicted to impact directly on business or the workplace climate; the employer's interest was in the specialist expertise gained during EHDR study. An EHDRG performing this work can be narrow, received or intrepid, and disconnected without negative consequences for the workplace. This comment also suggests that EHDR candidates working on industry-based projects may not be strengthening their ultimate position with a company in the short term.

#### **9.4 Accommodating troublesome attributes**

The process of 'Accommodating troublesome attributes' explains the link between the employers' notions about the type of person who is believed capable of achieving desired innovative outcomes and their preparedness to tolerate certain social attributes they generally considered problematic. Specifically, it refers to a willingness to accept difficult social attributes implicitly associated with the desired knowledge or problem-solving approach in order to gain specialist knowledge and skills, and/or an engineer capable of an intrepid approach to problem solving:

That sort of stuff gets pushed down but there's still a bit of it around in the process that determines that someone comes out at the end of the PhD pipe and yeah they're not average; they're unusual. But I don't think you can make too many comments other than the obvious ones that that's the way it happens, you have to be able to concentrate intently, to concentrate your resources and sometimes that cuts you off from people and attracts that internally focused person. (*Emp 10D*)

The coexistence of troublesome attributes and intrepid problem-solving ability and/or specialist knowledge creates a situation where desirable qualities are balanced against undesirable ones.

##### **9.4.1 Imaged knowledge and approach to outcomes: Exceptions**

There was a clear link between the employers' beliefs about the type of product outcome sought and their beliefs about the problem-solving approach needed to produce the outcome. The received approach was considered appropriate for an

adapted outcome and an intrepid approach for an original outcome. However, there were some interesting, anomalous cases:

#### 9.4.1.1 Case 1

EmpHR 22C appeared to value a received approach for engineers in the workplace, but acknowledged the value of previous intrepid problem-solving activities that greatly benefitted the organisation in the past. In the passage that follows, EmpHR 22C expresses admiration for the visionary work of an EHDRG colleague and acknowledges its value to the organisation. However, the participant then states quite emphatically that the organisation does not need someone who envisages problems in new ways and that the organisation will determine for its engineers what the focus of their work will be:

**EmpHR 22C:** I'm just thinking about [*named PhD engineer*]. I've talked about him a fair bit ...who would have thought that we'd be building a [*specified facility*] five years ago; so right time right place. I mean he is an academic and he loves it and he just revels in all of that, so he would be well, well worthy [*sic*] to us. Now someone who's come out as a graduate, and we have people under him and he's sharing his knowledge down like that, they're probably more valuable than somebody who's come from a university with a PhD. 'We know you're intelligent, we know that you know a lot about this stuff but this is the bit that we need.'

**Karen:** Just to look at it the other way, had you not had this person [*the PhD*] on board you wouldn't have all that expertise that you can now tap into it?

**EmpHR 22C:** Absolutely and we would have had to import it from somewhere.

**Karen:** And actually perhaps wouldn't have had the long-term relationship built up and have a person who knows this company intimately as well as having that level of knowledge?

**EmpHR 22C:** Exactly. [...] at the moment we just want someone who can deliver some of the solutions that we've got... a lot of the requirements of the job we don't need that higher level of education, we need a basic education and we need to know our stuff.

EmpHR 22C appreciated an outstanding contribution to the organisation of a specific EHDRG with deep and broad specialised knowledge and an ability to develop novel solutions. However, EmpHR 22C did not see value in hiring EHDRGs, thus presenting what appeared to be contradictory views.

#### 9.4.1.2 Case 2

EmpP 19 placed great value on an intrepid problem-solving approach, bemoaned the received problem-solving approach inculcated in undergraduate engineering programs, noted evidence that an EHDRG is an intrepid problem-solver, but had not employed an EHDRG.

#### 9.4.1.3 Case 3

The tension noted earlier for seekers of niche innovators emerged here in that these employers sought novelty as a matter of survival, acknowledged an EHDRG as capable of producing something new, but felt that imaged personal attributes of obsessiveness and persistence meant the EHDRG likely would 'be zooming into it, a tendency to go into it and solve it and understand what makes up the problem in its intricate detail' (Emp 17). Thus, in order to gain the benefit of the EHDRG's knowledge depth and intrepid approach to problem solving, Emp 17 needed to control the problem-solving process by keeping the EDHRG on a budgetary 'leash':

I find the way I've learned to deal with it in this case, whether it's a PhD or an engineering side is to give people a leash; let them know the budget and use them to my advantage to drill into certain problems. And I know they have the skills and the power to actually drill into those problems more so than others, and solve it. Or come up with new tools because they've got the skills and the capabilities to be able to do that. (Emp 17)

EmpP 19 explained this need for control in terms of the EHDRG's application of personal restraint on the tendency to 'zoom in' on intricate detail:

It can be very exciting because, it depends on your motivation for doing your PhD. If you're the sort of person that wants to actually continue doing research where that might involve looking at a project for one to two years, that sort of thing, it's very unlikely you'll find that in private industry because private industry has to be much more reactive. The time scales are much shorter so you might be talking about weeks, one to two weeks to two or three or four months. We have an example right now where a major client of ours has said they want something done and they want it done by January 30th and that's with Christmas, New Year break and all the rest of it, they just want it to happen, that's what they expect. So if you're interested in a challenging environment in terms of the scale and the sorts of projects you can get and you're prepared to 'give up' the fact that sometimes there are lots of things you think 'It would be nice if I could just spend a little bit more time on this and follow through and see what comes out of it', then it can be really challenging and exciting. (EmpP 19)

Both Case 2 and Case 3 illustrate that the main area of concern for seekers of niche innovator is the imaged personal characteristics of an EHDRG.

#### **9.4.2 Refining factors for accommodation**

Two notions pervade the decision-making process outlined in Figure 9.2: the employer's perception of EHDRGs' approach to engineering-related problems or situations in the workplace, and the employer's perception of problematic social characteristics. The participants in this study tended to present both notions as innate personal characteristics of EHDRGs, with properties reflected in descriptors such as narrow or broad, connected or disconnected, conventional (received) thinker or intrepid thinker, organised worker or absent-minded. These descriptors can be applied to a person's character in general and to the way a person engages in a problem-solving task.

The relationship between these beliefs was most influential prior to the weeding process. For example, if an employer who sought an intrepid problem solver believed that engineering bachelor degree graduates tended to be conventional or received problem solvers, but that EHDR graduates tended to be intrepid problem solvers, the employer would be likely to look favourably on a potential EHDRG worker prior to the weeding process. This is because the second belief would mitigate the influence of the first belief. Alternatively, if that employer viewed EHDR graduates as narrowly focused on a research topic, this view would compound the belief that engineering graduates are received problem solvers, and the employer would view the potential worker unfavourably. In either situation, such reasoning would possibly influence an EHDRG applicant's prospects of being considered for employment.

### **9.5 Summary of chapter**

This chapter presents and explains the employers' processes whereby they concluded their determination of an EHDRG's fitness for the workplace. These processes were 'weeding' and 'determining' by reconciling. 'Weeding' entailed a combination of employer intuition (Sensing), value judgements (Norming) and social trial (Testing). The weeding process determined whether an employer's imaged concerns were

justified for a potential EHDRG worker. Examples of imaged concerns that were explored by the employers included the following.

- The employers' believed that it was necessary to determine whether an imaged narrow knowledge focus of EHDR study was evident. This was achieved by determining if an EHDRG had narrow vision and interests, which indicated to them that the EHDRG would not become more expansive in response to workplace need.
- Substantial concern existed that an EHDRG sought to remain in an isolated world and that this would be her or his preferred mode of working.

If attributes causing concern were found to be evident, then an EHDRG would be considered likely to have a deleterious effect on essential elements of the organisation: efficiency, client satisfaction and co-worker morale. If none of the above was the case, an EHDRG would likely have a greater positive effect than a graduate engineer in that their greater knowledge could be used to enhance output and originality, create client confidence and provide leadership and mentoring to co-workers.

Concerns about the personal-social characteristics of EHDRGs were paramount for the employers in this study. A significant component of 'weeding' was to test whether troublesome attributes imaged to be possessed by EHDRGs were displayed on social trial.

In the light of the attributes determined by 'weeding', the process of 'Determining workplace fit' ensued. An EHDRG might be considered in the context of the employer's desired innovative outcome and beliefs about the engineering problem-solving approach needed to achieve those outcomes. Employers remained prepared to accommodate troublesome attributes in circumstances where the employers sought original outcomes, believed that such outcomes result from an intrepid problem-solving approach, and believed EHDRGs were likely to be intrepid problem solvers, or when the employers sought specialist knowledge.



Employers who viewed EHDR knowledge as fixed and narrowly specialised, and whose image of this was confirmed by ‘weeding’, limited their accommodation of troublesome characteristics to graduates whose knowledge background was highly relevant to specific workplace demand. Employers who viewed EHDR knowledge as containing elements that were generally applicable and fundamentally transferable, and whose image of this ability in EHDRGs was confirmed by ‘weeding’, were inclined to value EHDRGs for roles in engineering work more distantly related to their EHDR research topic.

Employers reconciled EHDRG image with workplace need in the following ways. EHDRGs who did not display troublesome personal attributes were considered favourably. An EHDRG who displayed troublesome attributes could be accommodated in two sets of circumstances: where the employer believed intrepid problem solving is valuable in achieving workplace outcomes, and where the employer is seeking highly specific, specialist knowledge.

## **9.6 Conclusion**

Three factors determined the value placed by the employers on EHDRGs in their workplaces:

- the originality required for product outcome;
- the problem-solving approach considered best for achievement of the desired outcome; and
- the beliefs that were entertained by the employers about EHDRGs.

Chapter 10 presents an elaboration of the relationship between these factors by linking the findings of this study to literature on creativity. It explains the employers’ images of EHDRGs as ones commonly entertained of highly intelligent, creative people. It also considers the employers’ beliefs about originality of outcomes and desirable problem-solving approaches through the lens of the theory of creativity in

organisations. Notions of creative activity and creative people are argued to be at the heart of the employers' reconciling of image with innovative need.

## Chapter 10: Relevance to Extant Literature

The aim of this chapter is to locate, rather than to verify, the emergent theory of ‘Reconciling image with innovative need’ within existing literature. Reviewing literature following the emergence of the theory allows the researcher ‘to make explicit and compelling connections’ between the findings of a study and the extant literature that the researcher considers to be relevant (Charmaz, 2006, p. 168). The extant literature is used to add depth and to extend the emergent theory (Glaser, 1978).

This study was motivated by an interest in clarifying the attributes of EHDRGs that are valued in the eyes of the employers who have worked with them. The rationale for the study was an expectation that these employers believed they had good reason for engaging EHDRGs, that knowledge of their reasons would contribute to the development of HDR graduates seeking industry work, and that little voice had been given to their reasons.

The emergent theory of ‘Reconciling image with innovative need’ demonstrates that, and how, the employers balanced their perceived need for innovation with the image they maintained of EHDRGs. The process of balancing showed that, when considering the potential value of an EHDRG for the workplace, the employers used their own images of EHDRGs in combination with their interpretations of the engineering outcomes sought in the workplace to reach a reconciliation point in the form of a decision to engage or reject the EHDRG. Their images displayed three main themes: perceptions of knowledge and skills developed, beliefs about approaches to engineering problems, and beliefs about the personal characteristics of EHDRGs.

The first three sections of this chapter situate the emergent theory in the literature pertaining to creativity, and I argue that the employers’ beliefs and decisions are informed by notions of creativity related to creative people, creative outcomes, and creative approaches to problem solving. The findings of the current research are reinforced by existing literature in the fields of social psychology and sociology in that the findings are concerned with creative achievement in social environments and

with implicit person theory (Sections 10.2 and 10.3). The emergent theory of ‘Reconciling image with innovative need’ provides a practical example of the enactment of these theories in Australian engineering industry.

Section 10.4 focuses on the relevance of the emergent theory to the literature on higher education. ‘Reconciling image with innovative need’ fills a gap in the literature that explores the links between HDR education and the world of work outside the traditional academic arenas. In particular, it contributes to the body of literature that investigates attempts to develop HDR programs with the aim of enhancing candidates’ awareness of the relevance of HDR education to work undertaken outside the academic arena. Such programs are highly dependent on the information about HDR graduates received from industry employers, and this information has been sparse and vague. In summary, the emergent theory can be seen to create a bridge between theories of creative achievement and implicit personal theory construction on one hand and the literature on HDR education and employability on the other.

### **10.1 Relevance to creativity literature**

The argument that creativity is central to the substantive process of ‘Reconciling image with innovative need’ is supported by the substantive theory’s complementarity with the notions of creative performance within social environments advanced by Amabile (1983), which are described more fully in Section 10.1.2. Amabile (1983) argues that there is a need for the integration of three components to achieve creative outcomes: domain-relevant skills, creativity-relevant skills and task motivation. The field of creativity studies is immense, but Amabile’s Componential Framework of Creative Performance (Amabile 1983) offers a useful way to understand the findings of this study and one that is sophisticated enough to encompass the complexity of the substantive situation. The process of ‘Reconciling image with innovative need’ aligns with Amabile’s Componential Framework in recognising the variation in employers’ valuing of outcome originality, the process for outcome achievement, and the EHDRGs’ characteristics of motivation and persistence. ‘Reconciling image with innovative need’ is a practical, situated example of the components of Amabile’s theory.

In the emergent theory developed in the current study, Componential Framework components are evident in the participant data, but in a fragmented, or unintegrated, form. The fragmentation is such that the components of Amabile's theory relating to personality characteristics were emphasised and problematised by all the employers, the component relating to knowledge was emphasised by adapter seekers and the component concerning creativity was emphasised by visionary seekers. Problematisation by the employers of the personal components of Amabile's theory is further shown here as a substantive expression of two other theoretical perspectives on creative performance, presented in Sections 10.2.2.1 and 10.3.1 respectively: Becker's theory of mad genius (Becker, 1992) and Kirton's theory of adaptors and innovators (Kirton, 1976).

### **10.1.1 Working definitions of creativity**

Creativity is a concept generally defined as the achievement, through the use of a creative cognitive process, of an original product, process or idea that is fit for purpose (Amabile, 1983; Sternberg, 1988a; Torrance, 1988; Woodman, Sawyer & Griffin, 1993). Amabile elaborates on the quality of creativity by offering two complementary definitions of creativity: a consensual definition that defines how a product is deemed to be creative in a particular field; and a conceptual definition that defines the essential qualities of a creative product in any field.

Amabile's consensual definition of creativity is as follows (Amabile, 1983, p. 31):

A product or response is creative to the extent that appropriate observers independently agree it is creative. Appropriate observers are those familiar with the domain in which the product was created or the response articulated. Thus, creativity can be regarded as the quality of products or responses judged to be creative by appropriate observers, and it can also be regarded as the process by which something so judged is produced.

The consensual definition can explain variation in the employers' perceptions of the originality of outcomes sought in the workplace. The employers came from different backgrounds, and their experiences may or may not have provided them with the perspective needed to judge creative achievement in the field of engineering. This might explain, in particular, the differences between the HR employers and non-HR employers in the same organisations. The HR employers did not have a clear

conception of what constitutes creative approaches to engineering problems and may not have appreciated the need for such approaches. Even the less prominent differences between workplace managers with backgrounds in science or engineering can be explained by their differing notions of creative activity within their own fields of expertise. However, in the case of HR managers, Nowicki and Ross (2002, p. 168) refer to a 'science-practice gap' evident in personnel recruitment practices. One explanation the authors provide for this gap is the lack of knowledge and awareness amongst HR staff of research conducted in human resource management. This results in selection procedures that are uninformed by research evidence of good practice and selectors who are unfamiliar with the experience of conducting research.

Amabile's conceptual definition of creativity is as follows (Amabile, 1983, p. 33):

A product or response will be judged as creative to the extent that (a) it is both novel and appropriate, useful, correct or valuable response to a task at hand, and (b) the task is heuristic rather than algorithmic.

Novelty of outcome and a sense that the outcome is appropriate and correct for its purpose are essential qualities of creative achievement. Barron (1988) refers to this sense of creative achievement as one displaying qualities of originality, aptness and fit.

Algorithmic tasks are those for which the goal is clearly identified and 'the path is clear and straightforward' (Amabile, 1983, p.33), often following predetermined processes and procedures. The stated necessity for the use of heuristic processes to define creativity is an attempt to capture this elaborate and poorly understood cognitive activity. Amabile defines heuristic tasks as those that do not have a prescribed or 'straightforward' solution pathway; they often do not have a clear goal at the outset of the solution attempt. Thus, the first tasks in creative problem solving are attempts at the conceptualisation and clear definition of the problem prior to attempts to negotiate a solution pathway. Amabile summarised a number of features of the cognitive style that enhance heuristic problem solving. These include the following:

- The ability to 'break perceptual and cognitive set' to see a problem very differently from how it first appears and to shift quickly away from

unproductive solution strategies. This extends to the ability to see anomalies and anticipate failures in an area of interest (Schank, 1988), which Csikszentmihalyi (1988) describes as an enhanced sensitivity of creative awareness.

- The ability to break from ‘performance scripts’ such as domain specific standardised sequential procedures (algorithms);
- An appreciation of complexity in a problem and a tolerance for working in complexity;
- The ability to tolerate ambiguity, to remain open to alternatives and to delay foreclosure until the solution is certain, including the ability to suspend judgement on ideas and proposed solutions;
- The ability to think widely (divergently), to see relationships between seemingly disparate ideas and to create broadly inclusive categories of information, along with the ability to think convergently in order to screen out extraneous information.

Much research on creativity has concentrated on this latter point. Woodman et al. (1993) noted the importance to creative thinking of generating many and varied ideas and of avoiding irrelevant distractions. The ideas generated must be fluent, well elaborated and have the capacity to transform existing knowledge in order to re-imagine situations.

The conceptual definition of creativity aligns closely with comments by the employers who sought visionary innovators with the capacity to embark on unconventional, intrepid problem-solving approaches. For example, visionary innovators were sought for their ability to build imaginative scenarios. Scenario building is not merely a flight of fancy; ideas are grounded in substantial, relevant knowledge and then subjected to divergent imagining. While none of the employers mentioned the need for heuristic processes specifically, their comments contrasting the standardised approach taught to undergraduate engineering students with the type of courageous thinking they valued, strongly suggested the desire for creative problem-solving approaches. Several employers casually introduced the term

‘creative’. My approach to the employers’ use of the term ‘creative’ is discussed in greater detail in Section 10.2.2.1.

