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Knowledge, Higher Education and Human Capital: A Case Study of Professional Master's Programmes in China

By

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Abstract

A growing number of master's programmes have become more professional, but less academic and research-orientated, to meet labour market needs. For example, new professional master's programmes were introduced in China 2009. They have grown rapidly and now account for almost half the number of full-time master's entrants. However, why are professional master's programmes expected to meet labour market needs better? In the related literature, the connection between higher education and the labour market has usually been explained by human capital, and economic evidence has supported this connection. However, few studies have considered why human capital can explain the relationship between higher education and the labour market.

This research looks at this *why* question from the perspective of knowledge. Based on existing theories, this research hypothesises that knowledge can link higher education to human capital. It establishes a conceptual framework which links knowledge, higher education, the labour market, and human capital. Based on the *why* question and framework, there are three specific sub-issues: what knowledge did students learn, how students learned it, and the role of knowledge in the labour market.

This thesis uses a case study to address these issues. It examines China's new professional master's programmes against the background of economic restructuring in China. During the fieldwork at a university in China, twenty-six semi-structured interviews with students and academic staff were conducted.

Government policy documents, ten course programmes, and 380 job advertisements were collected. The findings are set out briefly below.

First, students learned six categories of knowledge in the professional master's programmes. The six categories of knowledge were analysed as type I (propositional or conceptual codified knowledge), type II (process or procedural tacit knowledge), and type III (personal or dispositional tacit knowledge). Secondly, students learned the six categories of knowledge through four types of professional practicum, and they learned different categories of knowledge through different types of practicum. Thirdly, the role of knowledge in industry and the labour market in China was interpreted from different perspectives: government policy, course design, labour market needs, academic staff and students.

The findings of knowledge types and their roles explained what constitute the human capital of R&D engineering professionals, and identified two kinds of human capital: research human capital and engineering application human capital. The findings develop the definition and classification of human capital. The findings concerning the practicum explained that different types of programmes can transmit different kinds of knowledge, thus making a contribution to understanding human capital formation.

The overall findings illustrate that knowledge is the reason why human capital can explain the relationship between higher education and the labour market, and why professional master's programmes can better meet labour market needs. The knowledge learned in professional master's programmes consists of types I, II and III knowledge. Type I knowledge can form research human capital, and can be learned in academic master's programmes. Types II and III knowledge can form engineering application human capital. They are practical and tacit, and need to be accumulated through practice. In China's economic restructuring, the engineering industry labour market wants the engineering application human capital, i.e. types II and III knowledge. The new professional master's programmes, designed with a professional practicum, were introduced to meet this need. Through multiple industry-based practices, students learned types II and III knowledge and can thus possess the engineering application human capital. Therefore, they can meet labour market needs better than students from research master's programmes, which have no practicum.

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Preface

My previous education background and academic experiences led me to the point where I needed to conduct this study. First, I have a strong interest in higher education, particularly postgraduate education. Before this PhD course, I engaged in some research projects focusing on postgraduate education reform in China. This research experience laid the academic foundations for this research. Secondly, I have completed all the levels of education in China, from pre-school to postgraduate education, which has provided me with an indigenous and comprehensive understanding of China's education system. Thirdly, I possess a bachelor's degree in engineering, so I have a special interest in engineering higher education. This background also enabled me to have an insider view of engineering education issues, knowing the real, practical problems. Finally, I have a personal network associated with China's universities, which enable the fieldwork for this research to progress smoothly.

This thesis targets the readers who have an interest in higher education, in particular, professional master's education, who are interested in the relationship between higher education and economic development (human capital), who study the knowledge in professional education, and/or who want to know higher education development in China.

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Abbreviations

CEO	Chief Executive Officer
EV	Electronic Vehicle
GDP	Gross Domestic Product
HEIs	Higher Education Institutions
HR	Human Resources
MBA	Master of Business Administration
R&D	Research and Development
STEM	Science, Technology, Engineering, and Mathematics
URL	Uniform Resource Locator
VET	Vocational Education/Training
WTO	World Trade Organization

Chapter One: Introduction

Introduction

The main purpose of this introductory chapter is to explain how the research focus was developed from the existing theories, findings, and practices, and why it is worthy of study. The first section introduces the theoretical context to identify the broad research gap and research focus. The second section profiles China's new professional master's programmes to clarify the background further. The third section outlines the research question and its subsidiaries. The fourth section discusses why the study is significant. The final section outlines the structure of thesis.

Research Context

Increasing numbers of master's programmes have been developed that are less academic and research-orientated but more professional, practical or applied (see in Glazer-Raymo, 2005, pp.5-22). For example, in 2009, a new type of professional master's programme was introduced in China (the programmes will be profiled in the next section: China's New Professional Master's Programmes). The new professional master's programmes have grown rapidly, but meanwhile the research programmes have been downsized. Now the new professional programmes account for almost half the full-time master's entrants. According to Glazer-Raymo (2005, pp.99-108), labour market demand is one of the impetuses for professionalising master's programmes. The question then is, why are professional programmes presumed to meet labour market demands better than academic programmes?

So far, there have been few studies addressing this problem directly. There are related studies focusing on the relationship between higher education and the labour market, and they usually explain the connection based on human capital theory. However, few studies have considered why human capital can be the connection. Theoretically, there is a broad research gap as to why human capital can explain the relationship between higher education and the labour market.

According to related findings, higher education plays an important role in both aggregate economic growth and individual benefits (for example, Wolf, 2002; Bloom et al., 2006; King and Palmer, 2006; McMahon, 2009, pp.69-117; Deiaco et al., 2012; Morgan and White, 2015). The related findings usually involve four key concepts: knowledge[1], higher education, the labour market, and human capital. The following bullet points give some examples (key concepts are highlighted in bold).

- The **knowledge** (including skills, abilities, and competencies) embodied in individuals that are related to economic activity forms **human capital** (OECD, 1998, p.9).
- The stock of **human capital** is significant for **economic growth**

1 Knowledge here is used in its broad sense, including skills, abilities, competencies, which will be explained in detail in Chapter Two.

(Schultz, 1961; Lucas, 1988; Romer, 1990; Lucas Jr, 1993; Becker, 2009, pp.23-24).

- **Knowledge**, as embodied in human beings in the form of **human capital**, has a close link to **economic development** (OECD, 1996, p.9).
- **Higher education**, where **knowledge** is transmitted, equips the labour force with higher **knowledge** and skills (OECD, 1996, p.23).
- In the knowledge economy, **the labour market** prefers workers with higher levels of **knowledge** and skills (OECD, 1996, p.16).
- **Human capital** is accumulated through formal schooling (Becker, 2009, pp.17-21) including higher education; investment in **higher education** can increase the stock of **human capital** (Paulsen, 2001, pp.55-94).
- **Higher education** is said to develop students to become highly sought after in the **labour market** (Helyer and Lee, 2014).
- **Higher levels of education** are accompanied by higher wages, lower unemployment probabilities, and higher labour force participation rates in the **labour market** (De la Fuente and Ciccone, 2002, p.9).

As shown in the bullet points above, knowledge, higher education, the labour market, and human capital are key concepts that often appear in the existing findings and evidence. These four concepts can constitute a broad theoretical framework, as Figure 1-1 shows. The existing studies have identified the relationship between each pair of concepts among the four, like knowledge and human capital, higher education and human capital, higher education and the labour market, or human capital and the labour market. However, some of the relationships tend to be considered from a unilateral perspective, for example, only from the perspective of the knowledge economy or the labour market, rather than from the viewpoint of higher education and/or knowledge as well. Some of the relationships see higher education as an entirety engaging in economic activities, but ignore the inner mechanisms of higher education, for example, the content of knowledge and knowledge accumulation in education programmes.

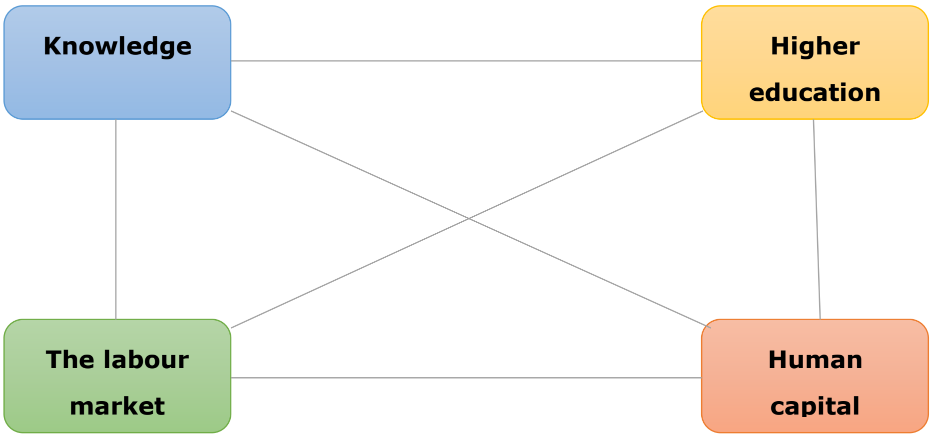


Figure 1-1 Four concepts in the relationship between higher education and the economy

Nevertheless, based on the framework above (Figure 1-1), each concept has a link with each of the other three, so it can be inferred there is an overall connection linking the four concepts together. Based on a broader and more in-depth literature review (the related parts are set out in Chapter Two: Literature Review), this research hypothesises an integrated relationship: underlying human capital (that explain the relationship between higher education and the labour market on the surface), knowledge can link higher education and the labour market.

In particular, with regard to professional master's education, the hypothesised integrated relationship is further highlighted. Professional education has an even closer link to the labour market than conventional higher education. Jarvis (1983, p.52) points out that students should gain sufficient knowledge and skills in professional education to be competent to begin professional practice. This implies that the knowledge and skills acquired in professional education are vitally important to the labour market. The question, why professional master's programmes (rather than academic programmes) are expected to match the labour market better, remains unclear. This leads back to the initial problem: why human capital can explain the relationship between higher education and the labour market. Professionalising master's programmes lack a theoretical underpinning. An overall link between human capital, knowledge, higher education, and the labour market, especially from the inner perspective of higher education, could help to address the problem.

In sum, this research aims to close the broad theoretical gap surrounding human capital, that is, why human capital can explain the relationship between higher education and the labour market, at least, to some extent. Based on the existing theories, it hypothesises an overall link between human capital, knowledge, higher education, and the labour market. It aims to explore the overall link and address the problem. This thesis takes the new professional master's programmes in China as an example to study this issue. The following section profiles China's new professional master's programme reform.

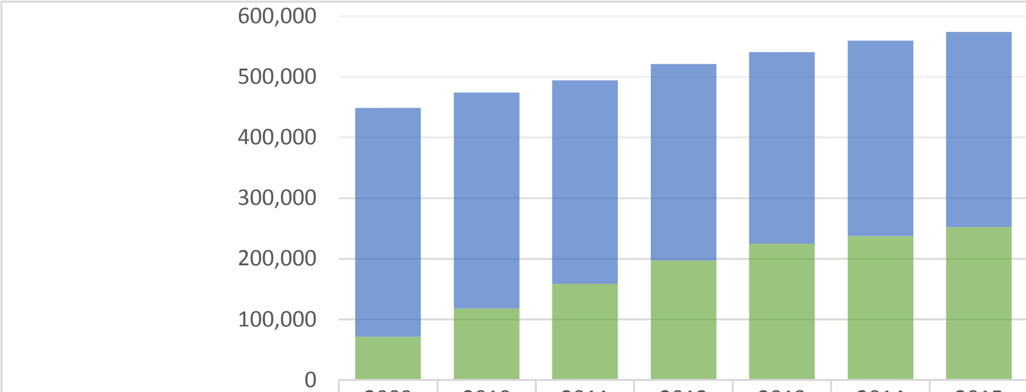
China's New Professional Master's Programmes

Since 2003, postgraduate education has gradually expanded to fulfil the demands of economic and social development in China. Up to 2007, there were more than 1,100,000 postgraduate students in China, indicating that China had the second highest number of postgraduate students in the world (陈霄飞 Chen and 林颖颖 Lin, 2007). Meanwhile, to meet the demands of the economy and society further, the postgraduate education sector established another goal: switching from large postgraduate education towards good quality and strengthened postgraduate education (Chinese: 研究生教育大国向研究生教育强国转变 *yan jiu sheng jiao yu da guo xiang yan jiu sheng jiao yu qiang guo zhuan bian*) in 2007 (陈至立 Chen, 2007). One of the missions is to enhance postgraduate students' skills and abilities to meet the needs of economic and social transition. Aiming at this goal, a range of reforms to postgraduate education have been carried out over the last decade. The introduction of full-time professional master's programmes is the most significant one of them.

A brand-new master's qualification, entitled Full-time Professional Master's Programmes (Chinese: 全日制硕士专业学位 *quan ri zhi shuo shi zhuan ye xue wei*), was launched in 2009 in China. In the past, academic master's programmes dominated master's education, supplemented by a few part-time professional master's programmes, such as the MBA. As Glazer-Raymo (2005, p.27) points out, academic and professional master's programmes are at two ends of a continuum that represents the growing diversity of contemporary master's degree programmes; there are other forms of programme with varying degrees of academic or professional characteristics staying between the two ends. In China, academic master's programmes and traditional professional programmes (like the MBA) represent the 'two ends', with the new professional master's programmes 'in-between' them.

The new professional master's programmes are different from the previous professional master's programmes (e.g. the MBA). The old one only offers day release or block release courses for employed individuals, but the new one has full-time courses and admits fresh graduates with no previous employment experience. The new professional master's programmes resemble the conventional academic programmes, in terms of admission, registration, duration, much of the curriculum, and final assessment methods. However, the new professional programmes aim to develop students' applied knowledge, technological skills, problem-solving ability, and project skills, rather than theoretical research ability, which is the key difference from the academic programmes.

Since 2009, the new professional master's programmes have expanded dramatically. There were only 19 academic disciplines authorised to award a professional master's degree before 2009, but by 2011 the number had increased to 39 academic disciplines (国务院学位委员会 Academic Degree Commission of the State Council, 2011). Furthermore, entrants of new professional master's programme have been increasing, while entrants of academic master's programmes have correspondingly decreased, as shown in Figure 1-2.