A difference between the employers’ views and Amabile’s argument is evident in the employers’ reduction of intrepid problem-solvers to people who display unusual personal characteristics. Unlike Amabile and other creative theorists, the employers did not describe in any detail the mechanics of cognitive processes needed to produce original outcomes. While this might suggest a gap in the employers’ knowledge about the best combination of the abilities identified in each component to achieve the outcomes sought, it does reveal the employers’ reliance on and trust in their ability to ‘read’ these capabilities from personality characteristics in EHDRGs. Thus, even if the employers have an awareness of the cognitive processes needed to achieve a creative outcome, they might still place greater importance on personal characteristics that ‘fit’ the workplace environment over an ability to generate ideas. The employers’ concerns for ‘fit’ reveal a disjuncture between the employers’ aims of achieving creative innovations and what they view as successful workplace functioning.

Innovation is defined as ‘the successful implementation of creative ideas within an organisation’ (Amabile, 1983; Amabile et al., 1996) and can include the implementation of creative ideas generated elsewhere (Amabile et al., 1996; Woodman et al., 1993). All of the roles considered by the employers in the current study as suitable for EHDRGs are aimed at producing innovative outcomes as defined by these authors, in that these roles lead to outcomes which at the very least successfully adapt creative ideas generated elsewhere. Niche and visionary innovators were expected by participants to produce original and useful ideas, products and processes. The employers seeking EHDRGs for these roles valued the graduates for what they perceived to be the graduates’ abilities, either innate or developed through EHDR experience, to imagine and create novel and useful products or conceptual outcomes. The employers who sought niche innovators and visionaries sought EHDRGs who were capable of creative achievement.



### **10.1.2 The componential framework of creative performance**

In the interest of brevity and readability, the Componential Framework of Creative Performance (Amabile, 1983) is firstly summarised without detailed comment on the similarities between its components and the components involved in 'Reconciling image with innovative need'. However, its relevance to the views of the employers presented in Chapters 7, 8 and 9 is readily apparent.

The three components of creative performance noted as necessary by Amabile (1983) are domain-relevant skills, creativity-relevant skills and task motivation (see Table 10.1). In the case of EHDRGs, domain-relevant skills form the pool of engineering-related theoretical and technical knowledge and basic principles. Greater domain knowledge improves a person's ability to engage in the generation of many and varied ideas relevant to a problem scenario (Simonton, 1999). Amabile (1983) argues that a high level of domain knowledge is essential to informing judgements about the usefulness of problem-solving pathways and about the utility of the outcome; such judgements are successfully realised through the capacity for convergent thinking (Woodman et al., 1993). Domain-relevant skill at a level needed for creative achievement also requires a 'natural aptitude' or 'special talent', developed further during formal training. Woodman et al. (1993) noted that the need for extensive domain knowledge is often unrecognised by those seeking creative outcomes.

Amabile refers to creativity-relevant skills as 'the something extra' that leads to exceptional outcomes. Creativity-relevant skills form the thinking processes that control decision-making about the way the search for a solution should unfold. Primary among these processes are the heuristic strategies that lead to problem redefinition and solutions to novel problems. Within engineering practice, these strategies transcend well-honed standard engineering approaches and procedures. One measure of creativity is found in the competent solution of novel problems (Newell et al., 1962; Simonton, 1999). However, Amabile (1983) and Csikszentmihalyi (1999) argue that this ability is important but not enough in itself, as it fails to recognise another important concept to creative problem-solving: the ability to identify problems initially and to formulate and, if necessary, to re-envision the problem in new ways.

Creativity-relevant skills produce what Sternberg (1988b) identified identifies as performance components to creativity. These are the generation of unusual inferences, metaphorical and analogical thinking and recognition of second-order relationships, which when applied to a sound domain knowledge base result in 'imaginatively gifted recombination' (Torrance, 1988). Creativity-relevant skills also include the ability for focused concentration over an extended period; the ability to abandon and forget unproductive strategies, and to temporarily set aside intractable problems; persistence in the face of difficulties; and a high energy level (Amabile, 1983, p. 74).

Task motivation is the third component of creative achievement in Amabile's Componential Framework. Task motivation includes a person's attitude toward a task and reasons for undertaking the task. 'Task motivation can be seen in this context as the most important determinant of the difference between what a person *can* do and what he *will* do' (Amabile, 1983, p. 77, original italics). The componential model integrates the three components. Amabile argued that each component is essential for a creative outcome and that the level of creativity achievable for a task outcome is dependent on the individual's competence with each component. Equally important in her framework are the means by which the domain- and creativity-relevant skills are shown to be developed.

The three components of the Componential Framework for Creative Performance are presented in Figure 10.1.

**Table 10.1: The components of creative performance (Amabile, 1983, p. 68)**

1	2	3
<b>Domain-relevant skills</b>	<b>Creativity-relevant skills</b>	<b>Task Motivation</b>
<u>Includes:</u> <ul style="list-style-type: none"> <li>• Knowledge about the domain</li> <li>• Technical skills required</li> <li>• Special domain-relevant 'talent'</li> </ul>	<u>Includes:</u> <ul style="list-style-type: none"> <li>• Appropriate cognitive style</li> <li>• Implicit or explicit knowledge of heuristics for generating novel ideas</li> <li>• Conducive work style</li> </ul>	<u>Includes:</u> <ul style="list-style-type: none"> <li>• Attitudes toward the task</li> <li>• Perceptions of own motivation for undertaking the task</li> </ul>
<u>Depends on:</u> <ul style="list-style-type: none"> <li>• Innate cognitive abilities</li> <li>• Innate perceptual and motor skills</li> <li>• Formal and informal education</li> </ul>	<u>Depends on:</u> <ul style="list-style-type: none"> <li>• Training</li> <li>• Experience in idea generation</li> <li>• Personality characteristics</li> </ul>	<u>Depends on:</u> <ul style="list-style-type: none"> <li>• Initial level of intrinsic motivation toward the task</li> <li>• Presence or absence of salient extrinsic constraints in the social environment</li> <li>• Individual ability to cognitively minimize extrinsic constraints*</li> </ul>

*10.1.2.1 Influences on development of domain and creativity skills*

According to Amabile, the development of domain-relevant and creativity-relevant skills requires innate ability or characteristics as well as formal education and experience. This captures much of the way the employers understood the value of EHDRGs. The variations in the extent to which the employers valued EHDRGs were largely determined by differences in their beliefs about the outcomes of EHDR training: the potential for transferability of general and specialised knowledge gained during formal HDR study and the experience of perseverance for completion of original research with its demand for generation of imaginative ideas.

Finally, Amabile provides a set of personality traits that contribute to creativity-relevant skills. These include self-discipline, an ability to delay gratification, perseverance, independence of judgement, tolerance for ambiguity, autonomy, internal locus of control, willingness to take risks, self-initiative and drive for excellence (Amabile, 1983, p. 74). Amabile identified this list of traits from the vast literature on creative personality. This literature is discussed further in Section 10.2.2 of this chapter.

Independence of judgement is singled out by Amabile as the only consistent finding in studies of creative personality. This trait is also viewed as non-conformity and

independence from social approval, and Amabile (1983; 1998; 1996) and Amabile et al. (1996) argue that attempts to exert pressure to conform, even to conventional notions of creative productivity, are detrimental to creative outcomes.

#### *10.1.2.2 Influences on the strength of task motivation*

Amabile's third component, task motivation, is high if the individual's interest in and intellectual preferences for the task are strong and if the reason for undertaking the task is intrinsically rather than extrinsically motivated. As well as intrinsic motivation for the task, motivation for creative achievement depends both on there being little or no extrinsic constraint placed on the person and on the individual's ability to block out the effects of any external pressures or constraints.

The importance of task motivation is relevant to the substantive theory because it reveals the importance of the intensity of the EHDR students' motivation for interesting problem scenarios. Their motivation for involvement in interesting, challenging tasks led them to eschew what they believed to be uninteresting engineering work, despite short-term financial and career costs. The employers in this study who sought visionaries recognised the importance of curiosity and interest for the production of creative products. The employers who sought adapters and niche innovators perceived potential difficulties with EHDRGs, whom they saw as being unable to tolerate work for which they were unmotivated. They also feared difficulties that might arise from the EHDRGs' inability to tolerate external pressures. Thus, Amabile's contention that intrinsic motivation combined with a lack of extrinsic constraints are required for creative outcomes adds depth to the observation, made in Section 7.6, that important tensions exist for employers who seek niche innovators and who require original outcomes but who also exert substantial external controls. According to Amabile, creative outcomes are less likely in such environments.

#### **10.1.3 Outcomes of failure to integrate components**

Amabile (1983) offers predictions of outcomes generated from uneven combinations of the three components of creative performance:

- The products of low domain-relevant skills combined with high creativity and task motivation tend to be eccentric or insignificant: in short, not creatively innovative. Such outcomes are likely for the employers who claimed to value creativity as an exercise for generating many ideas, but who did not value the extent and depth of engineering knowledge and skill needed to inform the ideas or to judge their potential. These outcomes would also result from the employment of an EHDRG who was not motivated to adapt and develop domain knowledge to suit the workplace task.
- The products of high domain-relevant skills and task motivation but low creativity-relevant skills tend to be correct and predictable: in short, not creatively innovative. Such outcomes are likely for the employers who sought expert engineering knowledge, but did not value intrepid approaches to engineering problems. These results are likely associated with innovative adapter engineering work.
- The products of high domain-relevant skills, high creativity-relevant skills and low motivation are judged to be moderately creative. Further, EHDRGs are unlikely to maintain interest in demands for such work if they lack motivation for it, as identified in the student study presented in Chapter 4. However, judging from the comments of the students, tasks needing high levels of domain-relevant skills and creativity-relevant skills would likely result in significant motivation for the graduates.

Amabile's Componential Framework provides a lens through which to view the employers' beliefs and expectations that strengthens the focus of the substantive theory of 'Reconciling image with innovative need'. In this way, the Componential Framework reveals the differing values that the employers placed on EHDRGs to be concerned with creative achievement, creative processes and creative personal characteristics. However, although the concept of creativity was mentioned explicitly several times in the course of interviews with the employers, no attempt was made during the course of data collection and constant comparative analysis to theorise it beyond the ideas presented by the participants. Several participants used the expression 'creative' to describe a process that involved thinking differently to the norm about something and some referred to engineering as an 'art'. The participants

and I used the expressions 'creative' or 'creativity' loosely, as a commonplace expression throughout the interviews, and the term meant different things to different employers. When asked directly, participants stated that creativity was very important, and most maintained that their companies were expected to be creative and innovative.

#### **10.1.4 Creativity and professional identity of engineering HDR students**

The students who participated in the focus group study displayed characteristics of creative engineering problem solvers. They displayed independence of judgement, autonomy and non-conformity in their approaches to their research. They were confident in their extensive specialist and engineering generalist knowledge and identified an enhanced ability to solve difficult problems. Undertaking a PhD provided them with the knowledge and technical domain-relevant skills, as well as guided experience in idea generation that, according to Amabile (1983), is required to enhance creativity-relevant skills. Additionally, the ability to undertake PhD study was evidence of what Amabile (1983, p. 68) termed 'innate cognitive abilities' and adequate 'perceptual and motor skills'. It was well beyond the scope of this study to explore the students' abilities to engage heuristic problem-solving strategies; however, it is assumed that the ability is needed to complete PhD study.

Creative innovation requires task motivation on the part of the innovator, and the students could be said to be highly motivated. They were aware of their capacity to overcome, through determination, discipline and perseverance, seemingly intractable problems. They displayed a strong preference for engineering work that provided intellectual challenge. Assuming they were provided with original, challenging engineering problems, it appears they would likely be motivated to solve them. This attraction to intellectual challenge meant that, notwithstanding their financial concerns, they appeared to favour somewhat insecure but intellectually rewarding work conditions, despite a risk that these were unlikely to provide the financial status and recognition they sought. The students' comments about their drive for challenge and autonomy were consistent with the observations of Auriol (2007) about PhDs in the workforce:

The vast majority of doctorate holders ... feel more satisfied with those criteria linked to the content of the work (intellectual challenge, level of responsibility, degree of independence and contribution to society) than with those related to employment conditions (salary, benefits, job security, location and opportunities for advancement). (Auriol, 2007, p. 20)

Using Alvesson's definition (Alvesson, 2004), the students can be said to have displayed strong professional identities as knowledge workers. Alvesson (2004) defines the term 'professional identity' as a person's subjective construction of who he or she is professionally and, by implication, how he or she should act in a professional capacity. Alvesson distinguishes 'professional identity' from the idea of 'professional role', which is a set of externally created expectations of a professional person and often determined by a group such as an employee's work organisation. Professional role defines a person's position in relation to others in the group context, and Alvesson points out that it is possible to perform a professional role that is at odds with one's professional identity. It is reasonable to assume, however, that doing so is likely to result in diminished motivation in the professional knowledge worker and thus in outcomes that are less creative (Amabile, 1983; Amabile et al., 1996).

The employers in this study frequently imaged EHDRGs as obsessive, narrow in focus, or driven to pursue an unfettered search for knowledge and problem solution. This image suggests recognition of the dissonance between the EHDRGs' professional identity, in this case forged by strong interest and allegiance to the practice of 'pure' engineering, and the broader goals of the professional role in a workplace. This dissonance was interpreted by students and employers alike as a potential source of tension between the EHDRGs' goals and those of the employers, and likely to result in unsatisfactory workplace performance. From this viewpoint, it can be argued that EHDRGs' strong professional engineering identities reposition the deficits in discussions concerning HDR employability. The situation suggests that the professional role defined within the industry workplace is not adequate to make use of the professional knowledge worker's abilities and motivations, and this has implications for the capacity of the workplace to generate creative engineering innovations.

## 10.2 Focus on personal characteristics of creative people

Perhaps the most salient characteristic of creative individuals is a constant curiosity, an ever renewed interest in whatever happens around them. (Csikszentmihalyi, 1999, p. 330)

This quote from Csikszentmihalyi (1999) reflects the beliefs expressed by the employers seeking visionaries in the present research. It is a comment about the personal characteristics they associated with EHDRGs and with an intrepid problem solving approach.

Personality characteristics are important to the creativity-relevant skills of creative achievers in the Componential Framework (Amabile, 1983). The implicit person theories invoked by the employers focused largely on the personal characteristics that they associated with EHDRGs. The employers' hypotheses about the impact of EHDRGs' behaviours and attitudes revealed their concerns about the troublesome nature of the imaged characteristics.

The employers imaged EHDRGs to be highly intelligent and persistent people capable of providing 'the intellectual horsepower' (Emp 18E) to find novel solutions to challenging, unique situations. In addition, they associated the ability to create new or different ideas with particular personality characteristics, including an unconventional approach to problem solving. The employers believed EHDRGs chose HDR study because they preferred to stay in the relative safety of the university environment, rather than work in a 'hard-nosed' commercial environment. EHDRGs were considered to be self-focused, obsessive and insular in their work practices. At the extreme, the employers used explicit expressions that stereotyped EHDRGs as odd, vulnerable and obsessively driven individuals who prefer solitary work. They were referred to as 'eccentric', 'backroom boffin', 'autistic', 'unusual' and 'nerdy'. It is easy to be amused by what appear trite and fanciful ideas, especially when they are presented in a jocular and irreverent manner. However, the consistency with which these views were presented convinced me to turn to the literature for explanation. The link made by the employers between the student's decision to undertake EHDR study and having these characteristics suggests an implicit theory of personality and, as was illustrated in Chapter 8, the assumption of



personality oddness was used by the employers as a premise to predict EHDRGs' difficulties fitting into a 'normal', challenging workplace.

Interestingly, EHDRGs were also referred to as 'absent-minded professors', thus also capturing a commonplace or popular image of academia. The personal characteristics of concern to the employers were those that have been commonly associated with creative people and were viewed as potentially troublesome regardless of the employer's preferred outcome or problem approach. The employers' descriptions at times fit with popular characterisations of creative genius, whether accurate or not, such as of Albert Einstein or Vincent van Gogh: absent-minded, socially avoidant, driven by perfectionism in problem solution, egotistical, unusual, a little mad and uninterested in the 'real world' and everyday life.

The following section first provides a brief overview of the theory of implicit person theories and weaves these into the employers' comments that image EHDRGs. Section 10.2.2 then presents literature that explores the personal characteristics commonly associated with creativity from historical, physiological and psychological perspectives. The aim of this section is not to provide an exhaustive review, but to reveal points of intersection with extant literature and potential pathways for future theoretical exploration of issues related to industry employability and EHDR education, as expanded in Section 10.4.

### **10.2.1 Implicit personal theories are implicit person theories**

I argued in Chapter 8 that the employers invoked implicit personal theories of EHDRGs when they considered the suitability of these graduates for their workplaces, and noted that these appeared to be what is referred to in the literature on implicit person theories (Ross, 1989; Sternberg, 1985). Implicit person theories are inferences based on strongly held, unquestioned beliefs, typically about personal traits or social behaviours of a certain group of people, which have not been externally theorised or tested (Ross, 1989; Sternberg, 1985; Uleman et al., 2008). At their simplest, implicit person theories create inference from one observed characteristic or trait to an unobserved one. Ross (1989, p. 342) broadens the definition of implicit person theory to include 'schema like knowledge structures' about people from which conjecture is made about their future behaviours.

Since implicit person theories influence people's behaviours and decisions toward the person about whom the theories are maintained, uncovering implicit person theories is valuable to increasing insight and understanding of a social phenomenon:

Implicit theories are constructions by people ... that reside in the minds of these individuals. Such theories need to be discovered rather than invented because they already exist, in some form, in people's heads. (Sternberg, 1985, p. 608)

Essentialist implicit person theories are beliefs that certain characteristics define the nature of certain groups or classes of people and are therefore immutable (Haslam et al., 2006). To someone maintaining an essentialist perspective, all people belonging to the group are considered to be fundamentally alike because they share the same 'essence' or biological basis for the characteristic, as in Emp 14D's comment about visionaries being 'hard wired that way' and Emp 10D's comment about 'the nature of the animal'. The immutability of belief in essentialist implicit theories likely explains the resilience of the employers' personal theories in shaping their views about EHDRGs, despite their successful experiences of EHDRG workers. This suggestion is supported by findings of Podsakoff and Organ (1986), who commented on the prevalence of lay or personal theories found in self-report management data and noted that 'confirming cases are given disproportionate weight in overall impression and are most likely to be recalled' (Podsakoff & Organ, 1986, p. 534).