	2009	2010	2011	2012	2013	2014	2015
the entrants of academic master's programmes	377,654	356,622	336,110	324,152	316,060	322,763	322,028
the entrants of professional master's programmes	71,388	117,793	158,499	197,151	224,859	237,237	252,272

Source: data from the Statistics of the Ministry of Education [online]

Available at: http://www.moe.gov.cn/s78/A03/moe_560/s8492 (Accessed: 22 July 2015)

Figure 1-2 The entrants of academic and professional master's programmes

Currently, the curriculum of new professional master's programmes is similar to that of academic programmes. The key difference is that professional master's programmes have a professional practicum (Chinese: 专业实习 *zhuan ye shi xi*). The translation here is *professional practicum* rather than other terms for the following reasons. A practicum is a part of the curriculum in formal education. It refers to study in a specialised field which is designed to give students supervised practical application of the previously studied theories. The practicum resembles an *internship*, but the latter is not a necessary part of the curriculum. The term *placement* refers to 'the temporary posting of someone in a workplace to enable them to gain work experience'[2] in the British context.

2 Oxford Dictionaries. Available at: http://www.oxforddictionaries.com/definition/english/placement (Accessed: 31March 2015).

Nevertheless, while placement is a type of professional practicum, it is not the only one (see the findings in The Design and Implementation of the Professional Practicum, Chapter Four, p.177). Therefore, the *professional practicum* can more appropriately convey the Chinese meaning of 专业实习 (*zhuan ye shi xi*).

To sum up, the new professional master's programmes in China is an example of the professionalisation of master's programme worldwide. China's postgraduate education sector introduced it to meet labour market demands and to match the economic development of recent years. The new professional programmes have expanded to almost the same magnitude as academic programmes. In curriculum terms, the professional programmes are still similar to academic programmes, except for the addition of a professional practicum.

Research Question

This study aims to explore why human capital can explain the relationship between higher education and the labour market. It examines new professional master's programmes in China. Based on the literature review of professional education (details in Knowledge in Professional Education, Chapter Two, p.34), the knowledge acquired from professional education is a possibly appropriate viewpoint to consider the *why* inquiry. This thesis hypothesises that knowledge can link human capital and the labour market. Based on the existing theories and the hypothesis, this study aims to find an integrative relationship between knowledge, higher education, the labour market, and human capital.

Based on the literature review (details in Research Gaps and Research Questions, Chapter Two, p.80), some surrounding narrow research gaps have been identified, such as the knowledge learned in China's professional master's programmes, how the knowledge is acquired, and the role of knowledge in the labour market. These issues constitute the research question framework of this study, as shown in Figure 1-3.

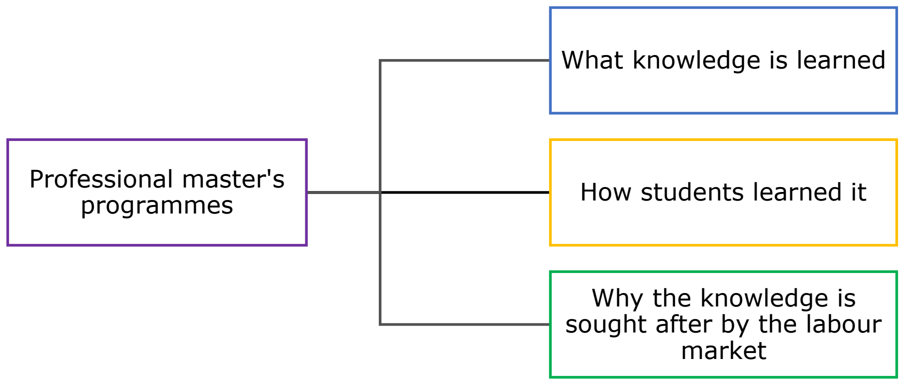


Figure 1-3 The research question framework

The main research question is

Why are the new professional master's programmes, specially designed with a professional practicum, expected to meet labour market demands in China?

The research question is narrowed down to three sub-questions.

i. *What knowledge is learned in the professional practicum of the* *professional master's programmes?*

This sub-question aims to explore and categorise the knowledge acquired by students in the professional practicum.

ii. *How did the students learn the knowledge in the programmes?*

This sub-question considers how the professional practicum is designed in course programmes and how the students completed it in practice. The findings of this sub-question will be further analysed. They will be compared with the findings of the first research sub-question to show the relationship between the different types of professional practicum and the different categories of knowledge acquired.

iii. *Why is the acquired knowledge sought after by the labour market?*

The role of acquired knowledge in the labour market will be interpreted from five perspectives: government policy, the labour market, course design, academic staff, and students.

The paragraphs above briefly set out the research question framework. The objective of each research sub-question will be specified in more detail in Chapter Two (Research Gaps and Research Questions, p.80). This research considers the professional master's programmes in some engineering disciplines, for the following three reasons. First, this research is interpretative. The particular categories of knowledge will be connected to specific labour market demands. Therefore, it cannot consider professional master’s programmes in randomly selected disciplines or in a general way. It has to select specific disciplines and their corresponding industries and labour markets. Secondly, as will be established in the literature review (Research Gaps and Research Questions, Chapter Two, p.80), few studies have focused on professional engineering master’s education in particular, which is a research gap and needs studying. Thirdly, the background to the introduction of professional master’s programmes is China’s economic restructuring, and Engineering Industry Upgrading (Chinese: 产业结构升级 *chan ye jie gou sheng ji*) is a key part in the economic restructuring (姜作培 Jiang, 2009). Therefore, professional engineering master’s education is the preferred angle from which to consider the issue. Nevertheless, more disciplines and professions/industries can be considered in future to paint a broader picture. This issue will be discussed in the concluding chapter.

Research Significance

This section explains that why this research is a worthwhile and interesting study, from the viewpoint of both its theoretical importance and practical implications.

First, this research can contribute to the existing theories. Theoretically, human capital has been established as the connection between education and the labour market, but has not been explained why or how this connection operates. This thesis aims to close this theoretical gap from the viewpoint of knowledge.

It may thus deepen the understanding of human capital and other related theories. The research also could enrich theories about knowledge and courses in professional education.

Secondly, this study has practical and policy implications. It aims to address why the professionalised master's programmes can match labour market needs better. As established, a growing number of master's programmes have been reformed to become professional worldwide. The emerging practices need theoretical underpinning to account for this trend. This research can offer an interpretation and be a useful support for other similar higher education reforms. Specifically, this study examines China's practice, which has been rarely studied previously by either Western or Chinese scholars. Consequently, it could have special practical implications for China's higher education sector.

Additionally, this research does not focus on master's education in isolation, but also considers its background context, i.e. economic restructuring in China. Therefore, it can help to understand the policies, the practices and the development of master's education in China. In recent decades, China's spectacular progress has attracted much attention in the world (Song et al., 2011). The new professional master's programmes aim to serve China's innovation-driven growth paradigm today. This study will show the efforts and experience of China's development. The initiatives and experience of this reform may have practical implications for countries with a similar development agenda.

Thesis Structure

The next chapter reviews the related literature to establish the theoretical framework, to identify specific research gaps, and to narrow down the research focus. Professional education in the West and China are examined at the outset to indicate the broad research direction. Then it reviews the literature on knowledge in professional education, how learning takes place in professional education, and human capital theory. The theoretical gaps and methodological gaps in each field are identified. Finally, the research questions are discussed.

Chapter three sets out the methodology and research methods. It establishes the methodology as qualitative research and designs the research as a case study. The face-to-face and email-based interviews and the documents are designed to generate the data. It describes the fieldwork and data and also outlines how the data were processed.

Chapters four and five are data chapters. Chapter four presents the context of the data, illustrates the findings for each research sub-question, and also discusses further findings from the data beyond the research questions. Chapter five analyses the data, linking the findings to the existing theories and developing the existing theories.

The final chapter concludes the entire research. It summarises the findings, discusses the research contributions, implications and limitations, and also points forward to what might happen in the future.

Summary

This introductory chapter offered the theoretical context and profiled the professional master's programmes. It indicated a broad research gap and set out the research questions. It also explained why this study is significant. Finally, it outlined each chapter in the thesis. The next chapter reviews the related literature to narrow down the research gaps and clarify the research questions.

Chapter Two: Literature Review

Introduction

This chapter reviews the related literature for two purposes. First, it looks at what have been done so far in the existing literature to establish theoretical frameworks for related research issues. Secondly, it looks at what have not been done so far in the existing literature to identify specific research gaps and narrow down the research focus of this thesis.

The research focus is cross-disciplinary. The social phenomenon (professionalised master's programmes) falls into professional education; the research inquiry (why human capital can explain the relationship between higher education and the labour market) originates from the economics of education; the formation of human capital involves consideration of the knowledge and learning methods that have been studied in the existing professional education literature. The literature from different research fields was reviewed in an intertwined manner. However, for clarity, the literature review is not presented in an interdisciplinary way (as I studied it), but is divided into four topics involved: professional education, knowledge, practical learning, and human capital.

This chapter starts with a review of professional education in both the West and China. The second section reviews knowledge generally and then knowledge of professional education specifically. The third section considers the course design and the practicum of professional education. The fourth section examines human capital theory and its connection with the issues reviewed. Based on the concerns that emerged from the literature review, the final section discusses the research gaps and research questions.

Professional Education

This section introduces professional education for two purposes: to offer the context of the key topics of this research; to identify some possible research gaps for the following discussions of the literature. First, it outlines some characteristics and principles of professional education in the West. Secondly, it looks at China's professional education in general. Thirdly, it reviews the Chinese literature about the new professional master's programmes. Finally, some broad research gaps are discussed.

An Overview of Professional Education

Professional education aims to train new recruits to become the competent practitioners of a profession (Jarvis, 1983, p.31). There are two types: initial professional education or pre-service professional education, and continuing professional development (for example, see Taylor, 1997, p.9; Bines, 1992, p.22). As a branch of tertiary education, professional education has a close link with conventional higher education. It depends on the higher education system for its delivery and takes academic disciplines as its basis. As Hughes (2000) points out, professional education perceives the disciplines within higher education as part of the wider professional communities that they serve and prepare students to be members of the professional community.

In addition to the connections with higher education above, Taylor (1997, pp.3-4) points out that professional education has three main differences from conventional higher education. First, it has a close connection with the professions traditionally and an even closer link with employers and the government today. In practice, in addition to the professions, employers, and the government, professional education has an array of stakeholders, which will be discussed in 'The Stakeholders in Professional Education' (Chapter Two, p.19).

Secondly, practice is a feature of professional education. Professional education prepares students for qualified practice (Taylor, 1997, p.4). Its curriculum addresses knowledge for and about practice (Taylor, 1997, p.4) and introduces students to the skill base, the knowledge base, and the professional approach necessary for a career in industry (Simpson and Jackson, 2000). The course is also delivered in the context of professional practice rather than in the university *per se* (Taylor, 1997, p.4). The course delivery and the practice issues will be considered in 'Course Issues in Professional Education' (Chapter Two, p.50).

Thirdly, compared with the young undergraduates straight from school, the students in professional education are often mature and have specific motivations for studying (Taylor, 1997, p.4). However, while motivation for studying is an important topic, it is not the focus of this thesis.

In addition to the three differences referred to by Taylor, a number of scholars suggest that professional education also has a special knowledge base that is different from conventional higher education, which will be discussed in 'Knowledge in Professional Education' (Chapter Two, p.34).

The Stakeholders in Professional Education

Professional education has a variety of stakeholders, which has been discussed in some monographs. Taylor (1997, p.11) suggests that professional education has been traditionally more interactive with and more responsive to the macro context than conventional higher education. Compared with conventional higher education, professional education has a dynamic connection with professions, employers and government, and these forces shape its course structure, content and delivery (Taylor, 1997, pp.3-4). In recent years, these contextual forces have become particularly important for the shape and direction of professional education (Taylor, 1997, pp.11-12). Therefore, the stakeholders involved in specific contexts offer a possible research perspective. This sub-sub-section reviews the stakeholders in professional education in particular.

Watson (1992) identifies a triangular relationship between stakeholders in professional education: sponsors, providers and clients, as below.

- The sponsors range from the government, which funds and supports higher education in general, to the direct sponsorship of individual students (Watson, 1992). According to Watson (1992), this group of stakeholders is concerned about whether the educational system as a whole can meet society's needs of highly qualified people.

- The providers, i.e. HEIs (higher education institutions), have to balance professional demands against conventional university missions, such as personal enrichment or research, rather than employment preparation (Watson, 1992).

- The clients, that is the students, do not always have the same interests as the sponsors or providers. They are not only concerned with professional qualifications or professional development but also are 'acutely aware of their problems and prospects in the employment market', which involve not just economic or social rewards but also issues like career flexibility or intellectual or emotional satisfaction (Watson, 1992).

Taylor (1997, pp.14-18) argues that Watson's triangular model is simplistic and there may be sub-groups who do not share the same interests as the other members within each interested party.

- On the sponsor side, besides the government, which provides financial support and makes legislation and policy (also identified by Watson), there are also the professions that establish entry requirements and codes of practice, and employers who seek suitably qualified entrants and wield increasing influence. They can have a variety of different values for professional education. Although Watson does not directly mention the *professions* in any group of stakeholders, he points out that there are the divergences between professions and education in terms of entry requirements, cohort progression/identity, inculcating culture, exit standards, and labour supply (Watson, 1992, p.4).

- For the provider group, the conflict between general higher education and professional education has often been noted. Taylor sees them as two sub-groups of providers. The divergences between them include status, knowledge base, educators' values, the disciplines they are based on, and so forth (Taylor, 1997, pp.14-18). Watson (1992) points out that educationists and professionals hold different values in their course aims. General education aims tend to be larger or vaguer than professional requirements, and graduates may lack work practice experience (Watson, 1992).

- For the last side of the triangle, Taylor (1997, pp.14-18) uses *learners* to replace *students*, to cover more participants in professional education. Moreover, Taylor (1997, pp.14-18) argues that the recipients of professional services must be also included in the client group, because they not only play a role in supervised field practice but also in the design and delivery of courses.