The employers in this study invoked implicit theories, frequently essentialist in nature, about the type of person who undertakes EHDR study. Their theories reflected beliefs about personal characteristics commonly associated with highly intelligent and creative people. In his study of college students' implicit theories of the characteristics of creative people, Sternberg (1985) noted that they did not focus on the analytical or problem-solving ability of these people, but on their personal qualities of motivation, unconventionality and aesthetic talents. In the same study, specialists in a particular discipline, however, also focused on abilities to perform certain tasks in a particularly able fashion, such as the ability to imagine more quickly and explore ideas and to arrive at problem solutions, or the ability to challenge basic principles and imagine better explanations for physical phenomena. Thus, the discipline specialists had greater awareness of the essential creativity skills identified by Amabile (1983) and others. The method used in the present study

brought into relief the importance of creativity to the employers. The method was not designed to discriminate between respondents, but a more pointed survey investigation into differences between employers with EHDR experience and those without might yield a clearer association between discipline research expertise and awareness of creative processes in engineering.

It is not the intention of this thesis to argue the need to foster creativity in innovative organisations, although that is sometimes stated to be one motivation behind moves to enhance the employability of HDR graduates (for example, Borrell-Damian, 2009). The findings of the present study challenge the practical relevance of Amabile's framework for industrial engineering workplaces. The findings position employers' implicit personal theories as potential antagonists to components of the framework. The contrast between the requirements for creativity noted in Amabile's framework and the actions of the employers illustrated in the substantive theory suggests that the attitude of employers toward EHDRGs in engineering workplaces potentially deprives the workplaces of a valuable resource for continuing creative engineering achievement.

### **10.2.2 Common perceptions of intelligent creative people**

Through my analysis of the interview data, I was drawn to the notion that, despite their obvious idiosyncratic nature, the employers' personal theories might be supported by empirical study and reflected in formal theory, particularly with respect to the thematic thread that identified EHDRGs as having particular personality traits such as oddness or differentness. I wondered if the employers were 'right' about EHDRGs being narrowly focused or socially difficult. In other words, were their implicit theories well founded?

#### *10.2.2.1 The myth of the mad genius*

Creativity has long been associated with a mysterious flash of insight that occurs to highly intelligent people who display unusual or eccentric personalities and behaviours (Becker, 1992; Rickards, 1999). This view has been promulgated through biographical studies of eminent creative geniuses, usually artists and writers, which reveal troubled lives and eccentric, isolated and obsessive personalities (for example, Ackroyd, 2008; Monk, 1990). Historically, this view of creative 'mad genius'

(Becker, 1992) has been explained as a form of divine mania (Jamison, 1993) and more recently as a psychopathological state (Eysenck, 1993; Jamison, 1993), leading Simonton (1994) to muse:

If the history of civilization is very much the record of creative achievement, then the annals must register a generative decline into mass psychosis. The larger the body of creative artifacts a culture has accumulated, the more insane must its people be. (Simonton, 1994, p. 286)

The perniciousness of the notion of 'mad genius' in popular thought contributes much that can explain the reservations of the employers following their image construction of EHDRGs (Adams et al., 2010).

As a strong proponent of the link between creativity and psychopathology, Eysenck (1993) argues that there is a physiological link between creativity and a state he refers to as 'psychoticism'. Further investigation into this contention suggests the link to be located in the suppression of latent inhibition associated with a wide horizon of relevance that is needed for divergent thinking. A wide horizon of relevance is found in both creative achievers and people suffering from schizophrenia (Carson et al., 2003); the occurrence in both groups suggests a similar origin. These findings were refined in a later review (Carson, 2011) which illustrated the role of the protective factors of high intelligence, strong working memory and cognitive flexibility in overcoming vulnerabilities, such as latent inhibition suppression, to mental illness. This likely explains the findings of an extensive literature review investigating an association between creativity and mental illness (Waddell, 1998), which found no compelling evidence to support a link. Waddell (1998) concludes that attempts to link creative ability with mental illness or aberration disadvantage both groups:

We may do more harm than good to the cause of creativity if we inadvertently convey the idea that creativity and mental illness are both forms of deviance. We may do more harm than good to the cause of alleviating mental illness if we romanticize mental illness and trivialize its impact by associating it with creativity. We may do more harm than good if we fail to note that mental illness impedes creativity or if promoting an association between creativity and mental illness takes precedence over either encouraging creativity or reducing mental illness. (Waddell, 1998, n.p.)

Becker (1992) explains the popular association of madness with highly creative people who are capable of originality of thought and action as one that took hold in the eighteenth century. The creative genius was considered a social and political danger who was viewed as an irresponsible and irrational threat to conventional and traditional order, or even an 'agent of change and revolution' (Becker, 1992, p. 35). Becker suggests that the Romantic notion of the genius as an outsider and non-conformist was converted and embraced by those who sought to be viewed and recognised as creative intellectuals. Creative inspiration was presented as a 'divine mania' possessed by artists who in most other ways were 'impoverished and deprived of political power and privileged class status' (Becker, 1992, p. 37). Eventually, with the emergence of interest in psychiatry, divine mania was re-visioned as deviance and psychopathology. However, the association remained between problematic personal characteristics such as unusualness, isolationism, obsession, and even madness, and the stereotype of the creative genius.

The association between measures of personality traits and creativity has been the topic of extensive investigation within the field of personality psychology, and bears relevance to the present study. Several employers imaged EHDRGs as introverts and thus potentially difficult in the workplace. However, there is little research evidence that introversion is a core personality characteristic of creative people, and Runco (2007) interpreted the common belief that creative people are introverts as a misreading of their persistent attention to a challenging task. Creative people were found to display persistence, curiosity, energy and intellectual honesty (Amabile 1983), and an internal locus of control (Woodman and Schoenfeldt 1989). No inventory of personality traits associated with creative people has been identified that is reliably predictive of creative achievement. At best, an extensive review of literature to date conducted by Runco (2007) listed the characteristics and tendencies itemised in Table 10.2, as combining in some ways in all creative people

**Table 10.2: Characteristics and tendencies of creative people (Runco, 2007).**

Autonomy	Tolerance of ambiguity
Flexibility	Risk taking and risk tolerance
Preference for complexity	Intrinsic motivation
Openness to experience	Unconventionality
Sensitivity	Self-efficacy
Playfulness	Wide interests and curiosity

EHDR candidates who participated in the focus groups displayed autonomy, preference for complexity, openness to experience, tolerance of ambiguity, risk taking and risk tolerance, intrinsic motivation, self-efficacy, and curiosity. Employers of visionaries and most employers of niche innovators who were interviewed for this study sought EHDR graduates who displayed autonomy, flexibility, openness to experience, tolerance of ambiguity, intrinsic motivation, unconventionality, self-efficacy and wide interests and curiosity. Many of the personality characteristics of EHDR candidates that the candidates themselves associate with their approach to engineering work appear to be those of creative people. The personality characteristics that distinguish the type of engineering graduate the employers associated with original outcomes are also those of creative people. The link noted in the literature between the positive characteristics of creative people and the preferred characteristics of visionary engineering workers elaborates the decision undertaken by the employers to tolerate troublesome characteristics in order to engage engineers who also displayed the characteristics associated with the production of creative, and therefore original and appropriate outcomes. In contrast to this association of positive characteristics with creativity, there is no evidence that troublesome characteristics such as isolationism, unsociability or obsessiveness are innate to creative individuals (Runco 2007). This suggests that the employers' concerns about an association between troublesome characteristics and creative EHDR graduates are unfounded.

### **10.2.3 Conclusion of section**

This chapter links the act of reconciling image with innovative need to the theory of creative performance. This link opens the possibility that the imaging of EHDRGs, including their troublesome characteristics, was associated with popular images of creative genius. However, there is little evidence in the literature to support an assertion that the creative characteristics of EHDRGs are, in general, any more likely to be unusual, odd or antisocial.

The employers interviewed in this study spoke about their own beliefs and understandings of the ways in which EHDRGs fit into their workplaces. None expressed expertise in the area of creativity or education. Many were unacquainted with the ways HDR students learn, although most were aware that a PhD had to

provide an original contribution of sorts. It is realistic to assume that the employers' knowledge of the ways intelligence, personality and original contribution are linked would reflect lay notions of creative genius. It is also understandable that such images of creative genius could be considered potentially troublesome in a goal-directed, industry-based workplace. What is important to the present research is that such images, correct or not, influenced the employers' views of the value of EHDRGs' potential contribution in the workplace. The influence of such imaging has not been considered in previous discussions concerning HDR graduate employability.

### **10.3 Focus reversal: Personal characteristics of the employers**

The process of reconciling image with innovative need can also be located in literature that considers the notion of employer tolerance for complex problem solving and desire for different and ideal outcomes. This literature is relevant to understanding the diversity identified in the employers' beliefs, and it shifts focus onto the ways in which the employers' ideas reveal characteristics of themselves as much as characteristics of EHDRGs. In particular, Kirton's theory of adaptors and innovators (Kirton, 1976; 1984) investigated the personal innovation preferences of managers and administrators.

#### **10.3.1 Relevance to Kirton's theory of adaptors and innovators**

The theory of adaptors and innovators (Kirton, 1976) places everyone's personality on a continuum that ranges from the ability 'to do things better' (which Kirton terms 'adaptive') to the ability 'to do things differently' (which he identifies as 'innovative'). Adaptors prefer to work using conventional patterns of behaviour and are described as prudent, concerned with group cohesion, consensus and cooperation, focused on problem solution rather than problem discovery and likely to seek solutions in 'tried and understood ways' (Kirton, 1976). Innovators tend to break with existing patterns and are described as tangential thinkers, as well as problem and solution discoverers who are viewed by adaptors as unconcerned with group consensus. Kirton argues that both personality types are creative, a position contested

by Amabile's framework, in which these characteristics of conformity to problem-solving approaches are markers of an absence of creativity.

Although Kirton does not explain his theory of adaptor and innovator personality types in terms of an individual's implicit person theories, the beliefs he associates with adaptors or innovators can largely be understood as implicit person theories. Creative work can create conflicts and tensions within workplaces, particularly for administrators within hierarchically managed organisations where creative work is viewed as inefficient and irrational (Cummings, 1965). Further, traditional management hierarchies have been argued to hinder creativity because they encourage people to maintain the status quo in order to secure their power within the organisation (Williams & Tang, 1999). A personal interpretation, recounted by EmpP 16, of such obstruction within an engineering hierarchy is presented in Chapter 8, Section 8.1.3.

Innovators can appear to adaptors to be insensitive, impractical or even unsound. Creative performance is the antithesis of conformity, and the sense of surprise elicited from creative achievement can be disturbing (Torrance, 1988). Importantly for the present study, Kirton found in his study of managers that 'adaptors thought that innovators tended markedly to be "neurotic" though adaptors were not able to define exactly what they meant by that term.' (Kirton, 1976, p. 625). Although innovators are able to avert crises due to their ability to think about problems differently, Kirton suggests that this ability is often unappreciated because it is associated in adaptors' minds with unpleasant, memorable events in the organisation. This leads adaptors to associate innovators with difficulties in the workplace and to view them as only useful once problems emerge.

Kirton did not focus on engineering work. The phenomenon he described, that adaptors associate the creative work of innovators with the anxiety produced in difficult problem-solving situations, appears in two modified forms in the current study of engineering employers.

Firstly, within engineering consulting work, the value of specialist and expert general knowledge is reconciled with the need for 'fluffy' interpersonal communication (Emp 17) to deal with the 'plant manager and that over the top of your neck, "Get this thing



working, you know it's costing us a million dollars a day for this burner not to be working" (EmpP 3B)<sup>11</sup>. In their experiences, the employers found that EHDRGs performed satisfactorily in these situation and solved difficult, and even intractable, problems. However, in the hypothetical situation the 'imaged' EHDRG is predicted to avoid the 'soft stuff' and to be unable to 'cope' (Emp 4). The difficult engineering situation is simultaneously associated with both successful and unsuccessful EHDRG performance.

Secondly, the perception of the rarity of seriously catastrophic events means that, even when the event had been predicted by a HDR graduate, its rarity did not warrant the reconciliation of problem-solving expertise with the difficulties of the imaged HDR graduate:

**EmpHR 22C:** ... and I can always remember and this was some years ago now, he'd [*visiting academic*] say, 'You know, [*name of organisation*] should be thinking about water because it's now up for sale on the river,' ... and I clearly remember thinking 'What! What a strange thing to be thinking about.' And here we are, [*now*] it's one of our priorities!

**Karen:** It probably would have been cheaper then.

**EmpHR 22C:** It would have been a lot cheaper ... But events have overrun us now... [...] I hope I don't sound like I'm discrediting it [*the PhD*] at all. I mean the knowledge. We might need to tap into it at some stage but do we necessarily need to employ that here on a full time basis? Probably not. We would tap into that as we needed it. But [*we want*] someone who is going to do the practical work ...

For employers such as EmpHR 22C, engineering work was valued for its conventional and practical application. The imaged impracticality of an EHDRG was considered too great a cost to the workplace and the EHDRG's capacity to envision future scenarios was all but ignored.

In later studies (Kirton, 1984; Kirton, 2003), managers in different departments or sections of the same organisation were found to have different orientations, with some sections predominately adaptor and others innovator in orientation. This offers an explanation for the variation found in the present study between employers in the same organisation, particularly the differences between the HR employers and unit coordinators and managers.

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<sup>11</sup> The comments are presented initially in various sections of Chapters 8 and 9.

### **10.3.2 Relevance to literature on recruitment**

The personal perspective of those who recruit and make initial selection of suitable employment applicants has also been explored in the literature. The subjective evaluation of workers based on the recruiters' personal beliefs that may favour adaptive work practices would be likely to disadvantage, at the first stages of consideration, the selection of applicants who are judged to be innovators. HR recruiters have been shown to display personal tendencies to favour certain graduates for employment, while recruitment interviewers were found to be influenced in their selection of candidates by their sense of similarity with and personal liking for the interviewee (Keenan, 1977). Keenan (1977) argued that recruiters have long been shown to display emotional influence when considering applicant suitability, and Harvey (2001) warns that any discussion about graduate employability requires attention to the recruiters' knowledge and attitudes:

Where a definition of employability refers to attributes it also implies that employers have an idea of the attributes that are necessary for the effective functioning of their organisation now and in the future and that they have mechanisms for establishing that graduates exhibit appropriate attributes. These and related assumptions may be convenient but they do not appear to be sound. (Harvey, 2001, p. 99)

Harvey supports his contention with evidence of recruiter's irrational beliefs about particular aspirants for positions in organisations: favouring certain universities without reason; expressing contradictory and confused beliefs such as 'linguists do not make good lawyers...we are looking for somebody who has innate language ability' (p. 104); and '... No preference on age. If I were employing somebody I would probably go for a younger person...' (Harvey, 2001, p. 105). Such imprecise notions of suitability of attributes are then used to evaluate an employment candidates' suitability and contribute to the recruiters' sense that an applicant 'fits' the organisation, workgroup or work tasks.

Although the importance of 'fit' was identified several times in the employers' comments throughout the present study, attempts to clarify its meaning during the interviews proved to be as difficult as they were for Judge and Ferris (1992), who described the typical response of HR personnel as 'I can't articulate it—I'll know it when I see it' (Judge & Ferris, 1992, p. 2). They identified four views of fit in a

review of earlier literature: fit as a control mechanism (norms, beliefs and values remain checked); as insurance for work force homogeneity (so that all workers think alike); as a job-related criterion (for example, in service industries with the aim to fit consumer orientation); and as an organisational image enhancer (ensuring that the organisation's image is predictable). Fit is viewed as an important but 'elusive' quality that can ensure the efficient performance of an organisation (Judge & Ferris, 1992, p.48). However, it also ensures worker conformity and predictability of performance outcomes and is likely to discourage the selection of those who think differently. Judge and Ferris (1992) suggest that employers who espouse the need for good fit wish to replicate their own approach within the workplace.

The finding that the employers invoked implicit person theories of EHDRGs partly situates the employability of EHDRGs within the literature on management style relating to organisational innovation and recruitment. The information provided to universities about the attributes sought in HDR graduates is not devoid of personal perspectives or personality influences. The results of the current study into employers' views of EHDR graduates adds to the literature on personality and innovative style by providing strong, practical evidence of this influence and its origins in the employers' construction of their personal theories.

### **10.3.3 Conclusion of section**

The literature presented in the previous sections of this chapter performs two functions: it adds theoretical depth to the internal components of the substantive theory developed in this thesis and it positions the substantive theory within a broader theoretical context. Individually, the employers' beliefs about the components of creative performance were fragmentary, and their implicit association of originality with creativity was tempered by other concerns regarding the conventionality of engineering approaches and beliefs about personal qualities of EHDRGs. The substantive theory of reconciliation draws the fragments together into a process of discrimination and selection, and the comparison in the previous sections of the chapter with relevant literature in other fields of inquiry integrates each fragment of the reconciliation process with more general theories. The literature on creative performance, implicit person theory, theories of creative personality, and

recruitment and management theories also provides various theoretical lenses that help to position the substantive ‘process’ theory in a broader theoretical framework.

#### **10.4 Higher education employability research**

The findings of the present study situate it within a larger discussion concerning ongoing attempts to unravel the factors that contribute to and detract from the successful engagement of HDR graduates in the non-academic workplace. The present research was motivated by a concern to foster HDR and industry joint engagement only to the extent that it is a response to concerns of EHDR candidates who hope to work in industry and who are uncertain about their value to industry employers. It concurs with Nyquist (2002), who states that ‘the university’s most important product... is the student’, and the passionate, driven and confident EHDR students in this study wanted their knowledge and skills to be valued in the workplace. The findings nevertheless contribute to a deeper general understanding of the highly influential, but little explored, voices in the discussion about HDR graduates’ employability: that is, the voices of industry employers.

The focus on employability of HDR graduates has been criticised for its emphasis on the need to foster generic skills, which are seen to be privileged above other outcomes of the university experience, such as the strengthening of disciplinary knowledge and scholarly identity (Barnett, 1994; Craswell, 2007; Holmes, 2001). Gilbert et al. (2004) suggest a more measured response to the demands of employer groups by calling for greater clarity in the terminology used, a greater attempt to distinguish between the needs of different disciplines and doctoral students, and clearer guidelines for how the students’ employability attributes are assessed. This study goes some way to addressing these viewpoints.

The findings presented in the present research show that many issues of concern to employers of EHDRGs are hidden by the current emphasis on skills alone. The employers’ interview comments made it clear that generic skills cited by the employers were frequently no more than the capabilities they required of any successful professional in their workplaces. There is a realistic perspective: all professional workers (including academics) function best with abilities such as communication and language skills, ability to get along and collaborate with

colleagues and clients, as well as some awareness of the financial cost of relevant resources. However, the ability to think creatively from an engineering perspective and to make that ability evident was shown to be a highly valuable capability to some employers. It follows from this that increasing our knowledge about the ways creative problem solving is perceived and valued in engineering workplaces would likely contribute substantially to the HDR experiences of engineering candidates, render them more confident of their usefulness and value to industry and increase their employability.

The need for more qualitative information from employers has long been recognised (Borrell-Damian, 2009; Manathunga et al., 2009; Nerad, 2004; Tyler, 1998). This information would help to better understand claims by industry figures that PhD graduates are too narrowly focused and are ill prepared for work outside academia. The research findings reveal that, in the case of engineering students, concerns about the narrow focus of HDR graduates are simplistic and overestimated. The findings also address a need, identified in Borrell-Damian (2009), for more information that is exclusively focused on employers and HDR graduates in a range of specific discipline fields.

#### **10.4.1 Studies investigating university-industry collaboration**

Unlike studies into HDR students' experiences, there remains very little empirical information about the views of employers of HDR graduates. However, as noted in Chapter 2, some information about the attitudes of employers, or at least industry collaborators, is evident through analysis of student experiences.

There have been a number of positive assessments of student experiences of collaborative doctoral programs in which industry shapes and funds the research. Details of these programs are outlined in Chapter 2, Section 2.3.2 of this thesis. Concerns about the negative impact of industry expectations and interference in industry-funded research projects have largely remained unrealised; student experience has been mainly positive (for example, Mangematin, 2000; Pitt et al., 2010).

Many students in collaborative situations also have the opportunity to attend professional courses and workshops provided by the industry partner. However, an interesting finding for the present research is that most of these studies found that industry collaborators maintained a distance from the PhD project once it was underway (Behrens & Gray, 2001; Mangematin, 2000; Pitt et al., 2010; Thune, 2010). The research was often only of minor interest to the firms and did not have direct relevance to the firms' operations. For example, none of the students in Thune's investigation found their industry collaborator to be waiting for their results. Some students reported that they perceived a lack of interest on the part of the industry collaborator (Thune, 2010), and this resulted in little contact with the collaborator firm, despite the success of the PhD project. These findings suggest that the experience of industry collaboration does little to help the student gain anything more than a minor acquaintance with the social, professional and business operation of the firm. Rather, they spend their time within the university and are mentored by their academic supervisor, suggesting that they have little opportunity to develop the generic skills identified as necessary for successful workplace integration (Pitt et al., 2010; Thune, 2010).

According to the research findings in this thesis, industry partners are likely to be using the project initiation stage to engage in 'weeding' for suitable candidates. In this way they 'try before they buy' by getting to know the candidate a little, so that they can assess the personal and intellectual characteristics of the candidate. Further, successful collaborations occur where the university supervisor and industry contact person (often but not always a supervisor) have a pre-existing relationship and have experience of running collaborative PhD projects (Behrens & Gray, 2001). Through this relationship, the industry contact is likely to trust the supervisor's opinion of the candidate more than do unconnected employers who, according to Cabral-Cardoso (2001), maintain beliefs that academics do not understand industry needs.

Most CRC and industry PhD graduates find their first post-completion employment in industry. Pitt et al. (2010, p. 15) found that these were mostly casual or short-term

contract positions<sup>12</sup>. This further suggests that the early exposure during candidature was not adequate to overcome imaging concerns the employers might have; an additional period of weeding is needed to ensure the graduate ‘fits’. The conjecture is strengthened by the further finding that only 58% of CRC graduates in Australia believe that skills developed during candidature prepare them for their post-completion work, contrasted with 78% of non-CRC graduates (Manathunga et al., 2009, p. 98).

#### **10.4.2 Relevance to literature on employers’ perspective**

In the literature mentioned so far, employers’ experiences of working with industry PhDs have not been canvassed. Only one extensive report (Borrell-Damian, 2009) reviews industry PhDs in Europe from the perspectives of both universities and industry and thus includes feedback from industry collaborators. Although this report provides a good overview of the situation, it covers industry PhD collaborations across all disciplines and in 20 countries. As with earlier consultation efforts (Adams & Mathieu, 1999; Gallagher, 2000; Goldsworthy, 2002) the feedback from industry partners remains general in nature.

Borrell-Damian (2009) gained industry perspectives from Chief Executive Officers (CEOs), HR managers and R&D directors from many types of industry about PhD candidates from a variety of disciplines. While the perspectives of individuals in those positions are valuable, as is evident in the current study, they provide a skewed and incomplete picture of the ways HDR graduates are perceived in their immediate workplaces by their immediate supervisors. The participant sample used in Borrell-Damian (2009) is similar to those noted in earlier surveys such as Hager et al. (2002). These samples provide broad, general perspectives of the views of industry, but tend to deprive a study of the more specific perspectives of those most likely to have similar discipline backgrounds and work experiences.

The research findings presented in this thesis add depth to the insights gained by these larger, broad surveys by providing a closer perspective into the everyday

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<sup>12</sup> Pitt et al. (2010) reported that only 31% of CRC and 37% of non-CRC PhD graduates were permanently employed in the first position that lasted at least twelve months.

attitudes that pervade the industry workplaces of EHDRGs. The findings also illustrate the variation in employers' attitudes within one organisation and provide a model, the process of reconciling image with innovative need, to explain how each employer takes individual key factors into account to form an idiosyncratic view. Without this more nuanced explanation, descriptors of industry expectations of innovation appear unhelpfully vague.

#### *10.4.2.1 Relevance of creativity to understanding employers' views*

Borrell-Damian (2009) notes that industry employers seek creative abilities. The project aimed to explore

... how doctoral programmes, through their pursuance of original research combined with transferable skills development, were widening options for doctoral candidates' research careers in academia, government and the private sector and increasing generally the supply of highly-skilled professionals needed in the competitive labour markets of the new 'knowledge economy'. (Borrell-Damian, 2009, p.12)

Borrell-Damian appears to link 'original' to the notion of creativity, but this is never explicitly stated. Elsewhere, the relevance of creativity is noted throughout the report by Borrell-Damian (2009): the term 'creative' or 'creativity' appears 17 times in the document, five of these paired with 'original' or 'originality' (for example, 'original and creative'). However, despite the ambiguous and complex nature of the concept, the employers' understanding of the term was not elaborated, nor was much said in the document to provide a clue as to how the employers used or identified the creative characteristics, behaviours or thinking patterns. The most informative comment about creativity presented in the report states the following:

The skills of creative workers acquired during research training (e.g., capacity to deal with complex problems, capacity to work well in international environments, thinking 'out of the box'), can serve the knowledge society by developing new ways to deal with problems and finding imaginative solutions. (Borrell-Damian, 2009, p. 92)

The research in this thesis provides greater elaboration, in one discipline and industry context, of how creativity is understood by employers and the difference this makes to the way they value the outcomes of HDR education. Creativity in the type of work engaged in by EHDRGs is better understood as evident to employers through the



graduates' personal characteristics as much as their thesis experience. This finding provides considerable depth to the quoted comment by Borrell-Damian (2009) by illustrating (1) the ways in which creative processes and people are understood in engineering work, (2) how, from the employers' perspectives, creativity is or is not considered to be important to engineering work outcomes, and (3) how knowledge and skill is understood to be valuable, or not, to workplace adaptive or creative innovation.

#### *10.4.2.2 Relevance of 'imaging academia'*

The Borrell-Damian (2009) report identifies a 'general mindset' held by both those in universities and industry that 'sees universities as institutions with both limited concern and capacity to interact with industry' (Borrell-Damian, 2009, p. 105). The current study's identification of the stages involved in employers' reconciling of image with innovative need provides much insight into this mindset. The categories of 'Invoking personal theories' reveal the genesis of the mindset through self-referencing and the creation of a resilient image of a discipline-specific HDR graduate through imaging of the EHDRG. The study also reveals the employers' beliefs about the perceived link between EHDR training and the way innovation is achieved in 'Contextualising EHDRG innovative outcomes' and 'Favouring approach'.

A feature of the mindset identified by Borrell-Damian (2009) is the belief that universities and university academics maintain an aloofness from industry. Many universities canvassed in Borrell-Damian (2009) did not believe that graduates of collaborative programs would be more employable in industry. Others provided 'yes, but...' answers when responding about the industry employability of graduates from collaborative projects. These 'buts' included the belief that graduates would only find work in research-oriented companies, or that industry would be less preferable ('a second option') to purer research work. This latter belief concurs with a finding by Cabral-Cardoso (2001) concerning the views of Portuguese employers. The findings in the present study reveal that industry employers are sensitive to such attitudes of academics and HDR graduates. In their imaging of academia, the study participants interpreted these attitudes as evidence of a protected, cloistered university

community and of academic disinterest in industry. They then projected these qualities onto EHDRGs.

An interesting practical difference is evident between the European and Australian situation. In Table 3.3–2 (Borrell-Damian, 2009, p. 42), a benefit to industry identified from collaboration with universities is that the industry partner gains access to 'sophisticated instruments and large-scale facilities'. This view differs from the picture presented in the present study in the category 'Imaging academia', and particularly 'Imaging universities', in that Australian employers are unaware of the facilities available in universities, or see them as inferior to those in the industry sector. This may indicate marked differences in the endowment of universities in Europe and Australia. Perceptions of endowment or impoverishment of universities no doubt exert a significant influence on the attractiveness to industry of collaboration with universities. The finding also illustrates the need for local knowledge that reflects national and regional economies, industrial focus and corporate culture.

#### *10.4.2.3 Relevance of 'contextualising EHDRG innovative outcome'*

Borrell-Damian (2009, p. 73) notes that companies most appreciate the 'bridging' ability of PhDs and their 'intellectual property awareness', suggesting that much of the work considered valuable by these companies would be adaptive in nature. The report notes that doctoral graduates work in either research or non-research positions, sometimes shifting from one to the other (Borrell-Damian. 2009, p. 72). The innovation index provided in Borrell-Damian's report (2009, Annex 5, p. 118) includes factors similar to the types of innovation revealed in the process of 'Contextualising EHDRG innovative outcomes' in the present study, without providing guidance about salient factors for graduates in particular discipline areas. The findings in this thesis extend the findings of Borrell-Damian's report by revealing the gradations in innovative roles that employers conceptualise for one group of doctoral graduates, mechanical and chemical engineers. The development of an innovation index similar to Borrell-Damian, but with a finer-grained analysis and a discipline focus, would provide a useful tool to guide university-industry collaborations and EHDR students and recent graduates intent on industry work.

#### *10.4.2.4 Relevance of implicit personal theories of HDR graduates*

In Borrell-Damian (2009), many industry respondents stated that 'it depended very much on the quality of the candidate and how he or she fitted in the company' (Borrell-Damian, 2009, p. 73). This strongly suggests the use of implicit person theories in determining suitability for the workplace of people who choose to engage in HDR study.

The following four extracts from the report illustrate the most explicit information it reveals about the importance of personal characteristics to the employing companies' consideration of potential candidates:

For admission to industry-driven doctoral programmes or to those in which the industry hosts the candidate as if he/she were an employee, candidates may have to go through additional company interviews and/or follow company standard human resources procedures for recruitment. If the candidate is to spend a large amount of time in the company and is going to be seen as a potential employee, interpersonal skills and his/her potential fitness in the company culture are very important (e.g., Philips, Renault, Ancelcor Mittal). (Borrell-Damian, 2009, p. 45)

In all cases the candidate went through additional interviews with the company, to assess motivations, scientific qualifications and ability to fit into the company culture. In those cases where the legal status of the candidate would be that of an employee of the company, candidates also followed the standard internal HR procedures for recruitment. (Borrell-Damian, 2009, p. 61)

Some companies even hire doctoral candidates as staff before they complete their doctoral thesis, e.g. P&G or Lafarge. Other companies did not offer strong opinions but emphasised that it depended very much on the quality of the candidate and how he/she fitted in the company (e.g. Schlumberger, Synpo). (Borrell-Damian, 2009, p. 73)

An additional challenge is related to the difficulty of finding experts who fit in with the company culture or future direction. The capacity of the doctorate holder to integrate in the culture and values of the company, and the approaches it seeks to promote as part of its business development, may be as important as his/her scientific and technical profile (e.g. Infineum, Corus). (Borrell-Damian, 2009, p. 81)

Concerns about the imaged HDR and the potential impact of imaged HDR candidates remain implicit in the industry view presented in Borrell-Damian's report, but clues appear that indicate the theories are engaged even before the HDR

candidate commences the collaboration. Extract 1 refers to 'interpersonal skills and his/her **potential fitness** in the company culture', Extract 2 to 'motivations, scientific qualifications and **ability to fit** into the company culture', companies in Extract 3 'did not offer strong opinions but emphasised that it depended very much on the quality of the candidate and **how he/she fitted in** the company' and Extract 4 mentions that 'the difficulty of finding experts **who fit in with** the company culture or future direction ... may be as important as his/her scientific and technical profile'. Additional clues are provided in the extracts that indicate that an initial weeding process is undertaken, for example in Extract 2: 'through additional interviews with the company, to assess motivations, scientific qualifications and ability to fit into the company culture'.

## **10.5 Conclusion of chapter**

This chapter details salient points of correspondence between the components of the process of reconciling image with innovative need and literature of relevance from many disciplines. Each component of the reconciliation process—contextualising, imaging and selecting—was expanded or elaborated by, or contrasted with, other formal theoretical frameworks.

The substantive theory that explains the reconciliation of image with innovative need is shown to provide a link between the literature concerned with creativity, management, and implicit person theory and the literature focused on the employability of EHDRGs in industry. An important contribution of this study is its provision of a practical example of the ways in which extant theories of creativity and knowledge transfer are 'played out' in the beliefs of employers regarding EHDRGs in the industry workplace. The study also introduces the impact of implicit theory construction on the approaches taken by employers of EHDR graduates. The practical exemplification of these three theoretical constructs within the context of EHDR employability provides needed depth, from employer data and discipline-relevant contexts, to the discussion about the employability of HDR graduates. It particularly enhances understanding of the ways in which employers determine the value they hold of EHDRGs.

## **Chapter 11: Discussion and Implications of the Study**

This chapter evaluates the achievement of the purpose of this study and discusses its contribution to the field of higher education, in particular the education of HDR students for work outside the academic sector.

### **11.1 Achievement of study purpose**

This study set out to address the need for a deeper, more complete picture of the views held by employers of EHDRGs concerning the value of these graduates to the engineering workplace. The envisioned practical purpose of its outcome is to provide information and better insight into employer's views, by moving beyond simplistic descriptors that fail to adequately distinguish between disciplines or fields, or between specific HDR graduate qualities and those of other workers. Such information and insight can be used in consideration of the ways universities prepare their EHDR candidates who wish to pursue industry work, in educating students to make them aware of how they present to employers and in helping employers gain insight into how they make employment decisions.

The research presented in this thesis addresses this need and captures beliefs of employers of EHDRGs, showing that they are intimately tied to creative processes and creative people. The findings highlight creativity as an employability attribute of importance to employers. In addition, the study illustrates the ways EHDRGs are understood and used by employers to contribute to innovation in the Australian industrial workplace and reveals barriers to their opportunities for employment in industry.

The research achieved its aim by generating the substantive theory of 'Reconciling image with innovative need' that explains the views held by employers of EHDRGs and their impact on decisions to engage EHDRGs in the workplace. The theory is illustrated as a decision-making process for recruitment that reconciles an employer's image of an EHDRG with the employer's expectations for innovation outcomes and the employer's beliefs about the best ways to achieve the outcomes.

## 11.2 Contribution of the study

This thesis adds to current knowledge about the experiences and beliefs of stakeholders in the EHDR education process and contributes the following to knowledge about the value of HDR graduates in Australian industry workplaces.

1. The study presents a model, the substantive theory of 'Reconciling image with innovative need', that illustrates the specific, fundamental qualities of EHDRGs that influence their acceptance into the industry workplace. This model identifies the critical function of employers' personal beliefs about the nature of HDR graduates as well as the nature of problem-solving approaches and links these to the expected level of workplace innovation.
2. The study finds that creativity, in various guises, was an underpinning expectation of employers that coloured their views of the value of EHDRGs in their workplaces. The generated substantive theory provides a model representative of a componential framework of creativity that is relevant to the engineering innovative workplace context. The model is consistent with theoretical interpretations of creative activity in organisations, most notably the Componential Framework of Amabile (1983).
3. The research identifies a critical factor in employers' views about the relationship between traditional EHDR education and employment in the engineering workplace. This factor is creative ability, enhanced during HDR candidature, to address intractable problems and thus contribute an original outcome. This finding reframes EHDR employability in terms of employers' conceptions of three elements of creative performance: outcome, process and person.
4. The study identifies beliefs that formed resilient, implicit personal theories entertained by employers about personal characteristics and traits of engineers who pursue HDR study. The theories extend to beliefs about university academic staff and, by implication, the functioning of universities as organisations. These theories about highly intelligent, creative people problematise creativity as a personal quality. This finding indicates a

substantial, previously unarticulated challenge to attempts to integrate HDR graduates into the industry workplace.

5. The implicit personal theories were found to exert strong influence over an employer's estimation of the potential value of an EHDRG. This finding indicates that it is beliefs about the EHDRG person as much as, and perhaps more than, the qualification that matter. Although employers generally avoid engaging work applicants who display worrying characteristics, in a perverse way employers who seek visionaries, and therefore highly creative problem solvers, are inclined to view unusual personal characteristics as evidence of the creativity they seek. For these employers, the implicit theories do not create as strong a barrier to EHDRG acceptance as for other employers. This partly explains variation in the value placed on EHDRGs and the level of apparent acceptance by employers.
6. The substantive theory generated in this research rests on variation in the personal perceptions of employers about the roles, outcomes, knowledge and skills that are of value to industry. It reveals distinctive differences in the beliefs of individual employers within the same organisation. Though not directly relevant to the generated theory, the research also reveals differences between immediate workplace managers and HR personnel within the same organisation. In every case, the HR participants placed less value than the other employers on two elements of creativity: originality of outcome and need for intrepid approaches to problem situations.
7. The study reveals a disjuncture between EHDR students' professional identities and career identities. EHDR students with prior industry workplace experience and experience of industry-related projects and consultancies during their traditional candidatures displayed certainty regarding the value of their engineering expertise to innovation, but little confidence in their acceptance by industry.
8. The project demonstrates the value of a constructionist qualitative approach, and in particular GTM, as a means of gaining useful, sophisticated insights into research questions regarding HDR employability. Without such insights,

attempts to engender employability attributes in HDR graduates can miss essential qualities that meet the agendas of both industry employers and innovation policy makers.