Based on the reviews above, professional education has diverse stakeholders:

the government, professions, the labour market, conventional higher education value holders, professional education value holders, different kinds of students, as well as other participants. Moreover, today, both the macro context and professional education have evolved to become more varied and complex. As Taylor (1997, p.4) suggests, the range of stakeholders in professional education is expanding. Stakeholders today are even more diverse than either Watson's triangular model or Taylor's sub-group model. Additionally, stakeholders and how they relate to each other may vary depending on the context, for example, in different countries, different economies, or different higher education systems. Consequently, it is relatively difficult to make a general model of stakeholders today. However, there have been few studies considering the stakeholders of professional education within its specific context. Therefore, examining professional education from the perspectives of different stakeholders within a specific context is a possible research gap.

Besides the gap concerning the stakeholders, there are other gaps in the studies of professional education generally. For example, few studies focus on master's education, though there is a lot of evidence at undergraduate level. As mentioned in Chapter One: Introduction, increasingly more master's programmes have become more professionalized, so professional master's education is worthy of research. Furthermore, theories about professional education have been mainly developed in the West, but few have been applied to China's practice or linked to China's theories or practice. Therefore, it is a research gap that applying the existing theories of professional education to China's education practices.

Professional Education in China

The purpose of this sub-section is to offer an overview of China's professional education and to identify what have been done and what have not been done by Chinese scholars. This sub-section reviews the related journal articles and monograph books concerning professional master's education in China. The journal articles were searched in China Academic Journals[3] database. I selected and reviewed the articles which are published in key journals and cited frequently. Their research focuses, methods, and findings are summarised below.

First, some articles explain the meaning of professional education. *Professional education* in Chinese is 专业教育 (*zhuan ye jiao yu*). However, the Chinese words 专业 (*zhuan ye*) has more meanings than profession or professional; it also refers to the speciality, discipline or subject. Consequently, sometimes 专业教育 (*zhuan ye jiao yu*) in Chinese means specialised academic education, the counterpart to liberal education or general education (for example, see Chen, 2006). The Chinese term,专业 (*zhuan ye*), has different meanings, therefore many related research findings clarify that in a defined context 专业教育 (*zhuan ye jiao yu*) [professional education] refers to professional or vocational

3 China Academic Journals (CAJ), published by China Academic Journal Electronic Publishing House established by Tsinghua University, supervised by the Ministry of Education and authorised by General Administration of Press and Publications of PRC, is the most comprehensive and inclusive full-text database of Chinese journal publications in the world. By 2014, it had collected 9,894 Chinese academic journals and 51,334,341 articles in full-text in mainland China.

education, rather than academic discipline education (for example, 王沛民 Wang, 1999; 石中英 Shi, 2007; Xu and Zhu, 2007; Bie et al., 2009).

Secondly, much of the literature stresses the importance of introducing professional education. It might be due to the fact that professional education was marginalised within master's education, to some extent, before the new master's professional programmes were launched. 石中英 Shi (2007) suggests a 'professionalism crisis' that the public sees the concept 'degree' only as academic degree, followed by some reasons and suggestions. Today the economy and society largely require practical or applied professionals with a higher degree, so professional education should be deemed as having the same importance as academic education (翟亚军 Zhai and 王战军 Wang, 2006). Bie et al. (2009) point out three implications of professional education: (i) augmenting different types of specialisms and adapting the degree system to meet society's demands, (ii) facilitating industry growth in the knowledge economy and development transition, and (iii) delivering high-level specialists and promoting modernisation. According to 王沛民 Wang (1999), the pilot and then the establishment of professional education can deliver applied specialists and improve China's higher education system in the twenty-first century; professionalisation should be focused on by higher education researchers as it is the only path to modernization. Moreover, before 2009, some papers offer the policy advice that the professional education system should be enhanced (史耀媛 Shi and 许克毅 Xu, 2005; 邓玲玲 Deng and 徐建军 Xu, 2006; 石中英 Shi, 2007; 黄宝印 Huang, 2007). These policy suggestions might have facilitated the introduction of professional master's programmes.

Thirdly, the attributes of professional education are frequently discussed. The conclusions are similar. Professional education is both academic and professional (史耀媛 Shi and 许克毅 Xu, 2005; 刘国瑜 Liu, 2005; 翟亚军 Zhai and 王战军 Wang, 2006; Bie et al., 2009). Sometimes, research (刘国瑜 Liu, 2005) or practice (Bie et al., 2009) is also seen as an attribute of professional education. 邹碧金 Zou and 陈子辰 Chen (2000) identify three attributes of professional education: practicality, professionalism, and the integration of theory and practice. 史雯婷 Shi (2004) proposes that specialist knowledge and distinct professionalism are the two basic attributes of professional master's education. 袁广林 Yuan (2011) reviews the nature of professional education, including its vocational nature, professionalism, academic nature, research nature, and practical nature, and finally defines the nature of professional master's education as applied research.

Fourthly, the connection between professional education and higher education or the connection between professional education and professions is another research focus. The conclusions are similar to those of Western studies. Bie et al. (2009) explain that professional education is orientated to a specific profession. In a profession, the accumulation of professional knowledge, the delivery of professionals, and the intellectual support for professional education are all based on higher education (Bie et al., 2009). The establishment of a professional degree depends on the maturity of the profession, which implies that professional degrees exist only in the highly professionalised vocations (邓光平 Deng and 郑芳 Zheng, 2005). According to 黄宝印 Huang (2007), first, professional education must have a close link to a vocation; secondly, the profession *per se* should have its own knowledge base; thirdly, there must be specific professional competences in the profession.

Besides the research foci above, 邓玲玲 Deng and 徐建军 Xu (2006) assume that professional ethics education also needs developing.

Of the monograph books, two comparatively new books are reviewed here. Professional education does not have a long history in China and has evolved in recent years (see The Context of the Findings, Chapter Four, p.134). The latest books, rather than earlier ones, have a greater relevance for this research.

廖文婕 Liao (2013) analyses the course programme mode of professional education in China based on system science[4]. She identifies some characteristic indexes and then sets up a dynamic model of this system. Using her model, she simulates the different management/administration strategies of professional master's education. 邓光平 Deng (2014) examines the policy on professional education in China, summarising the evolution of policies, analysing their value orientation, identifying the basis of the policy, and appraising it.

So far, Chinese studies of professional education are still limited and

4 Systems science or systems theory is an interdisciplinary field that studies the nature of systems—from simple to complex—in nature, society, and science itself. The field aims to develop interdisciplinary foundations that are applicable in a variety of areas, such as engineering, biology, medicine, and social sciences. (Available from: https://en.wikipedia.org/wiki/Systems_science. Accessed: 11 July 2016)

undeveloped. Few studies have been developed a systematic theory of professional education, as in the literature in English. Meanwhile, as established at the end of the last sub-section, the existing theories of professional education in the West have not been connected to Chinese practices. Additionally, little of the Chinese literature focuses on knowledge in professional education, the practice of professional education, or the labour market for professional education graduates.

China's New Professional Master's Programmes

This sub-section considers the Chinese literature concerning the newly launched full-time professional master's programmes. The review starts with research reports and then goes on to review journal articles.

A research group focusing on the new professional master's programmes released a report in 2010. It analyses and designs the professional master's education in China from an inclusive and practical viewpoint. It considers the nature and the mission of professional master's education in China, summarises its history, investigates society's demands, outlines professional education in other countries, designs a system for professional master's education, and finally, provides some policy suggestions (研究生专业学位总体设计研究课题组 Yan Jiu Sheng Zhuan Ye Xue Wei Zong Ti She Ji Yan Jiu Ke Ti Zu, 2010).

Another report, published in 2013, compiles professional master's programmes from pilot universities nationwide, in disciplines such as law, education, engineering, and business administration. The report describes the professional master's programme individually from each university, in terms of course aims, implementation, course delivery, and management. For example, one case describes the professional master's course in Aeronautical Engineering at a university. The course collaborates with aeronautical companies to deliver 'bespoke' specialists for the industry. It explains the specific implementation of the course, such as student recruitment, curriculum design, and the construction of a practice base (全国公共管理等专业学位研究生教育指导委员会 Quan Guo Gong Gong Guan Li Deng Zhuan Ye Xue Wei Yan Jiu Sheng Jiao Yu Zhi Dao Wei Yuan Hui, 2013).

These research reports offer an overview of the new professional master's programmes all over China. Therefore, they provide the foundation for this research. The journal articles were also searched in China Academic Journals online database, taking the programmes' Chinese title, 全日制专业学位 (*quan ri zhi zhuan ye xue wei*) [full-time professional master's degree], as the keyword. The articles are sorted into some broad types by different research methodologies or research focuses, as shown below.

First, some empirical studies examine the new professional master's programmes for practical purposes. They often take a cross-sectional survey or a case survey and gather data from questionnaires answered by students, academic staff or administrators. These findings usually identify the problems in the programmes' implementation, followed by some suggestions. Zhang and Chen (2011) develop a set of questionnaires and use them in 36 research universities in China. They find that the students investigated were not very satisfied with the new professional master's programmes (by 2011), which has a negative impact on their academic performance. The curricula were not different from those of the academic programmes. The students wanted practice opportunity, and thought practice would be productive for them. 刘翠琼 Liu et al. (2013) use the questionnaire developed by Zhang and Chen (2011) in five forestry-science-based universities, and recognise the problems of course design, learning approaches, supervision, and professional practice, and finally offer some advice. Similarly, through case survey or nationwide survey, some other studies identify the problems in the implementation of the new professional master's programmes and provide suggestions. For example, problems include the admission examination, satisfaction with the course, students' motivation, curriculum design, teaching approaches, supervision, research projects, final dissertation, and even university facilities (see in 任欣荣 Ren et al., 2011; Geng et al., 2012; 王俊 Wang and 刘若泳 Liu, 2012; Cao, 2013; Zhang et al., 2013).

The studies above focus on the negative side of the new professional master's programmes. In contrast, 朱永东 Zhu et al. (2011) use a questionnaire survey and find that students, academic staff, and administrators positively appraised the new professional master's programmes. 徐燕敏 Xu and 刘若泳 Liu (2011) examine the new professional master's course in teaching education, identifying some factors influencing the students' evaluation of the curriculum. In sum, all the empirical quantitative surveys offer an overview of the implementation of the new professional master's programmes.

Some of literature focuses on the graduate employment of the new professional master's programmes. Their findings are relevant to this research. Cao (2013) finds that students of key university had more optimistic employment prospects than the students of other universities, and science and engineering students were more optimistic than art students, and employers' feedback on students' competence was mainly positive. 朱永东 Zhu et al. (2011) also find that 80% of employers agreed that graduates' knowledge and skills were enhanced by the professional master's programmes. But these studies only use a satisfaction questionnaire or an evaluation scale for students and/or employers to generate some rough statistical data, without any in-depth inquiry. Therefore, students' employment prospects need to be studied further.

Secondly, some case summaries or case profiles introduce the practical experience of the new professional master's programmes. Beihang University introduced an industry-university-research cooperation programme to enhance students' practical abilities (郑冬梅 Zheng, 2009). Wuhan University established its Professional Practice Base for students (文冠华 Wen, 2010), and switched the orientation of its master's programme from research to application (周叶中 Zhou, 2010). 聂文斐 Nie et al. (2011) describe a course model, which they refer to as the Three Stages Practicum, based on the Information and Communication Engineering programme at a case university. 李忠 Li et al. (2010) describe the scholarship system, the practice base for students, course delivery, and the support of local government for the professional master's programmes at a case university. 谭跃刚 Tan and 陈国良 Chen (2010) describe the reform of curriculum content and teaching approaches in the Modern Control Theory[5] module and summarise the effects and problems. Zhang and Song (2011) focus on master's degree dissertation issues in the software engineering course at a case university.

Of their findings, 文冠华 Wen et al. (2010) identify three types of professional practice. First, on-the-job students complete their professional practice in their affiliated enterprises. Second, some students practise in enterprises that have collaborative research projects with their supervisors or schools of study. Third, some students practise at Professional Practice Bases, located in collaborating companies, to help the companies solve their industrial problems.

Thirdly, from the methodology aspect, some of the literature makes hypothetical suggestions about the problems of the professional master's programmes and offers some solutions but without any empirical evidence. Qin et al. (2012) suggest four problems. First, the one-size-fits-all policy (Chinese: 一刀切政策 *yi dao qie zheng ce*) has a negative impact on the various development needs of different universities. Second, the public do not hold the new professional master's programmes in high esteem. Third, some universities have not been fully prepared to implement the policy of the professional master's programmes, and some supervisors are not motivated enough to supervise professional master's students. Four, the current master's education

5 Control theory is an interdisciplinary branch of engineering and mathematics.

system does not match the professional programmes' aims. 王筱静 Wang (2014) also suggests that the existing academic staff cannot meet the needs of professional master's education and offers some solutions. Ma et al. (2011) claim that a long-term mechanism for a national longitudinal survey of the professional master's programmes is necessary to identify and solve the current problems. 李占华 Li and 罗英姿 Luo (2012) summarise some problems in veterinary medicine professional courses and discuss some possible strategies for veterinary medicine course design. 赵丽娜 Zhao and 王传毅 Wang (2013) recognise some quality problems and suggest establishing a quality insurance system for this new professional master's programmes.

Finally, some of the literature theoretically discusses other issues not included in the categories above, for example, the importance of establishing a quality insurance mechanism (Cha et al., 2010; Hu and Yang, 2012; 熊玲 Xiong and 李忠 Li, 2010), university-government collaboration to enhance students' practical ability (Li and Lou, 2012; 张建功 Zhang and 刘兴华 Liu, 2011), and the contradiction between the academic traits of research universities and the practical attributes of professional master's education (张乐平 Zhang et al., 2013).

Of their findings, two are relevant to this research. First, 单晓峰 Shan et al. (2010) point out that society and the economy demand the development of professional master's education in China today, but they do not analyse this idea further, which is a possible research gap. Secondly, 王应密 Wang et al. (2012) suggest that the professional and practical competencies for future vocational practice are required by professionals and practices, and acquired through professional practice. They define professional and practical competencies as being more than technological ability; the formation of professional and practical competencies can be influenced by the practical context. Based on the characteristics of research universities, 王应密 Wang et al. (2012) propose two fundamental abilities for forming and developing professional and practical competencies: (i) the ability to construct problems and solve problems, and (ii) the ability to integrate and transfer knowledge.

Generally speaking, the new professional master's programme is a fresh topic in the Chinese literature; the research gaps in professional master's programme studies are still very wide. The literature is mostly an evaluation, a summary of experience, or a case profile, focusing on implementation issues. Little research considers the professional master's programmes with theoretical underpinnings and empirical evidence together. Concerning the relevance to this research, the existing studies investigate the satisfaction about graduate employment by students or employers; the importance of the new professional master's programmes has been established. However there have been few studies considering why they are so. Moreover, some studies involved professional competencies, but just offering suggestions. There is a lack of empirical evidence and theoretical analysis. There are still various possible ways to explore the professional master's programmes, for instance, knowledge acquisition, practicum delivery, and labour market prospects.

To summarise this section, it offered an overview of professional education in the West and in China. It first outlined professional education by summarising its main features and considered the various stakeholders involved to provide a possible viewpoint from which to examine professional education. Then it reviewed China's professional education in general and the new professional master's programmes in particular. The existing literature often focuses on the programmes' implementation issues, identifying problems and providing suggestions. There are still many research gaps. Based on the existing theories and evidence and the research gaps, the following three sections respectively consider three issues: knowledge in professional education, the course and practicum in professional education, and the human capital theory that links knowledge and education to the labour market.

Knowledge in Professional Education

This section reviews the knowledge involved in professional education. It begins with a summary of related knowledge concepts. The second section principally examines Eraut's theories about knowledge in professional education, and the third section reviews some other scholars' knowledge typologies for professional education. Finally, it recognises the research gaps in this field.

The Introduction of Knowledge

The definition or nature of knowledge is a complicated epistemological issue. Many philosophers have devoted themselves to exploring it, and it is still contentious. What knowledge is or where knowledge comes from are worthy of study, but they are not the focus of this thesis. Here, it is sufficient to consider some basic concepts and related different kinds of knowledge to offer a context for the knowledge involved in professional education.

The concept of knowledge can be seen in two ways. In a narrow sense, or everyday language, knowledge refers to codified, explicit, and public knowledge, such as information, facts, propositions, and so forth. It can be called propositional knowledge (for example, Pritchard, 2013, p.4) and be bracketed with skills, abilities, or competencies (for example, Jarvis, 1983, pp.64-79). But in a broader sense, or sometimes in academic studies, knowledge covers both codified and uncodified knowledge and both explicit and implicit knowledge. It includes skills, abilities, competencies, and so on. In the related literature, knowledge is often used in the broad sense. It has been classified into many types, e.g. propositional knowledge, technical knowledge, practical knowledge, knowing-that, knowing-how, tacit knowledge, and so forth.

Knowledge in this thesis refers to knowledge in the broad sense, covering all the kinds of knowledge referred to above, for the reasons below. As Eraut (1992, pp.100-113) suggests, in professional education, the term *knowledge* should be interpreted as having the broadest possible meaning; it should not be confined to codified or propositional knowledge but should include personal knowledge, tacit knowledge, process knowledge, and know-how. All kinds of knowledge are essential for professional performance (Eraut, 1992, pp.100-113). Nevertheless, the definition of human capital uses *knowledge* in its narrow sense (see in Human Capital, Chapter Two, p.62). Therefore, for clarity, when knowledge is referred to in its narrow sense in this thesis, it will be marked in round brackets, as 'knowledge (in the narrow sense)'; otherwise, knowledge in this thesis means knowledge covering all the kinds of knowledge referred to above.

Returning to the concept of knowledge, Gilbert Ryle[6] (1900–1976) proposes the 'knowing how' and 'knowing that' for the first time in his book *The Concept of Mind* in 1949 (see in Ryle, 2009, pp.14-20). He argues that *knowing how* does not necessarily mean *know that* (Ryle, 2009, pp.14-20). People can do something without being able to describe how to do it exactly. Alfred Jules Ayer[7] (1910-1989) develops Ryle's theory. People can possess skills without always consciously knowing the procedures that they follow; they can do many things well 'without remarking how they do them' (Ayer and Marić, 1956, p.13). Polanyi (1966, p.4) further proposes that 'we can know more than we can tell' in his book *The Tacit Dimension*. He identifies the knowledge mentioned above as *tacit knowledge*. By contrast, Pritchard only focuses on propositional knowledge in his book *What is this thing called knowledge?* but still points out that 'it is not the only sort of knowledge we possess' and 'there is, for example, ability knowledge, or *know-how*' (Pritchard, 2013, p.4).

Some contemporary scholars put forward more kinds of knowledge, when considering this philosophical concept, knowledge, in professional education.

6 Gilbert Ryle (1900 – 1976) was a British philosopher.

7 Sir Alfred Jules Ayer (1910 – 1989) was a British philosopher.

From the standpoint of professional education, Jarvis defines knowledge as 'a level of awareness, consciousness or familiarity gained by experience, learning or thinking', regarding 'the relationship between the awareness of the phenomenon and the experience that leads to it' (Jarvis, 1983, p.66). Beside the *tacit knowledge* identified by Polanyi, there is *codified knowledge* referring to public knowledge or propositional knowledge (Eraut, 2000).

Apart from codified and tacit knowledge, knowledge can also be categorised as culture knowledge and personal knowledge. Culture knowledge includes both codified culture knowledge and uncodified culture knowledge. Uncodified culture knowledge plays a key role in most work-based practices and activities (Eraut, 2004). It is acquired informally from participation in work practices or social activities, and it is often so 'taken for granted' that people are unaware of its influence on their behaviour (Eraut, 2004; Eraut, 2010). According to Eraut (2010), personal knowledge, the counterpart to culture knowledge, is defined as 'what individual persons bring to situations that enables them to think, interact and perform'. It incorporates codified knowledge in its personalised form, together with procedural knowledge and process knowledge, experiential knowledge, and impressions in episodic memory (Eraut, 2000). Personal knowledge can be codified or not. Codified personal knowledge involves the authorship or provides the basis for assignments and assessments in education where more than the replication of publicly available knowledge is expected (Eraut, 2004). In addition to personalised codified knowledge, there are also

- know-how in the form of skills and practices,
- personal understandings of people and situations,
- accumulated memories of cases and episodic events,
- self-knowledge, agency, attitudes, values, emotions, and reflection, and
- other aspects of personal expertise, practical wisdom, and tacit knowledge (Eraut, 2010).

Additionally, there are also technical knowledge and practical knowledge. Practical knowledge is derived from practice and validated in practice, including process knowledge or know-how, specific knowledge about a situation, decisions or actions, and 'practical concepts and principles' (Eraut, 1994, p.65). Technical knowledge is capable of written codification, while practical knowledge is expressed only in practice and learned only through experience with practice (Eraut, 1985).

Eraut's Knowledge of Professional Education

Based on the introduction to the concept of knowledge above, this section examines Eraut's theories and findings about knowledge in professional education. To explore the professional knowledge base, Eraut categorises professional knowledge into three types: propositional, personal, and process (Eraut, 1992). Eraut's three types of knowledge have been pervasive in professional education studies (for example, see Katz, 2000; Taylor, 1997). Therefore, the following paragraphs review Eraut's three types of knowledge.

Propositional knowledge includes the discipline-based theories and concepts derived from coherent and systematic knowledge bodies, the generalisations and practical principles in the applied field of professional action, and specific propositions about particular cases, decisions and actions (Eraut, 1992; Eraut, 1985). All discipline-based knowledge and most of the generalisations and practical principles of a profession are codified knowledge (Eraut, 1992). Propositional knowledge, that comes closest to traditional academic territory, is used for the construction of syllabi in conventional higher education (Eraut, 1992).

Personal knowledge is an intuitive and implicitly learned impression and needs to be pulled into the realm of professional education to be critically reviewed and disseminated (Katz, 2000). According to Eraut (1992), personal knowledge covers the people or situations encountered, the communication received, and the events and activities experienced through participation or observation. It is acquired through experience, social interaction, trying to get things done, participation or observation (Eraut, 1992). Some of this kind of knowledge could be classified as propositional knowledge or process knowledge, but most of it remains as a simple impression (Eraut, 1992).

Eraut (1992) defines process knowledge as 'knowing how to conduct the various processes that contribute to professional action', including 'knowing how to access and make good use of propositional knowledge'. Process knowledge plays a role in 'how the professional carries out tasks within their job function to build expertise' (Katz, 2000). Eraut (1992) particularly explains five interdependent types of process: acquiring information, skilled behaviour, deliberative processes, giving information, and controlling one's own behaviour. They are reviewed respectively below.

- The process of acquiring information involves using inquiry methods (Eraut, 1992). The effective and efficient inquiry way to acquire information requires four types of knowledge: an existing knowledge base in the area concerned, some kinds of conceptual framework to guide one's inquiry, skills in collecting information, and skills in interpreting information (Eraut, 1992).

- Skilled behaviour is a complex sequence of actions which has become so routinised through practice and experience that it is performed almost automatically (Eraut, 1992). Eraut (1992) takes what a teacher does as an example of skilled behaviour, and suggests that how to teach is tacit knowledge that may not be explained easily to others or oneself.

- The deliberative process refers to work, such as planning, problem-solving, analysing, evaluating, and decision-making, that cannot be accomplished by using procedural knowledge alone or by following a manual but requiring a unique combination of propositional knowledge, situational knowledge and professional judgement (Eraut, 1992).

- Giving information to clients is necessary for many professionals (Eraut, 1992).

- Controlling one's behaviour is a meta-process that evaluates one's doing and thinking, continually re-defines priorities, and critically adjusts cognitive frameworks and assumptions (Eraut, 1992). It is featured with self-knowledge and self-management, including the organisation of oneself and one's time, the selection of activities, the management of one's learning and thinking, and the general maintenance of a meta-evaluative framework for judging the import and significance of one's actions (Eraut, 1992). All these processes require two main types of information: knowledge of the context/ situation/ problem, and conceptions of practical courses of action/ decision options.

Eraut's three types of knowledge prescribe a broad typology of professional knowledge base that offers a fundamental framework for related studies, and it is pervasive in professional education studies. For example, Taylor develops it in the use of personal knowledge in professional education (see in Taylor, 1997, pp.18-20 and p.38). Nevertheless, some issues have not been studied empirically. For example, the knowledge learned in a specific discipline or profession is a research gap, and the connection between different types of professional knowledge and different professional practices is another possible research direction.

Eraut's Maps of Professional Knowledge

Besides the knowledge typology above, Eraut (1985, pp.132-133) also draws maps of the professional knowledge of head teachers and social workers respectively. These maps include skills or competencies, such as communication, learning to work in teams and organisations, and professional ethics, as quoted below.

A Map of Head teacher Knowledge and Know-How (adapted from discussion paper for University of Sussex research project (1984))

This can be mapped into three dimensions. (1) Areas of responsibility--these provide the contexts for knowledge use. (2) Skills and processes. (3) Knowledge, which needs to be subdivided to indicate the wide range of knowledge types that are likely to be used. The following further categorisation is highly provisional, but should serve as a useful base for further enquiry.

(1) Areas of responsibility

Curriculum and training	*School organisation*
Staff	*Relations with local environment*
Pupils	*Relations with governmental system*
Finance and resources	*Self-management*

(2) Skills and processes

Collecting information and advice	*Planning*
Giving information and advice	*Organising/administering*
Personal Relations	*Co-ordinating and controlling*
Handling groups	*Political skills*
Written Communication	*Team building*
External relations	

(3) Knowledge

Knowledge of people	*Knowledge of alternatives/trends*

External contacts and networks	*Practice in other schools*
Sources of advice	*Decision options*
Friends in high places/low places	*Ways of handling situations*
Personal styles/characteristics	*Latest reports*
Local community	*Issues under discussion*
	Social trends
Knowledge of rules/procedures	*Interpretive frameworks*
LEA systems	*Language of education*
Legal knowledge	*Social science concepts*
Budgeting	*Educational research*

(Eraut, 1985, pp.132-133)

A Map of Social Workers' Knowledge and Know-How (adapted from Baskett, 1983)

(1) Knowledge about resources and how to get them: the existence and worth of resources, what they can do and how they relate to needs, procedures for getting them and how to 'bend' them without 'breaking'.

(2) Knowledge about organisations and sub-cultures, their norms and values and how to deal with them: especially the peer group subculture, community resource systems such as schools and courts, client subcultures and their own administration.

(3) Knowledge of how to get knowledge: personal storage and retrieval systems, using several sources to establish veracity, using personal networks, skills in taking short cuts.

(4) Knowledge of self and how one learns.

(5) Formal knowledge, as found in books articles and higher education courses.

(6) Coping knowledge: practical precepts for coping with the pressures and contradictory demands of the work setting, e.g. "Wait, it will work", "Don't get sucked in", "Tell 'em what they want to hear" and CYA "Cover your ass".

(Eraut, 1985, pp.132-133)

Eraut also develops a map of management knowledge for headteachers learning about management. Eraut (1994, pp.76-82) classifies this knowledge into six categories: knowledge of people, situational knowledge, knowledge of educational practice, conceptual knowledge, process knowledge, and control knowledge. According to Eraut (1994, pp.76-82),

- 'situational knowledge is concerned with how people read the situations in which they find themselves';
- 'conceptual knowledge is defined as that set of concepts, theories and ideas that a person has consciously stored in memory';
- 'process knowledge is partly a matter of knowing all the things one has to do and making sensible plans for doing them; and partly a matter of possessing and using practical, routinised skills'; and
- control knowledge refers to knowledge that is important for controlling one's own behaviour (excluding knowledge concerned with the control of others, which could be process knowledge).

Eraut's discussion mainly stresses how to acquire or learn these kinds of knowledge. Nevertheless, he does not explain all of them and does not discuss what constitutes each of them specifically.

Eraut then puts forward a general typology of knowledge learned in the workplace, as quoted below.

Task Performance

Speed and fluency

Complexity of tasks and problems

Range of skills required

Communication with a wide range of people

Collaborative work

Role Performance

Prioritisation

Range of responsibility

Supporting other people's learning

Leadership

Accountability

Supervisory role

Delegation

Handling ethical issues

Coping with unexpected problems

Crisis management

Keeping up-to-date

Awareness and Understanding

Other people: colleagues, customers, managers, etc.