These findings offer challenges to three stakeholders in the education of engineers. They encourage university higher degree programs, including programs that attempt to encourage employability skills and attributes, to maintain an emphasis on the fostering and presentation of creativity skills in EHDR students. Secondly, the findings reveal inconsistencies and incompletely informed notions of EHDRGs maintained by the employers in this study, who are representative of many engineering employers in Australia. Finally, in a general sense, the findings also point to a need to address the failure of government policy to grasp an issue fundamental to the preparation of HDR candidates for employment in engineering and technology industries.

### **11.3 Implications of study**

The findings of this study have implications for the field of higher education, the engineering industry and government policy related to fostering university-industry collaboration and national innovation in science and technology.

#### **11.3.1 Implications for higher education**

The study shows that in the field of engineering in Australia, HDR qualifications set up special challenges for those who wish to work in industry. This has implications for the ways in which universities present HDR study in engineering fields to prospective students. EHDRGs are almost universally competing for employment in industry with non-HDR engineering graduates, and are being judged by potential employers on criteria largely unrelated to the possession of an HDR qualification. However, an applicant's possession of an EHDR qualification immediately prompts a series of expectations, concerns and covert tests in an employer that are not applied to undergraduate engineering applicants. Commencing EHDR candidates would benefit from knowledge of these hurdles.



Length of HDR training and the socialisation for an academic context are criticised for removing research candidates from workplace-relevant experience and problem orientations (Kemp, 1999a). This study revealed that employers mainly use an EHDR student's exposure to industry during candidature as an opportunity to assess the personal characteristics of graduates. This finding is reinforced by Thune's observation (Thune, 2010) that EHDR candidates in industry projects spend most of their candidature in the guidance of their academic supervisor and that most projects are of peripheral interest to the collaborating firm. Thune's findings add credence to the observation here that the limited workplace contact in industry-based projects is not likely to enhance a candidate's knowledge of routine workplace practices and pressures and that, in many cases, industry-based projects are valued because they address concerns of employers about the personal characteristics of EHDRGs. Borrell-Damian (2009) concludes that industry is motivated to engage in collaborative doctoral projects in order to access high quality workers and is challenged in finding them. This access is explained in the present study as a process that allows 'weeding' to take place.

#### *11.3.1.1 Concern about academia*

The employers in this study displayed a disturbing lack of confidence in the academic community to educate students for industry work, as indicated in the process of invoking implicit personal theories. Furthermore, they did not consider universities places where this training should happen. The study found that the notion is naïve, for example, that employers value an emphasis on the development of entrepreneurial skills during candidature. Employer 7's comments reflected a clear opinion that 'It's [university] the last place...' to learn these skills. The employers sought in an EHDR applicant interest in and awareness of the need to attend to these skills. However, their concern was for attitude, not knowledge. Their lack of confidence in the resourcing and facilities of universities contrasts sharply with the findings of Borrell-Damian (2009), suggesting a need to consider not only discipline differences but also national, and even regional, perspectives in university-industry relationships. Further, the findings of the present study present a message to governments intent on fostering employers' perceptions of value in EHDR education: funding for university resources needs to respond to these concerns and needs to be seen to do so.

#### *11.3.1.2 Concern about creative problem-solving approach*

The study reveals the importance of HDR opportunities for creative problem-solving experiences within candidature. This ability in graduates is of utmost importance to their securing rewarding work that challenges them, the main reason for their choosing to pursue research study. The ability to produce creative outcomes requires skills and training in creative approaches to problem solution. By explicitly promoting the development of these skills, universities can enhance the employability of EHDRGs. Without engineers who possess the knowledge, creative skills and motivation to achieve these outcomes, it is unlikely that the most innovative outcomes are achievable. Problem identification and reconceptualisation, as well as intellectual risk-taking needs to be supported and enhanced in EHDR candidature. This suggests that pre-defined problems are not reliable means to producing industry-ready EHDR graduates for niche and visionary innovation. Eliminating problem identification and reconceptualisation from the EHDR experience could result in a less creative academic and HDR population, in an effort to respond to demands that will never deliver promised engineering jobs due to the undercurrent of employers' concerns remaining unstated. Reducing opportunity for creativity skills enhancement during candidature could undermine the underlying agenda linking higher education to industry innovation.

#### *11.3.1.3 Concern about image*

Most of the employers in this study sought creative outcomes and the enhancement of creative engineering innovation in their organisations, but appeared reticent to employ EHDRGs due to concerns about the graduates' imaged personalities and work styles. Since there is no compelling evidence that intelligent, creative engineers are more likely than others to have difficult personalities, there is a need to specifically promote a positive personal image of EHDRGs to potential employers.

If employers at large believe that remoteness and disinterest in social engagement is personally innate to EHDR candidates and reinforced in HDR study, EHDR candidates can be made aware of this concern and graduates interested in industry positions can be educated to assist their negotiation around employers' concerns. This assistance could include providing information to candidates about the variation in innovation expected in industry so that candidates can determine the workplaces

where they might feel most satisfied. Once their preferred innovative outcome is identified, their awareness can be raised about employers' concerns regarding EHDRGs' work practices and personal characteristics. Students can be informed of employers' use of weeding strategies, the influence on employers of implicit theories, and the characteristics that employers seek to disaffirm in a candidate. Candidates would then need to reflect carefully on their preferences and how comfortable they would feel if change were required of them to fit into a workplace. For most students, this information would be adequate to allow them to make informed decisions about their career pathways and place them in a position to negotiate successfully for employment in industry.

#### *11.3.1.4 Implication of preliminary study*

The preliminary study reveals a number of findings that also have important implications for universities.

For Australian EHDR candidates, knowledge of the three innovative role types would greatly clarify the picture held by EHDR candidates about potential work after graduation. EHDR candidates who undertake industry based PhD programs would benefit from exploration of an employer's beliefs that position the employer more explicitly as an adapter or an innovator, rather than merely an industry supervisor or contact person. Such information would place the candidate and university supervisor in the position to make a better informed decision about supervisor suitability.

Most of the preliminary study participants were attracted to work in industry, several were interested in pure research work, and few considered attractive the option of remaining in a purely academic position for long-term employment. This finding is consistent with results of several surveys (Barnacle, 2002; Barnacle & Usher, 2003; Mangematin, 2000). Furthermore, the generic capabilities the participants believed they had developed were similar to those noted in the literature on graduate employability attributes. Despite their preferences and skills development, few participants felt confident that they were attractive to industry employers. EHDR candidates clearly require more knowledge about future work possibilities.

A remarkable finding, considering the emphasis placed on the employability skilling of HDR candidates over the past decade in Australia, is that the candidates in this study believed a PhD qualification in particular was an impediment to subsequent professional career success in engineering. This observation on their part likely reflects the implicit personal theories and notions of problem-solving approaches entertained by employers. This study found that employers do not seek EHDRGs for specified positions in the workplace and there are no specific employment opportunities in industry for them. None of the employers identified positions that demanded an EHDR qualification. EHDR candidates would benefit from information on ways to package their interest in and ability to solve challenging and unusual problems relevant to workplace needs, to satisfy employers seeking intrepid problem solvers.

EHDR study will only remain attractive to students if their concerns are met. If universities are not prepared to do this, they should abandon the notion of EHDR employability as a reason to undertake EHDR study. HDR students advantage supervisors and universities (Mangematin, 2000), but for the substantial number of EHDR students who wish to work in industry, there is limited advantage unless more is done to improve their personal image in industry. Although this study did not explore the views of EHDR supervisors relevant to the substantive context, the students' experiences of candidature reflect the disillusionment described by Slaughter et al. (2002) of supervisors who need students to produce publications and conduct research. The students in this study were not 'locked-in' in the manner described for the engineering PhD students in Mangematin (2000), but were unclear about ways to shift from the demands of academia to achieve the goal of completion.

It is interesting that some employers viewed the engineering problem-solving approach as convention-bound, standardised and antithetical to production of something different. The employers interpreted the effect of the EHDR experience on this in one of two ways: as either more of the same, perhaps with a narrower focus, or as potentially liberating in the search for new ways to address problems. For graduates who wish to be employed for their intrepid attitude to challenging engineering problems, this finding suggests they should emphasise the novelty of HDR outcomes and the problem-solving experiences gained through achieving such

outcomes. Thus, linking the skills gained in creative problem solving to the needs of the target company would be beneficial for employability in workplaces seeking intrepid problem solvers.

For EHDR candidates, the role of PhDs to meet broad university research agendas while working in a resource-restricted environment was seen as an impediment to their successful transition to industry. Contrary to criticisms that HDR students engage in a theoretical journey irrelevant to practical needs (for example, Kemp, 1999a), the students themselves did not attribute delays to their persistent exploration of theoretical engineering topics or to the demands of creative thinking and problem solving needed for their project completion; they blamed the delays squarely on the lack of available resources and repeated demands for research work peripheral to their thesis topic.

### **11.3.2 Implications for engineering industry**

Employers are best placed to know the challenges and demands of their businesses, such as the difficulty in maintaining financial solvency, attracting and retaining clients and maintaining a positive working environment for employees. However, the findings of this study indicate that many Australian employers undervalue the importance of high levels of domain knowledge, including expert theoretical knowledge, to creative innovation. While many engineering educators have long been aware of the need to address the restricted technical focus of the undergraduate engineering curriculum (for example, Beder, 1999), the findings presented here raise questions about whether more focus should be placed on educating employers about the requisite elements of creatively innovative achievement.

The generated substantive theory reveals a remarkable tension between employers' desires for creative innovators and employers' avoidance of imaged creative personal characteristics in engineers. There is little scientific evidence to support employers' fears; indeed their immediate experiences inform them of the potential of EHDRGs to perform well in industry. Given that employers of visionaries and niche innovators in particular seek creative engineering workers, their concerns create a barrier that can interfere with or possibly prevent the engagement of highly competent engineering workers.

This research studied the views of employers who have engaged EHDRGs in the workplace. It can reasonably be assumed that suspicions raised from employers' often erroneous implicit personal theories of EHDRGs would lead many employers' to discount EHDRGs as potential engineering workers prior to commencing the weeding stage of the decision pathway. This deprives both EHDRGs and workplaces of potentially valuable talent.

The discrepancy between the views of human resources workers and employers engaged directly with engineering work (and workers) reveals substantial inconsistency in attitude toward the value of EHDRGs within organisations. No external recruiters were prepared to be interviewed for this study, but there is no reason to believe they would be better informed than internal human resources personnel. This is particularly worrying in that all applicants for engineering work must first meet human resources criteria and many are rejected by external recruiters prior to contact with the target organisation. Notwithstanding that most of these criteria are concerned with important bureaucratic and legal formalities, the beliefs of HR selectors can influence decisions about an EHDRG applicant's suitability at this early stage. This might deprive those employers (managers and co-workers) who are more immediately involved in the engineering work of the organisation, and better positioned to know the engineering demands of the workplace, of the opportunity to engage in the reconciliation process and arrive at a decision that meets their more informed understanding of the innovative engineering need.

The HR managers' decisions to accommodate engineering HDR graduates were very different to the other employers and co-workers in the same organisations. HR selectors, and possibly external recruiters, appear risk averse and unwilling to reconcile their image of EHDRGs with the innovative need of the organisation. They also might not have a clear picture of the degree of creativity required in the innovative outcomes of the organisation, or the differences in approaches to engineering problem solving. Those who will work closely with an EHDRG in creative problem-solving efforts appear most concerned about the creative potential of an EHDRG and are best placed to evaluate it. The finding suggests that in organisations seeking creative innovators, whether niche or visionary, steps must be

taken to ensure such workers have the capacity to influence the earliest selection processes used for potential applicants for creative engineering work.

### **11.3.3 Implications for government policy**

Government initiatives to encourage HDR graduates' industry employability fail to take into account the underlying predispositions of industry employers. The link between the employers' implicit personal theories and the employability of EHDRGs strongly illustrates the underlying complexity of industry views about EHDRGs' suitability for the workplace. This suggests that much greater exploration is necessary concerning the benefits and disadvantages of industry influence on EHDR training. The research reveals substantial gaps in employers' knowledge of the EHDRG experience, leaving some employers poorly positioned to make informed decisions before or during the reconciliation process. Further, employers' views are often based on erroneous beliefs about the relationship between knowledge, innovation and creativity.

As noted in Chapter 2, shortcomings in the education of researchers are argued to be reasons for employers' dissatisfaction with HDR graduates in many countries, including Australia, and are argued to threaten national economic potential because they dissuade employers from hiring HDR graduates. This argument fails to grasp employers' beliefs about elements of industrial work that are fundamental to creative industrial innovation. Employers' reticence to commit to engaging EHDRGs is an equal threat to innovation and national prosperity. Future government initiative is needed to enhance employers' understandings of the ways that advanced knowledge and creativity skills promote innovation.

Ultimately, the focus on generic skills training to solve HDR graduate shortcomings appears simplistic and somewhat misplaced. Such focus emphasises development of 'add-on' skills, most of which can be developed post-candidature and within the workplace; it does so at the expense of intellectual capabilities, inherent in excellent researcher training, that are necessary for creative innovation.

## 11.4 Future work

This study reveals a number of directions for future investigation and development by universities, the industrial workplace sector, and government areas concerned with higher education policy. The findings indicate that, despite the positive developments toward broadening the relevance of doctoral education for work beyond academia, universities and many employers fail to recognise and exploit the creativity-relevant skills that can result from PhD study; universities and governments fail to recognise the implicit theories held by employers about personal characteristics of HDR graduates.

This study was restricted to employers of mechanical and chemical engineering HDR graduates. A similar approach would benefit HDR programs in other engineering discipline areas, and in non-engineering disciplines, and would ultimately allow the mapping of differences in the types of outcome, knowledge and skills valued by employers of HDR graduates in various fields. Any serious effort to make use of the knowledge and skills of HDR graduates in work outside of academia would benefit from the results of such research.

Despite an evident lack of industry engagement during candidature in the European model of industry-collaborative PhDs, they appear to be successful in providing employers with a degree of confidence about the EHDRG's ability to 'fit in' and at least some opportunity for students to experience the industrial workplace. Industry-collaborative PhD programs appear to be more industry focused than the Australian CRC model. Both models have avoided the predicted industry control of PhD projects and both generally result in greater post-completion industry employment. However, the European model appears to provide greater industry contact during candidature and the opportunity for stronger ties between university academics and industry. If HDR industry-based employability remains a serious goal of the Australian government's higher education agenda, the European model is worthy of consideration.

Studies of substantive contexts reveal deeper insights into the elements that make up the context, relationships between elements and the processes at play within the substantive arena. While the revelations may be applicable to all or other similar



contexts, that generalisation is not an aim of these studies. This study was undertaken in medium and large sized Australian cities in a region with a long history of manufacturing, mining and defence technology industries. Employers' attitudes might differ in regions with different industrial profiles.

Perhaps the most unfortunate situation for the employment of EHDRGs in creative positions is that of employers seeking niche innovators. The tension between achieving creative outcomes and meeting time and financial constraints no doubt deprives organisations dependent on the production of unique products and problem solutions of much opportunity to develop highly creative innovations. These constrained organisations offer a fertile context for the study of creative engineering processes under such pressure. Furthermore, the cost of this pressure to the satisfaction of creative engineers who work there, and to the national innovation agenda, is worthy of further investigation.

Selection procedures in the HR departments of larger companies appear skewed against EHDRGs, although there is little of substance to support their negative bias. Further, HR selection procedures do not entirely correspond to the innovative needs of the engineering workplaces within these companies, as described by the engineering workers and unit managers interviewed in the study. Investigations into changing procedures to ensure greater initial input by the local unit managers who seek creative innovators could enhance the overall creative innovation of these organisations.

## **11.5 Concluding remarks**

The study's findings contribute needed depth to the discussion about the employability of HDR graduates by industry employers in Australia. Common ground is identified between HDR experience and the views of employers that has not been part of the graduate employability discussion to date, but that can be exploited to understand the ways HDR experience can benefit industry.

By focusing on a single group of engineering graduates, those with higher degrees by research, this study has illustrated the perceptions of knowledge applicability and creative processes in engineering workplaces, as well as the idiosyncratic ways that

these factors are considered by employers to be important to engineering workplace innovation. These perceptions were revealed through the employers' beliefs about the value and usefulness of EHDRGs to their engineering work, particularly in the light of the employers' persistent beliefs about the problematic personal characteristics of engineers and EHDRGs. It revealed notions entertained by the employers that had not been previously formally noted and that, in part, appeared to be self-contradictory and counter to best evidence.

This study also positions the concept of creativity as a significant element of the EHDR experience. An EHDR degree is not necessary for creative engineering outcomes, but it does have the capacity to enhance creative skills along with advanced knowledge. The study suggests that focus on employability skills that emphasise direct applications and practical outcomes undervalues the development of creativity skills in the education of HDR candidates. Employer-driven employability agendas have been shown here to be incomplete, mainly because they emphasise the requirements of innovative adaptation over those of creative innovation. Greater awareness of the complexity of employers' beliefs about research education would likely both expand EHDRGs' career options and enhance industry innovation in Australia.

## **Appendix 1: Qualitative Research in a Quantitative World**

### **A1.1 Additional background to Chapter 3**

The findings of this study would be of most interest to those who study, teach or work in engineering fields, even though they may be unfamiliar with the research methodology used here. Social research methodologies reflect a variety of worldviews and perspectives on knowledge. These differences are not the result of improved technology or techniques for acquiring, measuring or manipulating data, but rather they reflect the struggle, from many discipline-based traditions and perspectives, to understand a data set that is infinitely variable, constantly dynamic, and which allows for only indirect observation. Social research methodologies have struggled to gain legitimacy both within and across disciplines that are young compared to those of the physical sciences. These disciplines include psychology, anthropology, sociology, education, management and, more recently, information systems; all are concerned with forging ways to capture insights into social phenomena and human activity.

Early social research attempts went to great lengths to maintain an air of legitimacy by retaining the methods and objective stance of the natural sciences. However, the adherence to the scientific methods of the physical and natural sciences, with the need for reproducibility and statistical reliability that lent strength to research concerned with objectified, observable and measurable natural phenomena, became viewed as a limiting factor in the search for understanding of people's beliefs, experiences and social behaviours. The methodologies that are evolving to address these issues continue to challenge social researchers' attitudes. There is a large body of literature that explores philosophical and sociopolitical motivations of the 'social research act' and their methodological implications (for example, Denzin & Lincoln, 2000; Mouzelis, 1995; Seale, 2003; Seale et al., 2004).

As someone whose background is in quantitative, positivist social research, I found the literature on non-positivist research philosophies and ontology daunting,

particularly as it reflects continuously evolving perspectives expressed with inconsistently used and semantically varying terminology. Awareness by researchers of these perspectives, and where a particular study is paradigmatically and epistemologically situated, is essential in social research, despite the danger to the researcher of paralysis due to methodological information overload warned of by writers such as Crotty (1998), Dey (2004) and Seale (2003):

Methodological discussions...benefit the quality of research by encouraging a degree of awareness about the methodological implications of particular decisions made during the course of a project. Intense methodological awareness, if engaged in too seriously, can create anxieties that hinder practice, but if taken in small doses can help to guard against more obvious errors. (Seale, 2003, p 181)

The aim in Chapter 3 is to explain the research approach used in the study, in a way that is clarifying and useful for a reader unfamiliar with the non-positivist paradigms. In so doing, two particularly challenging ideas are discussed: the epistemological position of grounded theory and the way grounded theory inductively generates 'theory'.

### **A1.1.1 Simple paradigmatic dichotomy**

Until recently, it has been customary to describe social research as either quantitative or qualitative (Burns, 1997; Neuman, 1997). Despite the fact that many recent writers on research methodology and design dismiss this division as simplistic (Creswell, 2003; Crotty, 1998), exaggerated (Lund, 2005; Seale, 2003), or limiting (Ercikan & Roth, 2006), the traditional dichotomy serves to introduce some usual distinctions between two broad ontological approaches to social research, objectivist and non-objectivist. Based on a survey of social research methodology literature, Burns (1997) summarised the distinctions as shown in Table A.1.

It is important to note that Burns's comparison pertains to research design and presentation; it is not a suggestion that quantitative researchers are not involved in their research activities or that qualitative research is unreliable. Rather, reliability is measured and explicitly presented in quantitative research, while researcher involvement and potential influence in the research process is at least recognised and often openly acknowledged in the presentation of qualitative research. Additionally,

the terms quantitative and qualitative are not mutually exclusive, in that quantitative research makes use of many ideas that are not quantifiable, and qualitative research can make use of numerical data.

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**Table A.1: Quantitative style versus qualitative style (Burns, 1997, p. 14)**

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NOTE:  
This table is included on page 259  
of the print copy of the thesis held in  
the University of Adelaide Library.

Sarantakos (1998) illustrates, as shown in Table A.2, differences in the position of theory that suggest that qualitative research does not commence with firmly pre-defined theoretical concepts, although again this is an example of a simplistic dichotomy.

**Table A.2: Theory building in quantitative and qualitative research  
(Sarantakos, 1998, p. 15)**

NOTE:  
This table is included on page 259  
of the print copy of the thesis held in  
the University of Adelaide Library.

Sarantakos (1998) further includes in his list of common qualitative research aims ‘to explore social reality for its own sake or in order to make further research possible’ and ‘to understand human behaviour and action.’ Marshall and Rossman (1989, cited in Sarantakos, 1998) list the type of inquiry in which qualitative studies are fruitful:

- research that cannot be done experimentally for practical or ethical reasons;
- research that delves in depth into complexities and processes;
- research that seeks to explore where and why policy, folk wisdom and practice do not work;
- research for which relevant variables have yet to be identified;
- research on unknown societies or innovative systems;
- research on informal and unstructured linkages and processes in organisations;
- research on real as opposed to stated organisational aims.

The present study reflects all of these constraints and characteristics. By using qualitative methodology, this research set out ‘to capture what people say and do as a product of how they interpret the complexity of their world, to understand events from the viewpoints of the participants’ (Burns, 2000, p. 11).

## **Appendix 2: The Evolution of Grounded Theory Methodology**

### **A2.1 Additional background to Chapter 3**

The introduction of GTM openly challenged the assumptions and conventions of social research activity of the time, and the changes it introduced have permanently altered the landscape of social research. Nevertheless, the challenges presented by Glaser and Strauss (1967), Glaser (1978), Strauss (1987) and Strauss and Corbin (1990; 1998) left much that was unclear and confusing for researchers attempting to use GTM (Fendt & Sachs, 2008; Mruck & Mey, 2007) and since its introduction, several versions of GTM have evolved (Bryant & Charmaz, 2007a; Charmaz, 2006; Dey, 2004).

Fendt and Sachs (2008, p. 3) identified a number of reasons for the confusion surrounding the methodology, including the following:

- Inconsistencies in the methodology in its early stages of development;
- The ontological differences between Barney Glaser, an objectivist, and Anselm Strauss, a constructionist;
- Semantic differences in the vocabularies of different social research discourses that make use of the methodology.

To these, they add Suddaby's (2006) explanation that practitioners suffer from misunderstandings and misconceptions of the methodology.

The first two reasons listed are fundamental contributors to the confusion evident over the past 40 years, while the first reason in part reflects the contortion of the methodology needed to argue the case for inductive inference as a means of theory building. The third reason relates to the general development of social research methodologies over the past 50 years (partly as a result of the influence of GTM),

with a corresponding evolution in vocabulary leading to semantic confusion for novice researchers. For example, terms such as ‘qualitative’, ‘paradigm’ and ‘epistemology’ have been used to encompass somewhat different concepts (Crotty, 1998; Glaser, 1992; Lincoln & Guba, 1985; Schwandt, 2000).

All the reasons for confusion result from attempts to explain and clarify a methodology that transcends paradigms but that was first described from the mainly positivist perspective from which it simultaneously sought to release social research. An important aim of Glaser and Strauss (1967) in their introduction of GTM was to provide a means for the development of more contextually relevant sociological theories. Their motivation for doing this was to free sociological research from the constraints of working with poorly developed ‘grand theories’ that bore little relevance to many sociological contexts of interest to researchers (Glaser & Strauss, 1967). Between 1954 and 1965, 2080 scales and indices appeared in leading sociology journals, but only 2.26% were subsequently used more than five times. (Bonjean, Hill & McLemore, 1967 in Denzin, 1978, p. 40).

However, the methodology was initially developed from a postpositivist perspective at a time when positivist functionalism dominated social science research (Annells, 1996; Hall & Callery, 2001). Thus, many of the original texts on GTM reflect an objectivist epistemological perspective. This influence can be seen even in much of the terminology in use in GTM. For example, the methodology partly developed from the concept-indicator model developed for quantitative studies (Glaser, 2008; Strauss, 1987) and codes were used in quantitative research as pre-determined concepts used to identify bits of data (Kelle, 2005; Kelle, 2007). Strauss, in contrast, brought his experience in symbolic interactionism to the development of the methodology.

Their different approaches to developing and explaining GTM to new users led to an acrimonious disagreement between Barney Glaser and Anselm Strauss. With respect to analytical procedure, Glaser (1992) vehemently opposed the use of techniques, such as axial coding suggested by Strauss (1987) and Strauss and Corbin (1990), that Glaser claimed were prescriptive and forced data into theories rather than allowing theory to emerge from the data. Charmaz (2006) and others (Kelle, 2005; Melia,



1996) reveal milder concerns with axial coding and its potential to constrain analysis in some instances:

Although axial coding may help researchers to explore their data, it encourages them to apply an analytical frame to the data. In that sense, relying on axial coding may limit what and how researchers learn about their studied worlds and, thus, restricts the codes they construct. (Charmaz, 2006, p. 62).

In this study, I found axial coding inhibited my insights into the ideas expressed by the employers I had interviewed; I had a strong sense I was forcing the data to conform to the demands of the framework promoted by Strauss and Corbin (1998). They addressed the possibility that axial coding could restrict researcher openness to the data, the last two sentences reveal the ambiguity that imbues the early writing on GTM and that leaves novice researchers unsure about how to proceed:

We realise that beginners need structure and that placing data into discrete boxes makes them feel more in control of their analyses. However, we want then to realise that such practices tend to prevent them from capturing the dynamic flow of events and the complex nature of relationships that, in the end, make explanations of phenomena interesting, plausible, and complete. Analysts who rigidify the analytic process are like artists who try too hard. Although their creations might be technically correct, they fail to capture the essence of the objects represented, leading viewers feeling slightly cheated. Our advice is to let it happen. The rigor and vigour will follow. (Strauss & Corbin, 1998, p. 129)

Strauss and Corbin indicated that their coding procedures were guiding suggestions rather than formal doctrine. Kelle (2005) argues that Glaser's criticism of Strauss and Corbin's framework is overstated and that it is unlikely that GTM novices would conform rigidly to the process at the expense of analytical depth. Kelle (2005) also describes Glaser's extensive theoretical coding families (Glaser, 1978), also provided for novice researchers, as drawing on formal epistemological and sociological concepts with which most users would not be familiar.

The disagreement influenced the work of many grounded theorists, with some choosing to follow a Glaserian or orthodox GTM (for example, Holton, 2008) and others subscribing to the approach encouraged by Strauss and Corbin (1990; 1998). For many researchers, the framework provided by Strauss and Corbin is more workable, if limiting, for theoretical coding. Recent writers on the methodology

emphasise the value of their framework, or paradigm, as a guide or tool and not in a doctrinaire fashion. For example, in her PhD thesis exploring maternal social support, Williams (2005) returned to axial coding to prompt ideas late in her analysis after initially abandoning it because it seemed too constraining. Similarly, Fendt (in Fendt & Sachs, 2008) was inspired to conduct her research, on CEOs' postmerger management experiences, by Glaser's approach and then found the ideas of Strauss and Corbin helpful in their rigidity at a time when she began to experience doubts in her research activity.

Glaser (2008) claimed that GTM constitutes a paradigm of itself, and Miller and Fredericks (1999, p. 539) refer to GTM as 'the paradigm of choice' with respect to its popularity in qualitative research studies. However, using the Guba and Lincoln (1994) model to define 'paradigm', GTM sits most comfortably at the methodology level of the constructivist paradigm and the ontology, epistemology and aims levels of the postpositivist paradigm. I contend that it is a methodology that, at its inception, revealed paradigmatic liminality, evident through the juxtaposition of the need for researcher objectivity and distance on the one hand and sensitivity and intuition on the other. Other factors supporting this view are its attention to detailed procedure and encouragement to 'let it happen' and for a drive toward theory verification (universality) with an emphasis on local context and inductive inference from which no generalisation can be drawn. To some extent, the research approach introduced in GTM coincided with the start of what Denzin and Lincoln (2005) referred to as the 'blurred genres' phase of qualitative research development. These ambiguities in GTM were never satisfactorily explained in the early texts, but have been addressed more recently by theorists who argue the value of GTM in research reflecting other paradigmatic perspectives.

#### **A2.1.1 Is a grounded 'theory' a theory?**

A central claim of GTM as developed by Glaser and Strauss (1967) is that it leads to the discovery of an inductively derived theory that is verified by use of the inductive analytical process. Glaser (1992) and more recent writers on the theoretical status of the outcome of GTM contest this claim. At the centre of the question 'Is a grounded theory a theory?' is the validity of a 'theory' that is said to be verified by reference to

confirming data. Denzin (1978) suggested that the outcome of analytical induction is a type of theory:

In one sense, the use of theoretical saturation as a criterion for concluding observations on a concept has its analogue in the dictum of analytical induction that a theory is complete insofar as negative cases which invalidate it are not identified. (Denzin, 1978, p. 194)

Others dispute this viewpoint (Thomas & James, 2006). The methodology leads to the statement that X is always the case because the researcher looked for evidence to support X, found it and did not find disaffirming evidence. In the language of formal logic, this does not constitute a 'truth' claim: the absence of observation of cases to the contrary does not make something true. Thus, the quality of generalisability and hence the ability to predict, which are considered essential for a valid theory in objectivist research, cannot be said to have been met in a theory developed using GTM.

Yet GTM endures, because it provides a valuable guide through the process of logical inference in research and can result in deeper understanding of social phenomena as they occur in everyday contexts. Miller and Fredericks (1999) argued that GTM is a process of induction that Harman (1965, p. 1) referred to as 'inference to the best explanation':

Grounded Theory is a type of theorizing, focused both on the context of discovery related to a plausible explanation of some phenomenon and providing an inductive argument for its plausibility. It need not either accommodate or predict, although it may do one or the other in principle. (Miller & Fredericks, 1999, p. 550)

Charmaz (2006, p. 149) concurs with this view:

Checking hunches and confirming ideas, in my view, does not equal verification. Rather than contributing verified knowledge, I see grounded theorists as offering plausible accounts.

Fendt and Sachs (2008, p. 23) promote its potential to offer 'innovative perspectives' when it is used with 'courage and creativity', and encourage theorists to 'moderate the theory pretence' and 'drop the grand unified theory pretence altogether'. They view GTM as a process whereby research participants' subjective experiences are

abstracted into theoretical statements that can form the basis for ‘empirically valid hypotheses’. In this respect they concur with Eisenhardt (1989, p. 533), whom they cite, who uses GTM within a positivist research perspective and claims that GTM builds and ‘sharpens’ constructs through the iterative process of constant comparison that leads to the shaping of hypotheses.

Thomas and James (2006), in response to Miller and Fredericks (1999), went further by criticising the continued claim that GTM results in theory that provides ‘explanation’ when qualitative research has moved far beyond the need for this, but they find much of value in the outcomes of the process that leads to improved understanding and insight:

Understanding is no less worthy and there is a paradox in grounded theorists’ continued strivings for explanation. (Thomas & James, 2006, p. 773)

GTM was used in this study as a rigorous guiding framework for empirical analysis to enhance understanding of the poorly understood phenomenon of EHDRGs’ employment. Throughout the study, its capacity to assist me in seeing beyond the surface level of common assumptions and simplistic inferences became increasingly obvious to me.

#### **A2.1.2 The impossible ‘blank slate’**

The last component of GTM mentioned by Charmaz (2006, p. 6) ‘was conducting the literature review *after* developing independent analysis’ [author’s italics]. An issue that arose between the originators of the methodology was that of the starting point for research. Glaser (1992) is adamant that the research question, the main concern of participants, and the theory emerge from the data and that it is essential that the researcher commence with an open mind, which includes avoiding becoming familiar with extant theoretical literature on the substantive area under investigation. Strauss (1987), and later Strauss and Corbin (1998), developed a version of GTM that encourages the clarity of the research question and context before data collection commences. Thomas and James (2006) argue that the idea of starting with a blank slate, even if possible, is not desirable in interpretive research, and it is *a priori* assumptions that make qualitative research ‘worthwhile’ and ‘possible’. Their

criticism highlights the incongruence of maintaining objectivist assumptions about research while advocating for an open and empirically responsive inquiry. Suddaby (2006) argues that the requirement to avoid the literature until after the research has been conducted represents a misunderstanding of the motives of Glaser and Strauss:

Although Glaser and Strauss were motivated against grand theory, their formulation of grounded theory was never intended to encourage research that ignored existing empirical knowledge. ...The real danger of prior knowledge in grounded theory is not that it will contaminate a researcher's perspective, but rather that it will force the researcher into testing hypotheses, either overtly or unconsciously, rather than directing observation. (Suddaby, 2006, p. 635)

The recognition of the important role played by prior knowledge and experience reflects influence of the views of pragmatist philosopher C.S. Peirce, who asserted that our ability to infer correct meaning is innate:

If you carefully consider with an unbiased [*sic*] mind all the circumstances of the early history of science and all the other facts bearing on the question, which are far too various to be specifically alluded to in this lecture, I am quite sure that you must be brought to acknowledge that man's mind has a natural adaptation to imagining correct theories of some kinds, and in particular to correct theories about forces, without some glimmer of which he could not form social ties and consequently could not reproduce his kind. In short, the instincts conducive to assimilation of food, and the instincts conducive to reproduction, must have involved from the beginning certain tendencies to think truly about physics, on the one hand, and about psychics, on the other. (Peirce, 1901/1957, p. 238)

Although the influence of pragmatism on the development of GTM is not explicitly stated in the writings by Strauss, he was trained in symbolic interactionism during his doctoral studies, and that symbolic interactionism is closely linked with pragmatism. Both the philosophy of pragmatism and the theory of symbolic interactionism have strongly influenced the development of the interpretive-constructionist epistemological viewpoint, and it is this viewpoint that is maintained in the current study. As the epistemological ambiguities of its early development are acknowledged and addressed, GTM is viewed increasingly as a methodology applicable to any paradigm. The influence of pragmatism on the inferential processes fostered in GTM analysis is discussed further in the following section.

Dey (2004) moved the paradigmatic applicability of GTM further than Charmaz did: 'There is no such thing as "grounded theory" if we mean a single, unified methodology, tightly defined and clearly specified' (Dey, 2004, p. 80). He asserts that various interpretations of grounded theory coexist, having the following in common:

- A sensitivity to empirical evidence, with the aim of discovering ideas in the data;
- Data sought through 'theoretical sampling' during the course of the research, which allows for comparing and refining ideas;
- Use of qualitative data gathered during observation and/or interviews, with decisions about data collection made as the research progresses;
- The coding of data into conceptual categories;
- Termination of data collection and analysis once theoretical saturation is reached, that is when data no longer add any new information to the emerging picture.

Dey (2004, p. 92) exhorts social researchers to 'consider methodology as a "work in progress" rather than an abstract and ossified set of technical prescriptions'. In the present research, I arrived at a similar viewpoint during my work with GTM: the methodology is moulded to be workable with the data and context, rather than the reverse. As I became increasingly familiar with the data, I found much that was enlightening and useful in the original texts on the methodology, as well as much that did not seem relevant to the situation I was studying. Further, during analysis, the transcriptions and my field notes revealed and challenged my own assumptions and interpretations as well as providing evidence that my presence and position appeared to influence the participants' comments at times. The constructionist approach to GTM taken by Charmaz (2000; 2006) increased in usefulness by allowing me space for explicit reflexion.

In summary, GTM is a process of inductive reasoning, through data sampling and categorisation that arrives at a plausible explanation or fuller understanding of a social phenomenon or problem situation. While the researcher begins by formulating a general research question from his or her own knowledge and experience of the problem context or similar contexts, it is essential that the research avoids commencing from a given theoretical perspective or, as much as possible, from theoretically driven assumptions that lead to a premature hypothesis. The result of a GTM study can be called a ‘theory’ only if one accepts that has not been subjected to falsification testing and cannot claim generalisability. What it can claim is to have good fit and relevance for the substantive area under investigation and the potential to offer insights that might infer useful ideas to other contexts which display similar phenomena. While hypotheses from some grounded theories can be tested deductively for predictive power, others relate to situations or phenomena that cannot practically be tested; they remain highly plausible explanations and this is a well accepted understanding of ‘theory’ within the field of social inquiry.