Contexts and situations

One's own organization

Problems and risks

Priorities and strategic issues

Value issues

Academic Knowledge and Skills

Use of evidence and argument

Accessing formal knowledge

Research-based practice

Theoretical thinking

Knowing what you might need to know

Using knowledge resource (human, paper-based, electronic)

Learning how to use relevant theory (in a range of practical situations)

Personal Development

Self evaluation

Decision Making and Problem Solving

When to seek expert help

Self management	*Dealing with complexity*
Handling emotions	*Group decision making*
Building and sustaining relationships	*Problem analysis*
Disposition to attend to other perspectives	*Generating, formulating and evaluating options*
Disposition to consult and work with others	*Managing the process within an appropriate timescale*
Disposition to learn and improve one's practice	*Decision making under pressurised conditions*
Accessing relevant knowledge and expertise	
Ability to learn from experience	
Teamwork	***Judgement***
Collaborative work	*Quality of performance, output and outcomes*
Facilitating social relations	*Priorities*
Joint planning and problem solving	*Value issues*
Ability to engage in and promote mutual learning	*Levels of risk*

(Eraut, 2004, p.265)

Other Scholars' Views of Knowledge in Professional Education

Although Eraut's theories about knowledge of professional education dominate the existing literature, some other scholars have contributed to this area. This sub-section considers some of them to offer a comparatively broader review of this area.

Jarvis (1983, p.74) points out that knowledge, skills, and attitudes together form the essentials of professional practice. This implies he is referring to knowledge in its narrow sense. Although knowledge is bracketed with skills in

Jarvis' theoretical framework, skills are still part of the broad body of knowledge in this research. Therefore, this sub-section reviews not only Jarvis's theory about knowledge but also skills and attitude in professional education.

According to Jarvis (1983, p.74), professional knowledge refers to what members of a professional select from the overall body of knowledge as their practice foundation. He divide professional knowledge into 'knowledge that' (academic disciplines), 'knowledge how' (psycho-motor elements), knowledge of persons, moral values, and professional ideology (Jarvis, 1983, p.74). Jarvis takes knowledge in teaching education as an example to explain the five types of professional knowledge:

- 'knowledge that' derives from both empirical and pragmatic undertakings;
- 'knowledge how' is the basis for theories of teaching and learning;
- 'knowledge of persons' includes understanding the dynamics of classroom interaction, sensitivity in interpersonal relations in respect of the teacher-learner relationship;
- ethics includes understanding the moral standards expected of the teacher;
- and philosophy relates to the comprehension of and the commitment to the ideals of professionalism that have already been described (Jarvis, 1983, p.75).

According to Jarvis (1983, p.76), the cognitive domain of 'knowing how' is different from the skills domain of being able to perform a specific operation.

The former can be taught in curriculum, but the latter is acquired through practice. Jarvis (1983, p.76) suggests that a skill is a special ability that is often acquired only through training. According to Jarvis (1983, p.76), skill combines theoretical 'knowledge how' to carry out a procedure with 'knowledge that' upon which the occupation is based and the critical understanding of the practitioner; consequently, the practitioner can think about previous processes undertaken and use different techniques if demanded.

Jarvis (1983, p.77) cites the definition of attitude respectively from Allport (1954) and Krech and Crutchfield (1948), as shown below.

> An attitude is 'a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is associated' (Allport, 1954, p.45).

> An attitude is defined as 'an enduring organization of motivational, emotional, perceptual and cognitive processes with respect to some aspect of the individual's world' (Krech and Crutchfield, 1948, p.173).

Jarvis (1983, p.76), based on the two definitions above, concludes the characteristic of attitude is: 'cognitive and affective orientations towards the phenomenon in question and a behavioural tendency towards it'. In professional education, attitude can be seen as a belief, an ideology, or commitment.

Billett (2009) studies how to assist individuals to develop the capacities to realise their vocation, and develops an understanding of the kinds of knowledge, i.e. expertise, required for effective occupational practice. According to Billett (2009), effective occupational performance is based on three kinds of knowledge: domain-specific conceptual knowledge, domain-specific procedural knowledge, and dispositional knowledge.

Domain-specific conceptual knowledge refers to 'knowing that' (Ryle, 2009), e.g. concepts, facts, and propositions, from surface to deep, which can be spoken about and written down (Billett, 2009). Domain-specific procedural knowledge, meaning 'knowing how' (Ryle, 2009), is the knowledge that we use to do things, which is specific to strategic procedures but cannot be easily declared or easily represented (Billett, 2009). Dispositional knowledge comprises interests and beliefs, e.g. values, attitudes, which could be described as 'knowing for', related to both canonical knowledge and instances of practice and their criticality (Billett, 2009). According to Billett (2009), disposition can be developed through individuals' beliefs and be negotiated through their encounters with particular experiences. Dispositional knowledge not only energises the use and development of concepts and procedures but also shapes the direction, intensity, and degree of their enactment (Billett, 2009).

This sub-section considered Jarvis's and Billett's theories of professional knowledge to offer a broader review of knowledge in professional education. The findings and/or theories of other scholars may also be worthy of consideration; however, space of this thesis does not permit a review of every scholar's theories in detail. Consequently, this study mainly focuses on Eraut's knowledge of professional education and considers Jarvis's and Billett's theories as supplementary. Their theories together construct the theoretical framework of knowledge in professional education.

To sum up, this section reviewed knowledge in professional education. The first section introduced knowledge from the perspective of epistemology, and then considered knowledge from the perspective of professional education. The second section principally examined Eraut's knowledge typology of professional education. The third section considered similar theories from Jarvis and Billett. Although expressed in different ways, the three views have similarities: knowledge in professional education is not only codified and propositional but also tacit, such as *know-how*. Tacit knowledge, which is only acquired through practice, is a key aspect of professional education.

However, the subjects of most empirical case studies are nursing, teaching or social work, and largely at undergraduate level. There are few findings about knowledge in other professions, for example, engineering, and in professional master's education. Moreover, few studies have looked into knowledge issues in China's professional education. These are research gaps.

Course Issues in Professional Education

As established in the last section, knowledge in professional education is practical, tacit, personal, procedural and/or non-propositional. These kinds of knowledge need to be accumulated through practice, which is defined as 'non-formal learning' (see Eraut, 2000) or 'learning through practice' (see Billett, 2010). They do not resemble the 'academic knowledge' that can be taught by conventional didactics. For the purpose of acquiring practical knowledge effectively, 'periods of professional practice are built into the higher degree course' (Eraut, 1992). Therefore, the course module which offers professional practice, e.g. a practicum, is the key focus of this research.

This section reviews the course design, the practicum of professional education, and practical learning. The first sub-section examines the course design of professional programmes. The second sub-section narrows down the focus to the practicum in professional courses. The third sub-section considers some findings about practical learning. Finally, it identifies the research gaps.

Course Design

Bines (1992, pp.12-17) identifies three course models in professional education: (i) the apprenticeship/ pre-technocratic model, (ii) the technocratic model, and (iii) the post-technocratic model. The three models are outlined below.

The apprenticeship/ pre-technocratic model offers block release or day release in on-the-job work or in a job-related training school (Bines, 1992, pp.12-17). The curriculum is composed of 'the acquisition of "cookbook" knowledge embodied in practice manuals and the mastery of practical routines' (Bines, 1992, pp.12-17). This model of professional education applies to lower level courses in tertiary education, but not at master's level. Therefore it will not be reviewed in detail here.

By contrast, the technocratic model tends to take place in higher level courses. Bines (1992, pp.12-17) identifies three elements of this model: (i) systemic knowledge is developed and transmitted based on academic disciplines; (ii) this knowledge is interpreted and applied in practice by multiple professional activities in their context, for example, nursing process in nurse education; and (iii) the practice is supervised in a selected placement. Bines also argues this model has some weaknesses. For example, the three elements could fragment learning into discrete parts, like dividing theory from practice (Bines, 1992, pp.12-17). Particularly from the view of knowledge acquiring, this model ignores the nature of professional knowledge and activities and how professionals develop their practice, because most professional exercises are not based on only two separate steps, i.e. theory learning and application, but an integrated knowledge-in-action that is mostly spontaneous and tacit (Bines, 1992, pp.12-17). Moreover, real-world practice contains indeterminate situations that sometimes cannot be solved by taught knowledge. Practice *per se* is 'a continuous process of reflection in and on action' (Bines, 1992, pp.12-17), which cannot be embodied in this model.

Aimed at correcting the flaws of the technocratic model, the post-technocratic model was introduced. It not only stresses knowledge of practice but also the professional competencies derived from the 'experience of practice and reflection on practice in a practicum within which students have access to skilled practitioners who act as coaches' (Bines, 1992, pp.12-17). In this model, the practicum is the key element through which professional competence can be developed. It establishes a connection 'between the academic institution and the world of practice and between professional education and subsequent employment' (Bines, 1992, pp.12-17). This model is not yet fully developed and still has a number of challenges, such as how students acquire professional competence, what the best settings for this learning to take place are, how knowledge and action can be integrated in the course, how the practicum can be made effective, and how new partnerships between higher education, employers and services can be established (Bines, 1992, pp.12-17).

Practicum

As established in the last section, the curriculum in professional education addresses knowledge for and about practice, which is a key difference between professional education and conventional higher education (Taylor, 1997, p.4). Therefore, the practicum is a key part of professional education, and this section considers it in particular. The curriculum 'is delivered both in the context of the university and the field of professional practice' (Taylor, 1997, p.4). According to Bines (1992, p.21), despite practice becoming the centre of professional education and a long tradition of providing practice placements, the practicum remains the least developed element in professional courses. Bines (1992, p.21) points out three features of the practicum, referring to the views of Zeichner (1990) along with Bines's own explanation. The practicum is:

- Organisational, e.g. length and location. The practicum tends to be longer, frequent, and at the actual workplace.

- Curricular, i.e. what is to be learned and how. The practicum aims to develop the professional competence of students, integrated with other course elements. The practicum could be designed around 'a set of specific and sequenced tasks, activities and experiences, closely related to other course elements through supervision, tutorials, seminars and written assignments' (Bines, 1992, p.21). Course design should take some particular ways of teaching and learning, such as observation, modelling, routine practice, problem-solving, and evaluation. Each of them should be undertaken in partnership with experienced practitioners.

- Structural. This includes both the resources supplied to support the practicum and the contextual conditions in which the practicum exists.

Glenny and Hickling (1992) explore some principles of the practicum in a teacher education programme through a case study. They see the practicum as 'a bridge between lay and professional experience, knowledge and concerns' and as a process for training the students to meet their future professional demands (Glenny and Hickling, 1992). They identify four elements in this process:

> The first is to enable students to make explicit, and present for challenge, their own internal models. Secondly, through practical, first-hand experience students need to acknowledge current practice in schools. Thirdly, they must critically consider the theoretical basis upon which current models of good practice are

based. Fourthly, they need to mediate the previous processes in such a way as to inform their action as a reflective teacher (Glenny and Hickling, 1992).

Simpson and Jackson (2000) discuss that how the placement, a common type of practicum, links to other aspects of a sandwich course through a case study of a computing course. According to Simpson and Jackson (2000), the practicum has two functions in a sandwich course. First, the placement allows students to practice the skills learned previously in extended projects within a commercial environment, which means they may use the experience of what they learned in theory in a 'real' environment (Simpson and Jackson, 2000). Secondly, the placement also allows the students to bring their newly honed skills into their final year class study, which can enrich that year of learning (Simpson and Jackson, 2000). They also summarise the main advantages, as quoted below:

- the relationships between the academic course, the placement year, and professional development activities are made more explicit and coherent;
- the relationships between the parts of the educational experience are made more explicit; and
- the plan for the placement year can be made more coherent and related to the students' requirements (Simpson and Jackson, 2000).

Learning by Practising

Eraut and other scholars conducted an ESRC/TLRP funded project 'Early Career

Learning at Work: Project LiNEA (Learning in Nursing, Engineering and Accountancy)' from 2001 to 2005. The LiNEA project followed an earlier study of the learning of groups of professionals in mid-career, and the second study aimed at the learning of newly qualified nurses, graduate engineers and trainee chartered accountants in their first three years of employment (Steadman, 2005). Based on a longitudinal study, the project looked at the development of knowledge and skills in employment and developed the factors affecting learning in the workplace. Several publications disseminate the findings of this project (for example, Eraut, 2003; Eraut, 2007).

This project has certain relevance for this thesis. First, the project studied learning by practice, but not through taught modules at university. Secondly, the project investigated graduate engineers. In the LiNEA project, the engineering trainees possessed related degrees, e.g. in engineering or computer science, and most were seeking the advanced meta-qualification of Chartered Engineer (Steadman, 2005). Thirdly, to some extent, the project involved Eraut's knowledge in professional education already reviewed in Eraut's Knowledge of Professional Education (Chapter Two, p.38). Therefore, this sub-section reviews some of the project's findings.

The focus of the LiNEA project was the learning in the workplace that happens after graduation, not on practicums as part of courses. The LiNEA project concentrated on the factors and context influencing the learning and development of professional skills, rather than the professional knowledge and skills themselves; the key purpose of this thesis is to explore the role of the knowledge learned in professional practicums in the labour market. The learning issue is an approach in this thesis but not its destination. Therefore, the relevance of this project to this thesis is limited. Not all but some findings related to this thesis are reviewed in the following paragraphs.

Eraut disseminated some findings based on the first phase of the LiNEA project. Eraut (2003) identifies twelve characteristics of what the graduate engineers experienced in the workplace:

- Working in an 'open plan' office with desks adjacent to team members, line managers and senior engineers, making it easier to ask questions and to participate in discussions. Getting to know who does what, and the range of available expertise/skills around them is an important early requirement.
- A strong base of support from a wide range of mentors, managers, and team members in addition to accessible 'happy-to-help' people within their own branch of the company and also in other branches. Contacts take the form of face-to-face interaction, telephone, e-mail, or fax.
- All companies have a variety of on-line training courses/exercises for the graduates' own-paced self-learning, but it appears that there is no monitoring system to check on the progress of those using such facilities, and trainees believe it is up to them to use this provision only if they feel so inclined.
- Some companies have a national 'skills link' whereby a graduate can log their enquiry into the system from their desktop, and this will be accessible to all people on that site and elsewhere within the firm;

anyone who can help may suggest either an answer or the name of a helpful person to contact.