### **A2.1.3 Hypothetic inference, deduction and induction**

Having determined that the coding and categorisation procedures used in GTM guide the process of inductive inference, the next stage in the explanation of this methodology is to describe how the logic of inductive inference works to arrive at what can be described in various ways as an excellent hunch, a very good guess, a plausible explanation, or a valid hypothesis. The analysis process itself, however, relies on a combination of the iterative coding procedures and creative, hypothetic inference (abduction). It is the latter that shifts the research from thematic description to theoretical abstraction. Glaser and Strauss stated it simply: ‘The researcher has insights and he can make the most of them (as we have argued) through systematic comparative analysis’ (Glaser & Strauss, 1967, p. 251). Hypothetic inference, or the process of abduction, relies on the use of researcher background knowledge and understanding to interpret data in such a way that the result is a plausible hypothesis. The following quote from Bonfantini and Proni (1983) captures Peirce’s philosophy that nature conspires to allow inference to valid hypotheses, or ‘guesses’:

When men have to guess, they find themselves guided by systematic and complex visions of reality, philosophical conceptions, of which they are

more or less distinctly aware but which anyway shape their cast of mind, their deep habits which determine the bearings of judgement. These philosophies synthesize and organize, by process of generalisation, analogy, and hierarchical ordering, the knowledge and cultural acquisitions deposited in the course of centuries and derived from extensive social practices. So it is not to be wondered at that these philosophies possess (obviously in varying degrees) their force of truth, including the capacity to inspire new and valid scientific hypotheses. (Bonfantini & Proni, 1983, p. 134)

This perspective on accurate guesswork links to a number of researchers who have perceived the role of GTM to prompt and guide hypothetic inference. Miller and Fredericks (1999, p. 549) suggested that an under-recognised characteristic of the GTM process is that it is a well-developed guide to using inductive inference to generate hypotheses from 'background assumptions and causal histories': 'What grounded theory is about is the making of credible inductive argument for phenomena situated within a context of discovery whose logic is one version and application of the methods of induction.' Fredericks's view concurs with Eisenhardt (1989, p. 546), who asserted that GTM results in sound hypotheses by sharpening creativity: 'Creative insight often arises from the juxtaposition of contradictory or paradoxical evidence'. By positioning GTM as a precursor to empirical testing, Eisenhardt suggested that positivist research using quantified qualitative data is less adequate for producing these insights, presumably because interesting non-conforming data is rendered less visible in probability or descriptive studies.

Reichertz (2007) extends this view of a process for inducing creative insights by suggesting that in order to gain clarity during the constant comparison and categorisation of data, the researcher must take a leap into abstraction. GTM encourages this by providing opportunity for logical abduction, or hypothetic inference. Reichertz (2007, p. 222) describes the influence of abduction as follows: 'When faced with surprising facts, abduction leads us to look for meaning-creating rules, for a possibly valid or fitting explanation that eliminates what is surprising about the facts. The end point of this search is a (verbal) hypothesis.' According to Reichertz (2007, p. 222) predictions are 'tested' through the gathering of more data, and 'the *search for facts* that will "verify" [or negate] the assumptions [made]'. With each attempt at inductive verification, new surprises may arise and further hypotheses are developed to take these into account. This process is repeated until



predictions are confirmed, albeit inductively, and no new data is required to provide a plausible picture of what is going on in a particular situation. From this process, a new type, or enhanced way of looking at a situation, is invented or discovered (Reichertz, 2007). This new type must fit the situation or problem context precisely, and its position within a pragmatist philosophy requires it to be something useful for further action.

Strauss used different terminology to describe the inferential process of GTM, referring to the abduction phase as induction, 'actions that lead to...having a hunch or an idea' (Strauss, 1978, p. 11), and to the induction phase as verification, 'total or partial qualification or negation' (Strauss, 1978, p. 12). The process of verification makes use of theoretical sampling to find answers to hypothetic questions.

The process of abduction-induction would occur many times during the coding, categorisation and theoretical sampling process of GTM analysis. Each inference forms part of the intensive sampling and categorisation process that leads to the best explanation or most insightful understanding of a social phenomenon in a particular context; in other words, a substantive grounded theory:

In brief, abductive inference entails considering all possible theoretical explanations for the data, forming hypotheses for each possible explanation, checking them empirically by examining data, and pursuing the most plausible explanation. (Charmaz, 2006, p. 104)

Reichertz lists two strategies mentioned by Peirce to enhance the abduction stage of creative idea generation: stimulation by the application of extreme constraint or allowing the mind to wander in a conscious attempt to think outside the constraining logic of what is already known. This latter strategy outmanoeuvres the judgements that constrain the conscience mind. The cognitive experience of an abductive occurrence is often that of a 'flash' or 'lightning bolt' of insight, and this type of experience can occur in people engaged in any intensive problem-solving activity. Glaser and Strauss (1967, p. 251) acknowledged the important role of these flashes of insight in theory generation: '...these can come in the morning or at night, suddenly or with slow dawning; while at work or at play (even when asleep)'. Coincidentally, a participant in the current project provided the following description of a strategy to induce abductive insight that he experienced:

**Interviewer:** Do you think your PhD helped you to learn any of those skills?

**Interviewee:** I didn't think so at the time but in retrospect it probably did. I think it gave me a degree of confidence that I could tackle a tough problem and come out the other end in one piece. Because I had a huge crisis in the middle of mine and really 6 weeks couldn't do anything, and I didn't know what I was going to do, I couldn't see a way forward. And I used to walk the streets of Sheffield trying to think because I couldn't sit at my desk thinking.

**Interviewer:** It's agonising isn't it?

**Interviewee:** Yes it is. And eventually I just thought I've just got to go and do something. I went in and I took a few photographs of this oil scrap and in these photographs was inspiration. If I'd taken them 6 weeks earlier it would have been much easier.

In their criticism of GTM, Thomas and James (2006, p. 789) wonder that it is not viewed as merely 'the process of hard work and inspiration that combines to enable interpretation and new insights in any field'. My response is that GTM guides, and supports the researcher through the process of gaining insights in a way Thomas and James, and others, cannot offer. For them, it appears that an insightful idea results from complete chance, accident, or magic, or that it is guaranteed if the researcher works hard. Focusing on the cognitive process of abductive inference, as GTM forces the researcher to do, reveals the extent of researcher intelligence and control in generating insights.

#### **A2.1.4 Summary**

The guidance provided by GTM leads the researcher in inferential processes and enhances the potential for abduction; the methodological approach requires the researcher to maintain 'a state of preparedness for being taken unprepared' (Reichertz, 2007, p. 221). It provides guidance that also allows the researcher to maintain constant, intimate connection with the data and study context, consistent with pragmatic research aims. Further, it provides rigorous methodological guidelines that allow social researchers to explore intuitively interesting social questions and gain deeper insights into the social phenomena they study, leading to plausible hypotheses or explanations of direct relevance to the substantive social context. This deeper insight and understanding of the social world, in context and with pragmatic outcomes, is frequently the best that can be achieved in a fluid,

dynamic, interpreted social 'reality' and, as Thomas and James (2006) assert, it is enough.

## Appendix 3: Ethics Approval for Preliminary Study



OFFICE OF THE DEPUTY VICE-CHANCELLOR (RESEARCH)

SABINE SCHREIBER  
SECRETARY  
HUMAN RESEARCH ETHICS COMMITTEE

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CRICOS Provider Number 00123M

Applicant: Dr AC Zander

Department: Mechanical Engineering

Project Title: *The professional socialisation of post-graduate research students in Engineering: a preliminary study*

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THE UNIVERSITY OF ADELAIDE HUMAN RESEARCH ETHICS COMMITTEE


**Project No:** H-152-2005

RM No: 000006683

APPROVED for the period until: 30 April 2006

Thank you for the revised participant information sheet and advertisement dated 19.12.05. It is noted that this study will involve Karen Adams, PhD candidate.

Refer also to the accompanying letter setting out requirements applying to approval.

 Associate Professor Garrett Cullity  
Convenor  
Human Research Ethics Committee

Date: 21 DEC 2005

## Appendix 4: Preliminary Study Request for Participants

**Free lunch! Free lunch! Free lunch! Free lunch! Free lunch!**

### What do you plan to do after you finish your Masters or PhD?

I am conducting PhD research into the ways postgraduate research students in Engineering are prepared for the workplace. One of the first things I'd like to know is what you plan to do after degree completion. Will you

- remain in academia,
- return to work,
- start a job for the first time, or
- forget Engineering and join a rock band?

I would also like to know what happens in your candidature that prepares you for life after research and study.

Whether you have just started your candidature, are in the thick of it or are about to finish, please come to this discussion session on life after the research degree. And if you haven't thought about life after the thesis, you might pick up a few ideas to help you prepare for the inevitable.

**LUNCH WILL BE PROVIDED**

**Where:** N123b

**When:** Friday, 3 March 12:00–1:00pm

To confirm numbers, please contact Karen Adams on 8303 7021 or at [karen.adams@adelaide.edu.au](mailto:karen.adams@adelaide.edu.au)

**More information about this study is provided overleaf.**

# The professional socialisation of postgraduate research students in Engineering: a preliminary study

## Information for Participants

This focus group forms part of a PhD study that is looking into the beliefs that Engineering postgraduate students have about their future roles in the Engineering profession. We would like to know about your work or study experiences as an Engineer, and your goals on completion of your postgraduate degree.

Discussion in the group will focus on the following questions:

1. Why did you choose to do postgraduate research?
2. What do you plan to do when you finish your studies?
3. What is your professional work experience so far?
4. What elements of your postgraduate research experience contribute to your preparation for your eventual professional role?
5. Does anything in your postgraduate research experience appear to detract from or be irrelevant to your future goals?

Participants are asked to speak freely about aspects of their postgraduate experience that they believe are relevant to the discussion.

This group discussion will be of 2 hours duration. This is the maximum length of time; it might be shorter.

Please note the following about CONFIDENTIALITY in this study.

- This discussion will be audiotaped and transcribed. The audiotape will be used for transcription purposes only. The transcription will be conducted by a professional, confidential transcription service. No one else will listen to the audiotape.
- All identifying information about participants, including individuals' Schools, project topics, supervisors and sponsors, will be removed or altered to prevent identification of individuals or specific situations. No one except the researcher, Karen Adams, will see the unedited transcript.
- You do not need to identify yourself by name or School if you do not wish to do so. However, to take part in this study you **MUST** be enrolled as a postgraduate research student in the Schools of Chemical Engineering or Mechanical Engineering at the University of Adelaide.
- The audiotape and original transcript will be kept in secured storage and seen only by the researcher, Karen Adams.
- No student or university information presented at this discussion group will be used for any other purpose but the investigation described above.
- You may withdraw from this study **at any time**, including during the discussion or after. If you choose to withdraw after commencement of the discussion, your contribution will be removed from the data.
- A University of Adelaide Human Ethics Research Complaints form is included with this information sheet (at the Discussion session only).

You are free to contact the researcher at any time if you have concerns or questions about this study. Contact details:

Karen Adams Phone: 83038312 Email: [karen.adams@adelaide.edu.au](mailto:karen.adams@adelaide.edu.au)

## Appendix 5: Preliminary Study Consent Form

THE UNIVERSITY OF ADELAIDE HUMAN RESEARCH ETHICS COMMITTEE

### STANDARD CONSENT FORM FOR PEOPLE WHO ARE PARTICIPANTS IN A RESEARCH PROJECT

1.	I, .....	<i>(please print name)</i>
	consent to take part in the research project entitled: The professional socialisation of postgraduate research students in Engineering: a preliminary study	
2.	I acknowledge that I have read the attached Information Sheet entitled: The professional socialisation of postgraduate research students in Engineering: <b>Information for Participants</b>	
3.	I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.	
4.	I understand that the group discussion will be audiotaped.	
5.	I have been informed that, while information gained during the study may be published, I will not be identified and every care will be taken to avoid mention of information that might identify me.	
6.	I understand that I am free to withdraw from the project at any time and that this will not affect my candidature, now or in the future.	
7.	I am aware that I should retain a copy of this Consent Form, when completed, and the attached Information Sheet.	
	.....	.....
	<i>(signature)</i>	<i>(date)</i>

<b>WITNESS</b>	
I have described to .....	<i>(name of subject)</i>
the nature of the research to be carried out. In my opinion she/he understood the explanation.	
Status in Project: Principal Researcher	
Name: Karen Adams	
.....	.....
<i>(signature)</i>	<i>(date)</i>

## Appendix 6: Ethics Approval for Employer Study

COPY



OFFICE OF THE DEPUTY VICE-CHANCELLOR (RESEARCH)

SABINE SCHREIBER  
SECRETARY  
HUMAN RESEARCH ETHICS COMMITTEE  
THE UNIVERSITY OF ADELAIDE  
SA 5005  
AUSTRALIA  
TELEPHONE +61 8 8303 6028  
FACSIMILE +61 8 8303 7325  
email: sabine.schreiber@adelaide.edu.au  
CRICOS Provider Number 00123M

Applicant: Dr AC Zander

Department: Mechanical Engineering

Project Title: *The professional socialisation of postgraduate research students in engineering*

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THE UNIVERSITY OF ADELAIDE HUMAN RESEARCH ETHICS COMMITTEE

**Project No:** H-046-2006

RM No: 0000006881

APPROVED for the period until: 30 April 2007

It is noted that this study will be conducted by Karen Adams, PhD candidate.

Refer also to the accompanying letter setting out requirements applying to approval.

Associate Professor Garrett Cullity  
Convenor  
Human Research Ethics Committee

Date: 12 APR 2006

Page 1 of 1



## Appendix 7: Email Sent to Potential Employer Participants

Dear ,

Colleagues in the School of at The University of Adelaide have suggested that you would be a valuable person to interview for my PhD research into the professional socialisation and preparedness of postgraduate research students in Engineering. I am investigating the perceptions and experiences of students, employers, academics and recent research graduates about the value and relevance of Engineering research education. It is crucial that the views of employers of postgraduate engineers are included to guide the development of postgraduate Engineering programs. Your perspective will be of great value to the current study.

Key details of the interview process are outlined below.

- The interview will be conducted at your workplace or in another location of your choosing (Can I buy you lunch?).
- The interview will take approximately one hour, and it will be audiotaped.
- The interview will focus on the six key questions (see attached Information Sheet), but you are encouraged to speak freely about any area of the topic you believe is important.

More details about the study are included in the attached documents.

I appreciate that you are very busy and do hope that you will consider participating in this study.

Yours sincerely,

Karen

--

Karen Adams  
Coordinator, Research Communication Program  
Faculty of Engineering, Computer and Mathematical Sciences  
and  
Lecturer, School of Mechanical Engineering  
The University of Adelaide, South Australia  
Ph: +618-8303-7021 Fax: +618-8303-4367

CRICOS Provider Number 00123M

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## Appendix 8: Information to Employer Study Participants

### The professional socialisation of postgraduate research students in Engineering

#### Information for Participants

This interview forms part of a PhD study that is looking into the beliefs that Engineering postgraduate research students, Engineering academics, recently employed research degree holders, and employers of research postgraduates hold about the role of postgraduates in the Engineering profession. As an employer of research postgraduates in Engineering, what are your expectations for their professional role and how have their experiences of candidature prepared them for that role?

Discussion in the interview will focus on the following questions:

1. Why do you decide to employ a postgraduate engineer for some positions?  
(What sorts of positions require postgraduate education and training?)
2. What attributes do you believe postgraduate engineers should bring to a position?
3. What attributes do you believe postgraduate engineers bring to a position?
4. Are you ever surprised by what a postgraduate is or is not able to do?
5. If you had the opportunity to provide feedback to a university about their postgraduates' abilities, what would you say?
6. If you had the opportunity to provide feedback to postgraduate candidates about their value to employers, what would you say?

Participants are asked to speak freely about any aspects of their experiences that they believe are relevant to the discussion.

This interview could be of **60 minutes** duration. This is the maximum length of time; it might be shorter.

Please note the following about CONFIDENTIALITY in this study.

- This interview will be audiotaped and transcribed. The audiotape will be used for transcription purposes only. The transcription will be conducted by a professional, confidential transcription service. No one else will listen to the audiotape.
- All identifying information about participants, including individuals' place of employment, project topics, employees and sponsors, will be removed or altered to prevent identification of individuals or specific situations. No one except the researcher, Karen Adams, will see the unedited transcript.
- You do not need to identify yourself by name or organisation if you do not wish to do so. However, to take part in this study you **MUST** be an employer of a postgraduate Engineering research degree holder.
- The audiotape and original transcript will be kept in secured storage and seen only by the researcher, Karen Adams.
- No participant information presented at this interview will be used for any other purpose but the investigation described above.
- You may withdraw from this study **at any time**, including during the interview or after. If you choose to withdraw after commencement of the interview, your contribution will be removed from the data.
- A University of Adelaide Human Ethics Research Complaints form is included with this information sheet.

You are free to contact the researcher at any time if you have concerns or questions about this study.

Contact details: Karen Adams Phone 8303 7021

Email: karen.adams@adelaide.edu.au

# Appendix 9: Employer Study Consent Form

THE UNIVERSITY OF ADELAIDE HUMAN RESEARCH ETHICS COMMITTEE

## STANDARD CONSENT FORM FOR PEOPLE WHO ARE PARTICIPANTS IN A RESEARCH PROJECT

1.	I, .....	<i>(please print name)</i>
	consent to take part in the research project entitled: H-046-2006 The professional socialisation of postgraduate research students in Engineering	
2.	I acknowledge that I have read the attached Information Sheet entitled: The professional socialisation of postgraduate research students in Engineering: <b>Information for Participants</b>	
3.	I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.	
4.	I understand that the discussion will be audiotaped.	
5.	I have been informed that, while information gained during the study may be published, I will not be identified and every care will be taken to avoid mention of information that might identify me.	
6.	I understand that I am free to withdraw from the project at any time and that this will not affect my candidature, now or in the future.	
7.	I am aware that I should retain a copy of this Consent Form, when completed, and the attached Information Sheet.	
	.....	.....
	<i>(signature)</i>	<i>(date)</i>

<b>WITNESS</b>	
I have described to .....	<i>(name of subject)</i>
the nature of the research to be carried out. In my opinion she/he understood the explanation.	
Status in Project: Principal Researcher	
Name: Karen Adams	
.....	.....
<i>(signature)</i>	<i>(date)</i>

## **Appendix 10: Detailed Description of Emergence of Theory**

In the early stages of grounded theory analysis, many concepts and tentative categories are generated. In Phase 1, the work the employers expected was consistent with the advanced role expectation noted by employers of engineering graduates in general (EngineersAustralia, 2003). The employers described roles of team leader, people manager/persuader, client liaison, document writer/checker, desktop researcher and technical mentor. Desired engineering outcomes were either pre-existing products suitably adapted for specific workplace needs or novel and original products to meet clients' specific needs. At this stage it appeared that small, specialist companies sought both types of outcome and large companies sought adaptation of existing products only.

Phase 1 ended with the interview of Emp 7. The constant comparison of concepts and the review of transcripts in the light of new insights yielded five categories: 'Specifying EHDRG roles' related to the role and tasks expected of EHDRGs in the workplace; 'Admiring the EHDRG', 'Doubting the EHDRG' and 'Weeding out the inappropriate' suggested judgements made by the employers about HDR graduates. 'Reflecting on self' identified a process whereby the employers reflected upon their own experiences and compared these to their beliefs about current EHDRGs. Figure A groups concepts revealed in the initial coding of data from Employers 1–7 into these five early conceptual categories.

These categories were formed from concepts which can be described as attributable to the knowledge and skill level (knowledge-skill) achieved by EHDR graduates and to personal and social (personal-social) characteristics which the employers associated with EHDRGs. At the end of this phase, categories only reflected bundles of related concepts; a main concern had not yet become evident.

## A10.1 Phase 1 categories

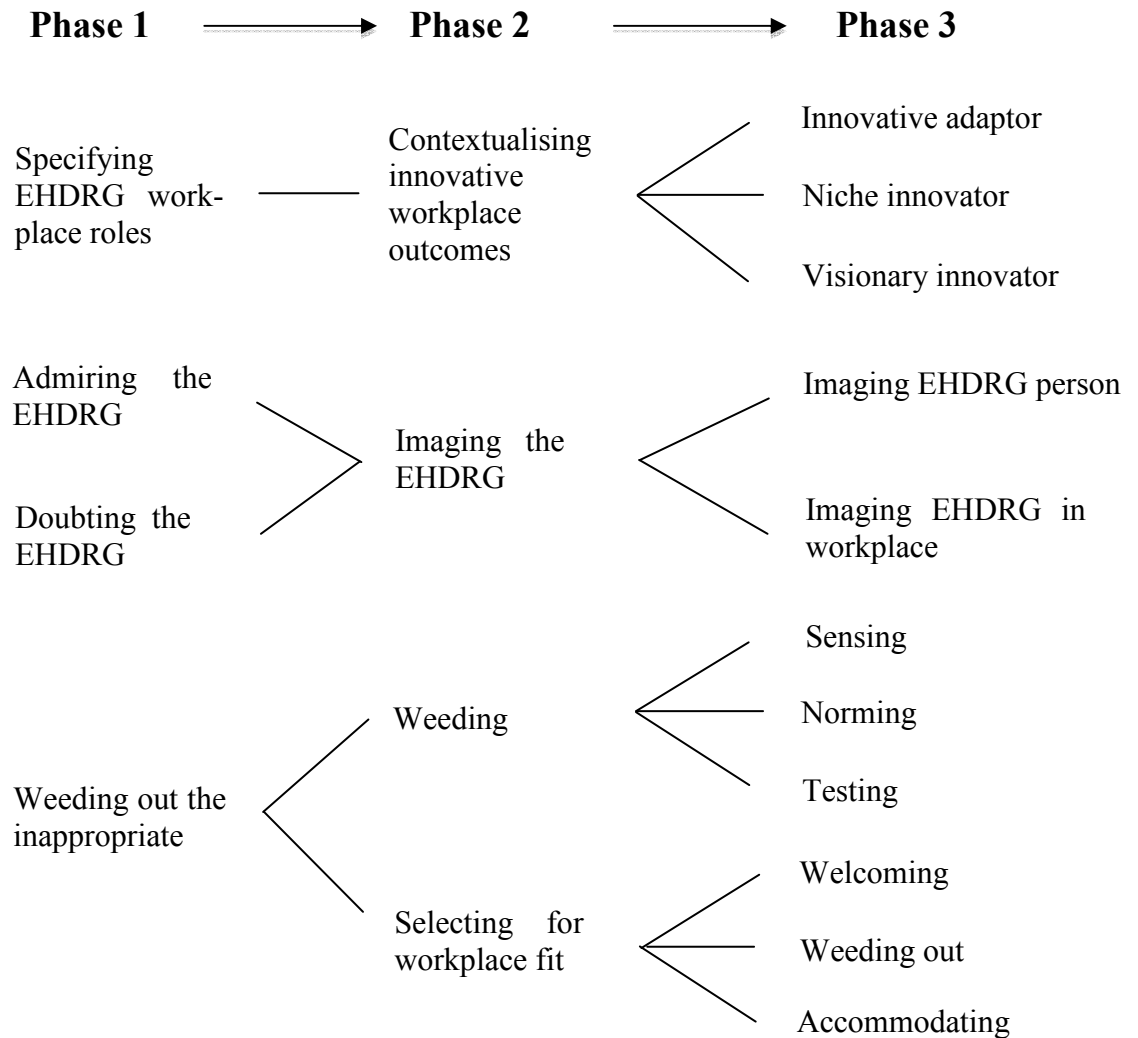
**Figure A: Phase 1 Categories.** concepts and categories from interviews with employers 1–7, identified with a predominantly knowledge-skill or personal-social focus, or both

<b><u>Specifying HDR graduate workplace roles</u></b>	<ul style="list-style-type: none"> <li>Team member</li> <li>Team leader</li> <li>People manager/ persuader</li> <li>Liaise with clients, sell products</li> <li>Document writer/checker</li> <li>Technical mentor</li> <li>'Intelligent client' to liaise with external providers</li> <li>Technical knowledge 'gap filler' for other workers</li> <li>Field scanner: Search for, identify and assess readymade products</li> <li>Adapt existing products to organisational needs</li> <li>Devise and develop new to world products</li> <li>Develop one-off products or problem solutions</li> </ul>	<ul style="list-style-type: none"> <li>Knowledge-Skill</li> <li>+</li> <li>Personal-Social</li> </ul>	<b><u>Doubting the EHDR graduate</u></b>	<ul style="list-style-type: none"> <li>Doubting EHDRG practical knowledge</li> <li>Doubting EHDRG social engagement</li> <li>Constraint on EHDRG drive</li> <li>Doubting EHDRG adaptability to product life cycle</li> <li>Doubting EHDRG concern for industry needs</li> </ul>	<ul style="list-style-type: none"> <li>Knowledge-Skill</li> <li>Personal-Social</li> </ul>
<b><u>Admiring the Eng HDR graduate</u></b>	<ul style="list-style-type: none"> <li>Valuing knowledge and intellect</li> <li>Valuing depth of knowledge</li> <li>Valuing theoretical knowledge</li> <li>Valuing ability to transfer knowledge</li> <li>Valuing commitment, focus and determination</li> </ul>	<ul style="list-style-type: none"> <li>Knowledge-Skill</li> <li>Personal-Social</li> </ul>	<b><u>Reflecting on self</u></b>	<ul style="list-style-type: none"> <li>Reflecting on personal experiences of study and work</li> <li>Reflecting on own success</li> </ul>	<ul style="list-style-type: none"> <li>Knowledge-Skill</li> <li>+</li> <li>Personal-Social</li> </ul>
			<b><u>Weeding out the inappropriate</u></b>	<ul style="list-style-type: none"> <li>Weeding out EHDRG industry irrelevance</li> <li>Weeding out an academic persuasion</li> <li>Weeding out 'a cloistered mentality'</li> <li>Weeding out ability to cope under pressure</li> <li>Weeding out 'esoteric' types</li> </ul>	<ul style="list-style-type: none"> <li>Knowledge-Skill</li> <li>Personal-Social</li> </ul>

Phase 2 clarified the employers' beliefs and actions and resulted in the emergence of more general, underlying themes. Contextualising innovative work outcomes expanded the notion of roles and tasks to focus on the desired outcomes of advanced engineering work in a workplace. Imaging the EHDRG combined the qualities the employers admired and those they considered problematic in EHDRGs to form images the employers entertained about EHDRGs. These images were used by the employers to anticipate likely outcomes in the workplace resulting from the presence of the imaged person; the imaging and anticipation are argued in this study to form implicit personal theories about EHDRGs. Weeding consisted of the use of strategies to detect the presence of desired and problematic characteristics. Selecting for workplace fit describes a range of decisions from a positive reception to outright rejection of an EHDRG, and included a grudging acceptance of a person who displays both desirable and problematic characteristics. Figure B lists Phase 1 categories and indicates how they were re-envisaged as Phase 2 categories, as well as the concepts within the Phase 2 categories. Phase 2 categories and concepts are elaborated in Chapters 7, 8 and 9 of the thesis.

#### **A10.1.1 Emergence of the notion of the 'creative thinker'**

Phase 2 presented the first suggestions that, for some employers at least, EHDR experience was linked to the idea of a creative engineer who is able and prepared to think differently about unusual, challenging problems. By the end of Phase 2, I had gathered and began to identify in some employers a strong thread of 'protectiveness', either focused on protecting the opportunity for engineers to spark unusual ideas or to protect against potential repercussions of EHDRGs in the workplace. I saw this as strong evidence of tolerance for different thinking and intolerance of difficult behaviour. Several employers had used the term 'creative' when they referred to an unconventional approach to engineering problem situations. I began to see a tension between admiration for different, or 'creative', approaches to engineering problems and concern about a different, or 'creative', engineer. I eventually abandoned the notion of protectiveness in order to focus on the factors in a decision process, because refocusing showed greater promise of a simpler, more refined theory.



**Figure B: Phase 1 to Phase 2 categories. Phase 1 categories re-formed after interviews 8–15 to create Phase 2 categories, shown here with their concepts.**

The following series of memos, written toward the end of Phase 2, reveals my reflections on the way employers displayed the tension, and my increasing awareness of the personal nature of the employers' views about EHDRGs:

Memo 19 February, 2008:

Encourager or protector of innovation and creativity? Is it the employer's character, or the company's that demands the type of innovation? Question: Is it (tolerance for creativity) the product of the organisation or is it the personal characteristic of some employers? For example, is it a result of the employer's personal story? In an article

called 'My Useless Holden Days' (The Australian, 7 Jan 2008), David Williamson refers to his lack of success as an engineer and made the point that 'To not be good at anything wasn't necessarily a drawback in corporate life if you could lead those who were.' This seems to fit with EmpP 1's comments about getting a thrill out of somebody else doing something really creative and clever, as well as enthusiasm expressed by Emp 9C and Emp 15D. Also, employers who seek visionaries encourage or at least tolerate and support, risk-taking and exploration of new ideas by their engineers. Those who seek niche innovators might be seen as a subgroup of visionary employers in that they support creative ideas but tend to tie this creativity directly to income generation (shorter, more pressured time frames). Some of these guys want to protect creativity or the creator – even Emp 4 could be seen as someone who thought these people might not 'cope' – they're weak/vulnerable and need protection from that workplace?

Memo

6 August, 2008:

Revisiting transcripts for idea of 'protection', having already coded for 'creativity' (which means anything from artistic, open-minded or 'different'). The concept of protection AGAINST the EHDRG occurred to me with the second and then strongly with the fourth and seventh interviews. But I say this as a concept put forth by employers seeking to protect their workplaces from isolationist, uncommunicative, difficult HDR graduates. I also sensed in a few interviews that some employers were protecting their egos (Emp 6B and 7 – both claimed they could be PhDs if they had wanted to...why say it?)! I think employers' views of the value of HDR graduates in the workplace are motivated by a desire to protect an element of the workplace, including themselves.

Memo 8 August, 2008:

What I have not been doing here is recognising what the employers were doing when they judged skills and characteristics. Sure they were judging. They were, more or less, accommodating the skill sets and various attributes. But, IN SO DOING, they were displaying their reasons for doing so. I think these reasons were motivated by a desire to protect something perceived as valuable: own position and future, existing workplace climate, creative thinking and drive in workplace, the current PhD

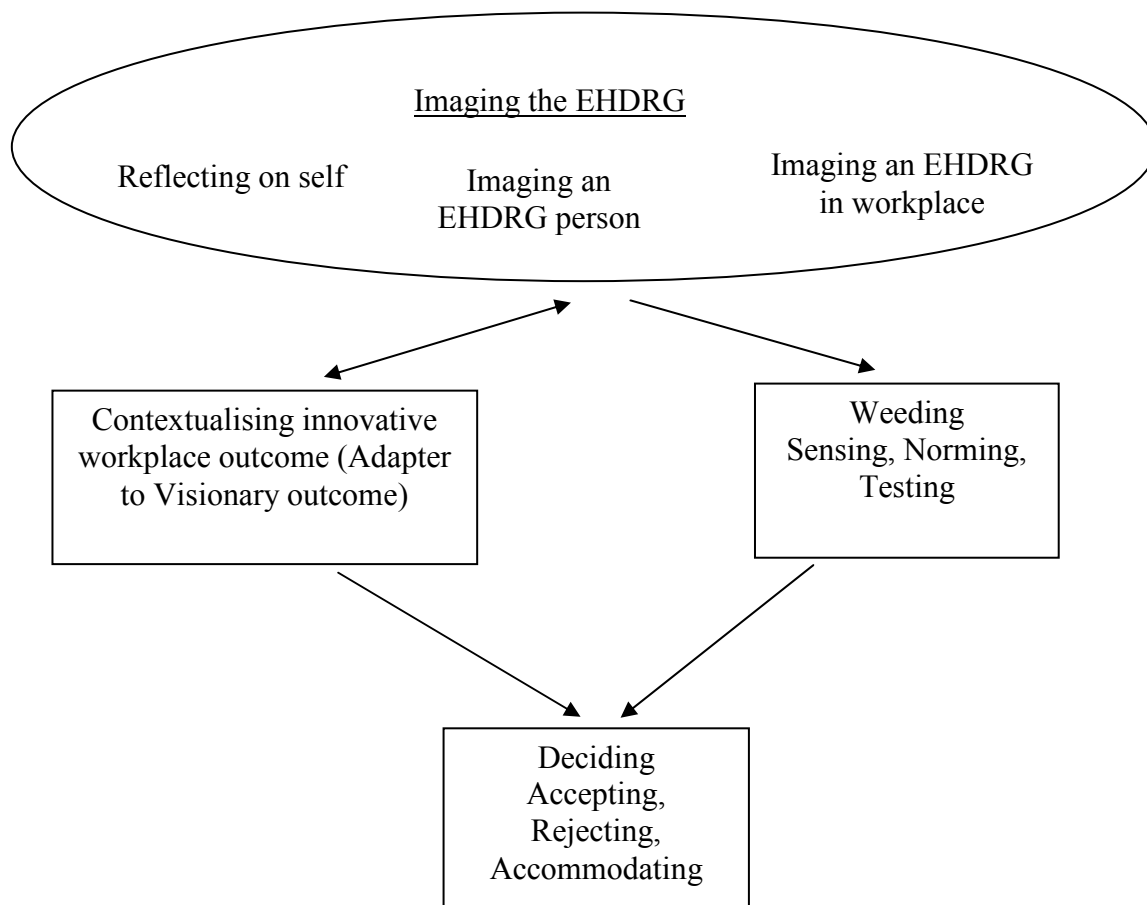


process, business viability. It is PERSONAL motivation by a sympathy or protectiveness that drives their process of decision making and judgement.

This strengthening of the notion of the personal motivations and beliefs behind employers' views and my focus on comments about creativity, especially following Phase 2, resulted in my 'informed hunch' about the employers' personal ideas concerning the nature and value of creativity as a personal characteristic and thinking style. The employers' attitudes to problem-solving approaches and personal characteristics are elaborated in Chapters 7 and 8.

At this stage of my research, the term 'creativity' was taken to mean what the employers referred to. To avoid imposing a pre-determined theoretical structure of creativity on the emerging data, I retained a definition of creativity formed exclusively from the descriptions and explanations given by the employers.

At the transition into Phase 3, I began to see the central position of an employer's construction of an image of an EHDRG from the employer's personal life reflections, views of the academic world and understandings of people who are enticed by engineering problems that are intellectually deeply challenging. The image of an EHDRG constructed by the employers contained views about the personality of EHDRGs and the problem-solving approaches of EHDRGs. Figure C illustrates the central role of the act of Imaging an EHDRG in influencing a) the perceptions of suitable work that an EHDRG might perform in the context of the employer's workplace and b) the use of strategies in the 'weeding' process. Imaging led the employer to weeding for the workplace context and ultimately to deciding on the value of the EHDRG.



**Figure C: Imaging EHDRGs. Hypothesised central position of the employers’ imaging of EHDRGs as a reciprocal influence on perception of achievable EHDRG innovative outcomes, and through the weeding process, on the ultimate decision about the suitability of an individual EHDRG**

Phase 3 led to saturation, following some additional clarification and refinement of the emergent categories and their relationships to each other. The stages, categories and concepts of the final theory, as illustrated in Chapter 6, explain the theory as a process leading to ‘reconciliation’ on the part of the employer. This term better reflects the action of ‘deciding’ identified in Figure B. The employer’s decision was the result of a judgement the resulted from ‘balancing’ identified desirable and problematic characteristics discovered in a particular EHDRG. The judgement then led to the decision to welcome, reject, or accommodate the cluster of confirmed characteristics identified in the EHDRG.

## Appendix 11: Definitions of Knowledge and Skill

**Specialised knowledge:** This is knowledge of, or closely related to, the EDHRG's thesis topic. It is sometimes viewed by employers as restricted or limited in scope. Specialised knowledge incorporates general engineering knowledge. It is always deep\*.

**General engineering knowledge:** This is also known as 'domain', 'conventional' or 'received' knowledge. It includes fundamental principles of engineering practice, theorems, equations and formulae, and standards. It is always broad\*\* and may be deep\*.

**General knowledge:** Knowledge exists of many areas of professional and human interest, including life experience. This is always broad\*\*.

\***Deep** means at a fundamental level or at a complex level.

\*\***Broad** means extensive, linked to many other relevant knowledge areas.

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**Specialised skills:** These are also known as technical knowledge or skills and include in-depth ability to engage skills related to practice in an area of engineering specialisation, in this case related specifically to the graduate's thesis topic. These skills are always expert^.

**General Engineering skills:** These include the ability to use standard engineering materials, software and procedures. These are always at least non-expert^^ and may be expert^.

**General skills (including general research skills):** These are skills, peripheral to general and specialised knowledge-based activities, that are related to professional or research practice. They include teamwork, project management, budgeting, mentoring and presentation skills. They can also include skills of a commercial or craft-based nature. They are always at least non-expert^^, and may be expert^.

**^Expert:** The ability to apply skill accurately and correctly in a wide range of appropriate circumstances.

**^^Non-expert:** The acquaintance with skill allows basic application to situations.

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