- Strong agreement on the benefits of having previous practical experience such as an industrial placement or a sandwich year.
- Views of HE are influenced by their immediate job needs and by the level of contact with industrial engineers.
- Access to short courses is good.
- Interest in the job is important, and carrying out challenging, real-world tasks is thought by graduates to be the most effective factor in learning.
- Graduates believe that they learn most from doing things under supervision, followed by learning from senior engineers (observation, discussion, etc.), and attending courses, reading and finally informal open learning.
- Graduates and their employers judge them as being strong in IT and its many applications, but weak in report writing and presentation skills.
- They often work on large projects with long time-scales but wish to understand more about how their tasks contribute to the overall project.
- A number of graduates find that they are engaged on too many simple, routine, even repetitive, tasks. However, they recognise the general benefits of some such activity, particularly early in their employment.

(Eraut, 2003, p.5)

These above describe some workplace features, such as institutions, people or conditions, which can influence graduates' work skill development. Eraut (2003) also offers two cases of graduate trainee engineers, describing what they did, what people or events they encountered, and/or what feedback they got. The focus of each case includes the graduates' work context, tasks, feedback from supervisors, their performance, and the development of their 'soft' work skills (for example, how to report or where to seek help in the company). This project does not, however, explore what kinds of specific engineering knowledge and skills were learned through work practices.

Based on the findings above, Eraut (2003) extended the earlier triangular relationship of learning factors: challenge, support and confidence (Eraut et al., 2000), by adding further elements to the previous triangular model of learning factors:

- Challenge + value
- Feedback + support
- Confidence + commitment

Moreover, based on observations, Eraut (2003) identifies the nature of participants' work and their relationships at work to produce a second triangle of the context:

- Allocation and structuring of work
- Encounters and relationships with people at work
- Individual participation and expectations of their performance and progress.

The second triangle focuses on the contextual variables that influence the learning factors depicted in the first triangle (Eraut, 2003). Eraut (2003) interprets the two triangle models based on the findings of the LiNEA Project and also raises some further questions about learning factors and the work context.

After the LiNEA Project had been completed, Eraut disseminated more findings about the factors affecting learning and drew some practical conclusions (for example, Eraut, 2007). Eraut (2007) explores an epistemology of practice, from three aspects:

- four key elements of practice: situational assessment, decision-making, actions and meta-cognitive monitoring;
- the mode of cognition and its dependence on time and prior learning; and
- the context, its influence on the mode of cognition and its affordance for learning.

Eraut (2007) also sets out the project's findings concerning modes of learning through a new framework. According to whether the object is perceived to be learning or work, the new framework recognises the learning processes as nine processes: being supervised, being coached, being mentored, shadowing, visiting other sites, conferences, short courses, working for a qualification, and independent study (Eraut, 2007). Eraut (2007) subsequently adds a list of shorter learning activities used within both types of process, including various types of mediating artefacts. After a recapitulation of the triangle model of factors affecting workplace learning, Eraut (2007) finally suggests there is considerable scope for enhancing workplace learning in a wide range of contexts and indicates what needs to be done to develop a learning organisation that is more than a rhetorical aspiration.

The findings of the LiNEA Project make a significant contribution to its research area. With respect to its relevance to this thesis, first, the LiNEA Project considered the issue of *real employment*, while this research explores the issue within higher education and the role of acquired knowledge for future *job prospects*. Secondly, the LiNEA Project mainly focused on *how* to learn in the workplaces, while this research focuses on *what* and *why* to learn, and the 'how to learn' issue is a subsidiary question to link the first and third sub-question and will not be considered in depth in this thesis. Thirdly, the LiNEA Project studied the development of certain 'soft skills' (or say *employability*), such as how to manage time or work schedules, how to report to supervisors, how to cooperate with colleagues, or how to seek help from the professional departments in companies. This research concentrates on the accumulation of professional knowledge, specifically in the engineering R&D sector. Therefore, although the LiNEA Project findings involve graduate engineers in the workplace, the findings have limited relevance to this thesis. It is sufficient to summarise the findings here to show what has been accomplished in this adjacent field.

To sum up, this section first reviewed three professional course models proposed by Bines. Then it considered the practicum as a key part of professional courses. Some principles and mechanisms were identified. This section also supplemented some of Eraut's findings from the LiNEA Project involving graduate engineers, in order to show the literature in an adjacent research field. The existing studies usually use a case analysis or a case summary as their research style. For Western professional education, the theories and findings are comparatively developed. The remaining research gap may be to connect Western principles to evidence from China. Moreover, few studies consider the impact of the practicum on learning practical knowledge, which is another research gap.

Human Capital

As explained in Chapter One: Introduction, this research explores why the professional master's programmes can meet the expectations of the labour market, and the relationship between higher education and the labour market overarches this research focus. In the existing literature, the relationship between higher education and the labour market has often been explained by human capital. This section therefore reviews human capital findings and debates and their relevance to this research.

Human capital is a huge topic in economics, politics, and other social science areas. There has been a tremendous amount of economic evidence in support of human capital theory. Many studies in the related social science research fields consider 'human capital' an abstract concept and use other factors, such as years of schooling, as a substitute for it. Consequently, the literature concerning human capital is vast, and an overall review is both impossible and unnecessary here. Therefore, this section first outlines human capital generally and then reviews the key issues relevant to this study.

The first sub-section introduces human capital theories, arguments, and the general and key findings relevant to education. The second sub-section reviews the application of human capital to higher education studies and then narrows down the focus to postgraduate education studies, professional education studies, and China's higher education studies. The third sub-section briefly gives some accounts of human capital by educationalists from different perspectives. The final sub-section analyses some qualitative traits of human capital. Finally, research achievements and gaps are reviewed.

An Overview of Human Capital and Its Debates

In their classic textbook *Economics* (2010), Samuelson and Nordhaus (2010, pp.501-520) define capital as the durably produced items which can be used as productive inputs for further production. For a long time, capital used to refer to the tangible assets constituted by structures (e.g. plant), equipment (such as machines), and inventories (for example, goods in stock) (Samuelson and Nordhaus, 2010, pp.501-520). Investment in tangible capital could be rewarding.

The concept of human capital originated from the exploration of the residual in economic growth, which could not be explained by traditional economic growth theory in the twentieth century (Wykstra, 1971). In fact, Adam Smith [8] proposed this notion in *The Wealth of Nations* (1776). He argues that people

8 Adam Smith (1723–1790) was a Scottish moral philosopher, pioneer of political economy.

with their work capability are part of the wealth of a nation, and makes an analogy between an educated worker and invested physical capital (Smith, 2005). However, this issue was not a matter of great concern for economists until the 1960s, when Schultz (1961) points out that investment in education can facilitate productivity by the formation of human capital, which addressed the modern economic growth puzzle.

Over the past decades, the stock of human capital has been verified as making a significant contribution to economic growth (for example, in Schultz, 1961; Lucas, 1988; Romer, 1990; Lucas Jr, 1993). Becker (2009) links human capital to individuals, indicating that a higher level of education can raise an individual’s income and long-term well-being. As the studies went deeper, human capital was defined as ‘the knowledge, skills, competencies and other attributes embodied in individuals that are relevant to economic activity’ in the 1990s (OECD, 1998, p.9).

In econometrics or labour economics studies worldwide, multiple measurements have confirmed the benefits of human capital for both individuals and aggregates. Human capital can contribute to national economic growth, increase individual earnings, and reinforce individual and/or social well-being. Since it has been identified that human capital is formed by education, a tremendous amount of literature emerged discussing the relationship between education and human capital. The key related findings are summarised below. (Some of the literature concerns human capital in higher education, postgraduate education or professional education, which is more related to this topic, so it is reviewed in a separate sub-section: Human Capital and Higher Education, Chapter Two, p.67.)

At the aggregate level, there are some notable conclusions. For example, an additional year of average formal education increases the level of aggregate productivity by approximately 5% on impact and by a further 5% in the long term (De la Fuente and Ciccone, 2002). The general quality of schooling throughout a country, e.g. the financial input, the student to teacher ratios or the average performance of students, may relate to the size of economic growth (De la Fuente and Ciccone, 2002). At the individual level, the evidence suggests that people with a higher level of education tend to have higher incomes, fewer chances of being unemployed, and higher labour force participation rates (De la Fuente and Ciccone, 2002).

The econometric findings offer an image that education (or the investment in education) can bring benefits or other forms of profit to individuals in the labour market and to the macro economy. The existing findings confirm that the relationship between education and the labour market resides in human capital. Nevertheless, it remains unclear why human capital can play this role. Human capital theory has been described as 'a black box' by some scholars. What the *thing* learned by education is, its role in the labour market, and how it plays this role remain unknown.

Therefore, it is not surprising that human capital theory was challenged by screening hypothesis during 1970s and 1980s. Screening theory argues it has not been conclusively demonstrated that schooling can augment individual productivity; it suggests that the role of education is rather a 'screening device' to distinguish between individuals with different productivity capability and screen out those with lower levels (Groot and Hartog, 1995; Li et al., 2009). To some extent, screening theory does not totally deny the contribution of education, but offers an alternative hypothesis to explain the positive correlation between education and returns. This alternative interpretation is posited, because the attributes of human capital are not clear, for example, what exactly has been accumulated in education and the role it plays in the labour market.

Specifically speaking, for the concerns of this study, some master's programmes have been reformed from being research-orientated to being professional. According to the current understanding of human capital, both the academic and professional master's programmes are at the same level of education qualification. The graduates of these two different types of master's programmes have the same years of schooling and the same monetary and time investment in their education. They should thus have the same prospects in the labour market. However, why are the professionalised master's programmes expected to meet labour market expectations better? The existing human capital theories and evidence cannot address questions like this. Such questions require a further exploration of the concept of human capital, in terms of the *thing* learned through education, which constitutes human capital, and its role in the labour market.

This sub-section offered an overview of human capital theory, introducing its origins, development, and arguments. It provided a context for the following reviews and identified a broad gap in human capital theory.

Human Capital and Higher Education

As mentioned in the sub-section above, some of the literature is concerned with human capital in higher education, particularly postgraduate education or professional education, which is closer to this thesis topic than general education issues. This sub-section reviews this area in particular to show what have been done and what have been not done in the related fields. (The general education literature was reviewed briefly above and will not be further discussed in this thesis.) This sub-section first considers the key literature about higher education, then moves to postgraduate education and professional education specifically. Finally, it looks at the Chinese literature related to this area.

Concerning higher education generally, in the existing literature, there are one book chapter (Paulsen, 2001, pp. 55-94) and one monograph book (McMahon, 2009) cited frequently, focusing on human capital and higher education policies from a macro perspective. Paulsen (2001, pp. 55-94) applies human capital theory as an overarching theoretical context, and he presents, explains and illustrates the use of selected concepts and models from the economic theory of human capital that have influenced the analysis and understanding of students' decision-making in the market for higher education. Paulsen (2001, pp. 55-94) puts forth a representative view of the literature on the theory and research that supports the economic concepts of human capital theory being examined. Paulsen (2001, pp. 55-94) offers examples of how selected concepts and models form the economics of human capital that can be used to examine and explain how financial and other factors affect students' college-going behaviour. Paulsen (2001, pp. 55-94) also examines some recent public-policy proposals that may have an impact on the demand or supply side of the market for human capital, for instance, they may increase student investment in higher education or move a student from a disadvantaged to an advantaged position in the market for investment in human capital.

McMahon (2009) points out a modern human capital approach to higher education policy in his monograph book: *Higher learning, greater good: The private and social benefits of higher education*. By elaborating on the nature, measurement and valuation of the private and social benefits of higher education in the knowledge economy, McMahon (2009, pp.2-39) suggests that higher education policy has not responded to the challenges facing the sector: 'a massive skills deficit generated by globalization and technical change', and while the real incomes of graduates have increased by a phenomenal 57% since 1980, the sector has not responded to the 64% of Americans who have been excluded from those benefits. This monograph book suggests government policies for higher education neglect the public good nature of higher education, based on the recapitulation of the private and social benefits of higher education in the United States of America and other OECD countries.

In addition to studies from the macro perspective, some related studies consider human capital and higher education from very specific angles and based on national or regional cases. For example, Faggian et al. (2007) identify the mobility effects of human capital acquisition based on a geographical methodology and framework. Their results confirm the Sjaastad–Becker hypothesis that individuals with higher human capital are more geographically mobile and also argue that the mobility effects of human capital acquisition have to be interpreted carefully in the light of other economic, geographical, and social influences (Faggian et al., 2007).

Garcia-Aracil et al. (2004) analyse the labour market rewards for some required human capital competences, using a sample of young European higher education graduates. Based on mathematical statistics, such as factor analysis and ordered logit regression, their results on wage rewards show that jobs which require higher levels of participatory and methodological competences are the best paid, whereas jobs with a higher requirement of organisational, applying-rules, and physical competences are worse paid (Garcia-Aracil et al., 2004). Their results for total rewards suggest that jobs with higher requirements of competences increase graduates' satisfaction, the only exception being applying-rules competences (Garcia-Aracil et al., 2004).

Herndon (2008) examines the relationship between a set of independent variables, including two measures of state spending on higher education, and the formation of human capital in his PhD thesis. Based on existing related statistic data in the United States of America, Herndon (2008) finds that increases in state spending per full-time equivalent enrolment in public higher education predict decreases in the formation of human capital, while increases in state spending per capita in public and private higher education predict increases in the formation of human capital. Herndon (2008) also finds that increases in state higher education spending predict increases in the formation of human capital in states with low productivity growth or with low levels of income inequality, but increases in state higher education spending predict decreases in the formation of human capital in states with high productivity growth.

Methodologically, some of the literature takes proxy factors related to higher education, such as the investment in higher education or the possession of higher degrees, as a substitute for human capital to consider the relationship between these proxies and other economic or social factors. For example, Winters (2011) considers the effects of local human capital levels and the presence of HEIs (higher education institutions) on the quality of life in U.S. metropolitan areas. Winters (2011) measures the local human capital level by the proportion of adults with a college degree and measures the relative importance of HEIs by the percentage of the population enrolled in college. Winters (2011) finds that the quality of life is positively affected by local human capital stock levels and the relative importance of HEIs.

The literature that specifically considers human capital in postgraduate education and professional education is far less than that for higher education. Concerning postgraduate education, some empirical studies focus mainly on individual returns, while few focus on aggregate benefits. The positive impact of postgraduate education on wages has been confirmed. Postgraduate degree holders earn more than undergraduates; PhD holders have higher incomes than masters (see in Jaeger and Page, 1996; Song et al., 2008; Fatima, 2009; Walker and Zhu, 2011; Morikawa, 2012).

Concerning professional education, Fatima (2009) in particular estimates the effects of investment in masters, doctoral and professional education on the subsequent growth in state workforce productivity. The findings indicate that cumulative investment in them significantly affects the subsequent growth in state workforce productivity (Fatima, 2009). Apart from Fatima, there is little in the literature focusing on human capital theory applied to professional education. Van Loo and Rocco (2004) argue that the existing human capital studies focus on training but pay little attention to continuing professional education. They also identify the differences between continuing professional education and training, and infer that the evaluation methodologies for human capital applied to training are not appropriate for continuing professional education (Van Loo and Rocco, 2004).

Finally, this sub-section reviews human capital studies in higher education and in particular, postgraduate education in China. Generally speaking, the evidence from the last three decades demonstrates that investment in human capital is beneficial to individuals and is one of the engines of China's progress (Liu et al., 2010; Morgan, 2013). At the individual level, related studies commonly use the

Internal Rate of Return formula, Net Present Value[9], and Mincer Rate of Return (for example, see in 赵瑜 Zhao et al., 2006; 彭少春 Peng, 2007; 吴旭华 Wu et al., 2010). They have reached the consensus that investment in postgraduate education is more worthwhile than in physical capital (赵瑜 Zhao et al., 2006; 吴旭华 Wu et al., 2010).

At the aggregate level, the related research often compares the impact of postgraduate education human capital and physical capital on economic growth, and/or compares the impact of postgraduate education human capital and the impact of undergraduate education or compulsory education on economic growth. Postgraduate education human capital has a clearly positive impact on economic growth (黄海军 Huang and 李立国 Li, 2012). Moreover, its contribution is higher than human capital from other educational levels (叶茂林 Ye and 郑晓齐 Zheng, 2003). Nevertheless, compared with the returns to investment in physical capital, this impact is still very small in contemporary China (陶军 Tao et al., 2011; 黄海军 Huang and 李立国 Li, 2012). Furthermore, compared with the United States, the impact of postgraduate education on economic growth in China is lower (黄海军 Huang and 李立国 Li, 2012). So far, few Chinese literature considers human capital in professional master's education.

To sum up, this sub-section concentrated on the literature considering human capital in higher education generally, postgraduate education and professional

9 In finance, Net Present Value (NPV) is defined as the difference between the present value of cash inflows and the present value of cash outflows.

education in particular, and then China's higher education and postgraduate education. The literature further provides sufficient evidence to confirm the contribution of higher education to individuals and the economy.

Nevertheless, these studies take a view angle from the externalities of higher education. They see higher education (or postgraduate education, professional education) in its entirety in society and/or the economy, and they confirm this *entirety* (i.e. higher education) can make a contribution to economic growth. So far, few studies have considered why higher education can make a contribution and why human capital can play this role. In particular, few studies have considered the *why* issue from the internal perspective of higher education, for example, higher knowledge and skills, or university courses. The existing theories and evidence offer little to illustrate whether certain kinds of knowledge learned in higher education can form human capital and contribute to the labour market and the economy. In the existing studies about human capital and higher education, an internal perspective of higher education is missing, which is a research gap in this area.

Contemporary Educationalists' Accounts of Human Capital

As established above, in the existing human capital studies, the traditional methodologies of econometrics or mathematical statistics dominate; methodologically, considering human capital issues from the internal perspective of higher education is a research gap. Some contemporary educational literature attempts to consider human capital based on individual accounts rather than the traditional methodologies of econometrics or mathematical statistics. This literature offers the methodological foundation for this research: findings can be based on individual accounts and other forms of qualitative data. Therefore, this sub-section considers this area of the literature.

As McGrath (2010) points out, some contemporary literature delves beneath the widespread belief that education (often repackaged as human capital) is significant to development and considers the role of education in shaping the wider discourses of development. For example, some educational studies choose a qualitative methodology to offer critical accounts of human capital. Lim et al. (2012) examine the 'task shifting' adopted by health professions and present ethnographic evidence derived from a case study of the pharmacy workforce issues in Malawi. Lim et al. (2012) argue that professional skills development is context-laden and in need of a human-centred approach that involves true indigenous participation – challenges not unlike those faced in the vocational skills discourse. This study adopts an alternative approach to consider human capital from the perspective of VET (vocational education/training) education rather than the traditional econometric methods. Its methodology and findings provide an innovative angle for this thesis to explore human capital and professional master's education.

Moreover, studying abroad or highly skilled migrants can bring mobility of human capital internationally; some emerging literature examines these issues to consider human capital from the perspective of higher education itself. Madziva et al. (2014) explore the specific ways in which the communicative competences of migrants from Zimbabwe with high formal levels of English operate in complex ways to shape their employability strategies and outcomes, drawing on 20 in-depth interviews of Zimbabwean highly skilled migrants in UK. Madziva et al. (2014) identify the gap between their high level formal linguistic competence and their ability to communicate in less formal interactions challenged their employability, and the migrants also 'lack the competence to narratives their employability' properly in England. Madziva et al. (2014) therefore suggest 'to realise the full potential of their high levels of human capital, they need to learn how to communicate competently in a very different social and occupational milieu'. Thondhlana et al. (2016) also focus on highly skilled migration from Zimbabwe to the UK, exploring these migrants' social capital sources/structures and content. These case studies broaden the horizon of human capital research.

The emerging literature about human capital from the eyes of educationalists offers not only rich critical accounts of human capital but also alternative approaches that can examine human capital. Their attempts help human capital studies to move beyond the shackles of economic methodologies. Nevertheless, comparatively speaking, as McGrath (2010) argues, education is still not the lead discipline when it comes to development; economics still dominates, and even other disciplines (for example, anthropology) seem to be more significant in shaping development thinking than education. To establish an educational interpretation of human capital requires building it up brick by brick in different dimensions. The existing literature makes significant contributions by laying the foundation for some of these dimensions. However, other 'dimensions' are not yet under construction. These ‘dimensions’ are the research gaps in this field, for example, accounts of human capital from the aspect of Chinese master’s professional education.

Some Qualitative Traits of Human Capital

In this section, the first sub-section (An Overview of Human Capital and Its Debates, p.63) identified a broad gap in human capital studies, the second sub-section (Human Capital and Higher Education, p.67) narrows down the research gaps in this research area, and the third sub-section (Contemporary Educationalists’ Accounts of Human Capital, p.73) reviews an alternative approach to considering human capital. Based on the review so far, the research gaps in human capital studies are further narrowed down as: (i) why human capital theory can explain the relationship between higher education and the labour market, and (ii) studying this issue through individual accounts and interpretations rather than mathematical methods. In addition to the narrowed down research gaps above, the second section of this chapter (Knowledge in Professional Education, p.34) identified some issues about knowledge in professional education, which is another research gap in the professional education field. The overlap of the gaps, i.e. knowledge in professional education and the relevance to human capital, is the objective of this sub-section.

This sub-section therefore considers some ‘qualitative’ traits of human capital (not econometric findings as in previous sub-sections). First, some commonly accepted definitions of human capital are cited below:

- 'The knowledge, information, ideas, skills, and health of individuals' (Becker, 1964).
- 'The concept of human capital refers to the facts that human beings invest in themselves, by means of education, training, or other activities, which raises their lifetime earnings' (Woodhall, 1997).
- 'The knowledge, skills, competencies and other attributes embodied in individuals that are relevant to economic activity' (OECD, 1998).
- 'An individual's embodied skills above their raw labour ability – can be obtained in many forms: schooling and training are the educational forms of interest here, but alternative forms may be experience or simply watching those who already have a large stock of human capital' (Belfield, 2000).
- 'The key aspect of human capital has to do with the knowledge and skills embodied in people and accumulated through schooling, training and experience that are useful in the production of goods, services and further knowledge' (De la Fuente and Ciccone, 2002).
- 'Human capital is defined by the OECD as the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being' (Brian, 2007).

Some characteristics of human capital can be inferred from these definitions. First, human capital is formed by formal education, training or other similar activities (Woodhall, 1997; Belfield, 2000; De la Fuente and Ciccone, 2002). This trait distinguishes human capital from the other forms of intangible abilities embodied naturally in human beings. For example, a good singing voice without any formal training is an innate talent rather than human capital.

Secondly, human capital is beneficial, but in various specific forms. It can be monetary, e.g. it can raise individual earnings (Woodhall, 1997). It can have an indirect influence on monetary returns, e.g. be beneficial in production or in further learning (De la Fuente and Ciccone, 2002). It can also facilitate the creation of personal and/or socioeconomic well-being, or even a more healthy life (Brian, 2007).

Finally, the existing form of human capital is said to be the 'knowledge, skills, competencies and other attributes' embodied in individuals (OECD, 1998; Belfield, 2000; De la Fuente and Ciccone, 2002; Brian, 2007). Knowledge used here is in its narrow sense, bracketed with skills, competencies, and so forth. When knowledge in the broad sense is involved, these well-established definitions imply that the nature of human capital is the knowledge possessed by individuals.

The analysis of definitions shows the concept of human capital can link knowledge, education, and the labour market together. Human capital consists of knowledge (in the broad sense, including skills, abilities and competencies), is accumulated through formal education, and has an impact on employment. This is the reason why human capital theory is considered here as the theoretical underpinning for examining the professional master's education reform in China.

Besides definitions, human capital also has classifications. For example, Becker (1962) points out that human capital comprises general human capital and firm-specific human capital. De la Fuente and Ciccone (2002) identify three components of human capital: first, *general skills*, which refers to the basic language and quantitative literacy or more broadly the ability to process information and use it for problem-solving and learning; secondly, *specific skills*, which is related to the operation of particular technologies or production processes; thirdly, *technical and scientific knowledge*, which is organised knowledge and analytical techniques. However, there has been little further study of this classfication.

To sum up this section, the findings from economic studies offer a clear picture that education plays an important role in the economy and society through the formation of human capital. It offers the overarching theoretical context for this thesis. Moreover, the commonly accepted definitions and classifications of human capital help to establish the theoretical sub-frameworks for this research, for example, the knowledge constitution of human capital. (The theoretical sub-frameworks are shown and discussed in Chapter Five: Data Analysis.) Some contemporary education scholars provide a new research approach, namely individual accounts, which can be considered in the analytical framework for this research (which is explained in Chapter Three: The Methodology and Methods).

However, from the standpoint of education, human capital theory does not seem to be fully developed, although some basic attributes have been identified. The components and the formation of human capital remain unclear. The first sub-section identified this broad gap, and the second sub-section narrowed down the research gap to why human capital can explain the relationship between higher education and the labour market. The third sub-section further offered an alternative research approach to address the gap, which is considering the issue from individual accounts and interpretation rather than mathematical methods. The final sub-section refined the gap, in terms of the constitution and classification of human capital. For example, human capital has been defined as constituted by knowledge (including skills, abilities, and competencies), but the specific kinds of knowledge is not known.

In summary, the research gaps in human captial studies related to this topic include (i) the specific types of knowledge (including skills, abilities, and competencies) accumulated in education programmes to form human capital, (ii) how they have been accumulated in education programmes, for example, by taught or through practice, and (iii) whether different types of knowledge can form different types of human capital and further can play different roles in the labour market. Methodologically, human capital has been studied largely by econometric methods as reviewed, but the nature of human capital also needs a descriptive analysis. At this primary stage, qualitative and interpretative methods can be considered.

Research Gaps and Research Questions

Based on the previous review, this final section summarises the research gaps in each field and then discusses the main research question and its subsidiaries in detail.

This chapter first examined Western professional education, Chinese professional master's education generally, and the new professional master's programmes specifically. Western principles and findings have had little application to China's practices. The existing Chinese literature often focuses on the implementation issues of the programmes to identify problems and provide advice. There are still many research gaps, for example, why the professional master's programmes can match labour market needs better (than academic programmes).

Based on the review of the literature, human capital can be the link between knowledge, education, and labour market returns. Human capital consists of knowledge; human capital is accumulated by formal education; human capital has an impact on employment. However, the gaps in human capital research area include:

- the types of knowledge acquired in education programmes to form human capital; and
- the approaches whereby these types of knowledge are accumulated in education programmes, such as being taught or practising.

Based on these gaps, this chapter further reviewed two surrounding sub-areas. First, concerning knowledge of professional education, the research gaps include the knowledge learned in professional engineering master's education in China's context. Secondly, concerning how knowledge is acquired in professional education, the research gaps include the impact of the professional practicum on learning different kinds of practical knowledge and the application of existing theories to the Chinese context.

To return to the above connection with human capital, it has not been explained that what kinds of knowledge play a role and why they can play a role in that way, and it is unclear that whether different types of knowledge can form different types of human capital and further play different roles in the labour market. Methodologically, human capital has been studied largely by econometric methods as reviewed, but the nature of human capital also needs a descriptive analysis. At this primary stage, qualitative and interpretative methods can be considered.

Based on the theoretical and the methodological gaps above, this research aims to examine China's professional master's programmes in engineering disciplines through a qualitative case study. The main research question is

> *Why are the new professional master's programmes, specially designed with a professional practicum, expected to meet labour market demands in China?*

The three sub-questions and their objectives are set out below.

i. *What knowledge is learned in the professional practicum of the professional master's programmes?*

This aims to investigate and categorise the knowledge learned by students in the professional practicum. The findings will be compared with the existing knowledge typologies of professional education and developed as a knowledge map (framework). This question, providing the 'keynote' of the knowledge framework, enables the following two questions to be explored.

ii. How did the students learn the knowledge in the programmes?

This will investigate how the professional practicum is designed and how the students completed it. The how-to-learn question *per se* is not a key inquiry in this thesis, but it plays the role of a bridge linking what-to-learn with why-to-learn. For example, in different types of practicum, students may acquire different kinds of knowledge. Therefore, the question will examine the course structure of the professional master's programmes first. Then it will concentrate on the professional practicum. Finally, it will analyse the relationship between the practicum types and the different categories of knowledge acquired.

iii. Why is the acquired knowledge sought after by the labour market?

This question is innovative, because there is little in the literature considering it directly. It crosses different research fields, i.e. the economics of higher education (human capital), knowledge in professional education, professional education courses, and learning theories (learning-by-practising). Few theories can underpin it directly. Therefore, it has to be based on the findings of the previous two questions.

Unlike UK and some other Western countries, China's higher education system has been sponsored mainly by public funds and supervised fully by the government, and the development of higher education has traditionally been driven by national demands and government policies, maybe due to the legacy of the central-planned economy of the last century (details in The Context of the Findings, Chapter Four: Data Presentation, p.134). Consequently, this research is different from some existing western studies that consider the issue from the perspective of employers only. The third sub-question aims to be addressed from a macro and comprehensive view and considered within the national development context of China. From this standpoint, the initiatives of the government and higher education sector are as important as the demands of individual employers and individual students.

The framework of this sub-question is primarily enlightened by Taylor and Watson's model of the stakeholders of professional education (The Stakeholders in Professional Education, Chapter Two, p.19). Therefore, this question is designed to be answered by accounts from the perspectives of different stakeholders.

As reviewed in Professional Education in China (Chapter Two, p.23), professional education has several stakeholders, including the government, professions, employers, course designers, the academic staff of universities, different kinds of students, and other participants, such as clients or the community. In China' context, government policy plays a key role, so the government is considered as the first stakeholder. The professions in China, which are not as developed as in the West, have less impact on professional master's education. Similarly, so far, there has been no evidence that 'other participants', like the community, can influence professional master's education in China. Therefore, the professions and 'other participants' are not considered as stakeholders in this thesis. Finally, this study takes a framework consisting of the government, course designers, the labour market, academic staff, and students as the stakeholders of professional master's education, as shown in Figure 2-1.

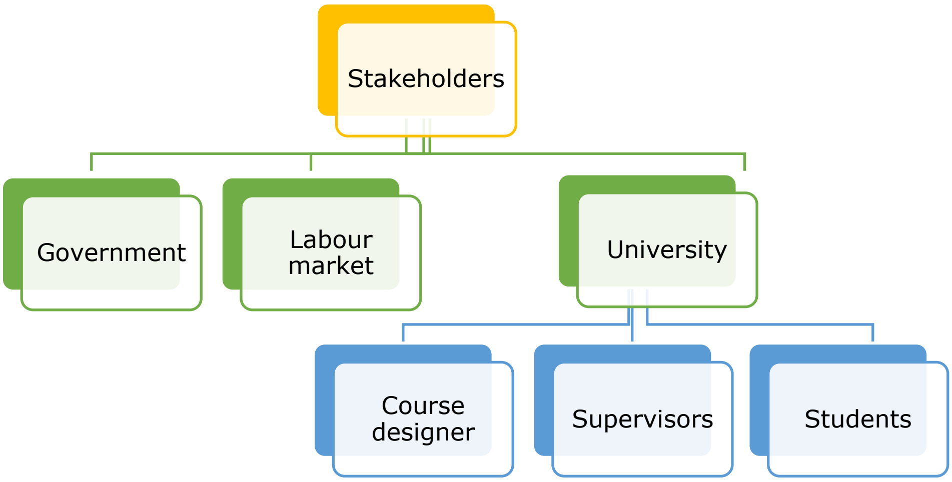


Figure 2-1 The five groups of stakeholders of professional master's education in China

This issue is designed to be interpreted from the five perspectives above. The role of the knowledge learned in the professional practicum will be considered in aggregate (its potential contributions to the economy and society) and for individuals (its impact on students' job prospects). The findings will be connected to the human capital theory to further develop the theory.

With respect to students, this research focuses on their *job prospects* rather than their actual graduate jobs for two reasons. First, investigating students' final jobs needs a further tracking survey over years (after the fieldwork is over), which is unfeasible for this PhD study. Moreover, the research aims at the role of knowledge in the labour market, while actual employment depends on many other variables, such as personal priorities or social networking (for example, see in Li et al., 2015), which are unrelated to the findings and aims of this study. Therefore, actual employment cannot accurately reflect the effect of knowledge acquisition. Consequently, after weighing the advantages and disadvantages, this research takes job prospects to approximate for the effect of knowledge on the labour market. Nevertheless, a tracking survey of professional master's graduates' employment might be a research direction for the future, which will be discussed in the concluding chapter.

Summary

This chapter reviewed the related literature and stated how the research questions were developed. First, concerning the research object, namely professional master's education, it considered professional education in the West and China, suggesting some possible research directions. The next two sections examined the literature on the knowledge and learning approaches in professional education. The fourth section reviewed the theories, findings, and methodology of human capital. In each field, the related principles, findings, and methods were sorted and reviewed, and research gaps and methodological gaps were identified. The final section specified the main research question and sub-questions. Based on these, the next chapter will consider the appropriate methodology and research methods for addressing the research questions, together with some ethical issues.

Chapter Three: The Methodology and Methods

Introduction

The purpose of this chapter is to set out the methodology and research methods used to address the research questions. The first section sets out the research methodology. The second section describes the research design and data collection design. The third section reports what were done and how the data were collected in the fieldwork. The fourth section describes the collected data and outlines how they were processed after the fieldwork. The final section considers the related ethical issues.

Methodology

This research uses a qualitative methodology approach, because it matches the purpose of this research. This section elaborates the reasons for taking a qualitative approach.

First, the qualitative research has three traits which are appropriate to this study. The first trait is that, in qualitative research, the research focus is through the eyes of the people being studied (Bryman, 2012, p.408). My research aims to interpret professional master's education from the perceptions of the students and academic staff involved. Secondly, qualitative research seeks to understand the behaviour, values, beliefs, and so forth of those studied in the context in which the research is conducted (Bryman, 2012, p.408). This research investigates the professional master's programmes against the background of China's development, so the context is relevant to the data analysis. Thirdly, qualitative research can provide rich and deep data (Bryman, 2012, p.408) to help answer the 'why' question of this study. Based on the three characteristics above, the research questions can best be addressed by taking a qualitative approach.

Secondly, this research is based on constructionism ontology (but not objectivism) and interpretivism epistemology (but not positivism), hence, a qualitative approaches suits it best. As revealed in Chapter One: Introduction, the research focus is constructed on the premises that (i) the relationship between higher education and the labour market is explained by human capital theory and (ii) the incentive for master's education reform is labour market demands. Nevertheless, in addition to these premises, there are other perspectives and theoretical underpinnings to consider concerning the professionalised master's programmes and the incentive of professionalisation. However, in this research, based on my research background and interests, the social construction of master's education is built upon this interpretation, not any generalised and external reality. Thus, the ontological position of this research is constructionism rather than objectivism.

Based on the constructionism ontology, the epistemological orientation is interpretivism. As established in Research Gaps and Research Questions (Chapter Two: Literature Review, p.80), the research questions are designed to be addressed by accounts from different perspectives (government policy, the labour market, course design, academic staff and students). This is a subjective understanding of a social phenomenon, different from external reality. Consequently, the natural science model cannot address the research questions, and interpretivism, but not positivism, is the epistemological position. Qualitative research stresses constructionism and interpretivism at its basis (Cohen et al., 2007; Bryman, 2012, p.36). Therefore, a qualitative approach (rather than a quantitative one, based on a large number of incidents of the same phenomenon) is the best approach for this research.

Furthermore, in this thesis the relationship between research and theory is inductive. This research aims to generate theories which emerge from the research data, so it is a typically inductive process. This is different from the deductive process. For example, as reviewed in Chapter Two (Human Capital, p.62), some human capital studies have tested the returns of investment in education using quantitative data and deduction using the evidence provided by the data. This study is different from the existing quantitative studies using deductive methods. According to Bryman (2012, pp.24-27), the inductive strategy is typically associated with qualitative research approach as it works from the observation of traits to produce possible explanations. Therefore, a qualitative strategy best fits the research aims here.

To sum up, this short section has classified the methodology of this study as qualitative, based on the features of qualitative research, the ontology and epistemology of this study, and the connection between the research and theories.

Research Design

According to Yin (2013, p.28), the research design is a logical plan for getting from *here* to *there*, where *here* refers to the research question and its subsidiaries, and *there* is the data to answer these questions. This section sets out the *plan*, namely the research design. In this section, the first sub-section explains why this research adopts a case study and gives reasons. The second sub-section defines and bounds the case, and then profiles the case study university. The third sub-section sets out that what kinds of data are designed to address each of the three research sub-questions. The final sub-section describes how the interview and document data are designed to be collected.

Why a Case Study?

This research uses a case study rather than other research styles, such as cross-sectional study, longitudinal study, or experimental research. This sub-section explains the reasons why.

Primarily, according to Yin (2013, pp.9-15), the case study is preferable in situations where:

- The main research questions are 'how' or 'why' questions;
- The researcher has little or no control over behavioural events;
- The focus of the study is a contemporary (as opposed to entirely historical) phenomenon.

In this research, the main research question is a 'why' question, and the subsidiary questions include ‘how’ and ‘why’ question, so they match the first bullet point. The research does not focus on the frequency or the incidence of the phenomenon studies, but tends to be explanatory. Therefore, according to Yin (2013, pp.9-15), a survey or archival analysis could not meet the aims of this research, but a case study does. Secondly, the professional master’s programmes studied in this thesis is a fact which cannot be manipulated or controlled by the researcher. It fits the second condition. Thirdly, the research object is contemporary, so according to Yin (2013, pp.9-15), historical and experimental research could not meet the aims of the research either. Therefore, this research and its questions fit the ‘niche’ of the case study.

Furthermore, this research examines the professional master’s programmes involving the specific design and delivery of courses. The micro context of the master’s programmes, i.e. the university, may have a bearing on the findings. Thus, the research is closely linked to the setting of an individual university, and so is the data collection. The research should be designed in an individual university. Therefore, the case study matches the research objectives and context.

In addition, the PhD study itself is self-funded and time-limited, and without any partnership in the fieldwork. The other research styles, such as a cross-sectional survey or a longitudinal study, are both unaffordable and unfeasible for this PhD thesis. The case study is feasible in terms of time and money for this PhD study.

Therefore, for all the above reasons, this research employs a case study. However, this does not mean the case study used here has no drawbacks. For instance, case study findings are difficult to be generalised. Lack of generalisability is a limitation of the case study.

Nevertheless, limited generalisability is acceptable in this study because the research aims to explore a theory to address a why question but not to generalize any established theory. At this preliminary stage, the case study might not have been the perfect choice, but it is the most reasonable one.

Defining, Bounding, and Profiling the Case

Yin (2013, pp.28-31) points out some principles for choosing the case. First, the case(s) should be chosen to most likely illuminate research questions; secondly, there are at least two steps: defining the case and bounding the case (Yin, 2013, pp.28-31). Based on these principles, the case in this research is defined as the professional engineering master's programmes at B University[10] in China in terms of knowledge acquisition, students' practices, and students' job prospects. The persons within this case are bounded as the students and academic staff involved in professional master's programmes.

B University was chosen as a 'common case', according to Yin (2013, p.52), or a 'representative or typical case', according to Bryman (2012, p.70). The

10 B University is in the anonym of the case study university.

representative case, typical case, or common case is an example of a broader category, and it provides a suitable context for the research questions to be answered (Bryman, 2012, p.70). The following paragraphs explain the reasons why B University fits these criteria, combined with the university's profile.

First, as reviewed in Chapter Two (China's New Professional Master's Programmes, p.27), there is a research report offers a country-wide overview of the programmes in China. It profiles some universities involved in piloting the professional master's programme reform. B University appears as one case in the report. Therefore, the report offered an external reason for choosing B University as the case to be studied.

With respect to internal reasons, first, B University is a research university with well-established postgraduate education in China. B University is a state-funded public university, founded in the 1950s, with two campuses located in a mega city in China's mainland. It has a highly respected reputation in science and engineering. It was one of the first universities to establish postgraduate education in the full sense in contemporary China. Up to March 2014, it had 12,715 registered postgraduate students, and 27 schools had master's courses, covering engineering, science, mathematics, management, economics, education, law, medicine, and the arts.

Secondly, B University not only implements the professional master's programmes, it also participated in reform pilot[11] from September 2010 to June 2013 before the nationwide reform was in place. It has accumulated a good deal of experience of the new professional master's programmes, and is therefore a suitable case to investigate.

Furthermore, B University launched its *Full-time Professional Master's Programmes* in 2009. Since then, it has carried out a range of reforms. For example, it introduced more robust course criteria, improved the curricula, strengthened the academic staff team, and explored new education paradigms. The numbers of professional master's programmes and entrants have been augmented. For example, in 2013, the professional master's programmes enrolled 1,476 master's students, while the academic master's programmes enrolled 1,742 students, showing almost half the new master's students were enrolled in professional programmes. Up to 2013, the new professional master's programmes had 23 professional areas covering 39 disciplines and 60 sub-disciplines[12]. B University can provide a comparatively developed institutional

11 The Ministry of Education conducted and supervised 专业学位研究生教育综合改革试点工作 (*zhuan ye xue wei yan jiu sheng jiao yu zong he gai ge shi dian gong zuo*) [The Pilot for the Comprehensive Reform of Professional Master's Programmes] from September 2010 to June 2013. The mission includes grasping the regulations of the professional master's programmes, improving the course criteria and evaluation, innovating educating paradigms, and so on. 64 selected universities participated in the pilot.

12 See in 我校 2013 年学历研究生招生工作结束 (*wo xiao 2013 nian xue li yan jiu sheng zhao sheng gong zuo jie shu*) [B University postgraduate students recruitment in 2013]. Available at: <http://news.[...].edu.cn/dispnews.php?type=4&nid=100680&s_table=news_txt> (Accessed: March 6th 2014)

context and practical experience of the professional master's programmes, which is a good basis for the investigation.

The case study university is briefly introduced here in order to explain why it was chosen for the case study. Specific information about the case study university, related to the findings, will be presented in Chapter Four: Data Presentation.

A Brief Introduction of the Analytical Framework

In this thesis, the analytical framework is mentioned in related sub-sections or sections in the literature review chapter, the research method chapter, and the data chapters. The research is interdisciplinary and involves theories of knowledge (epistemology), professional education (higher education), and human capital (economics), and the framework is complex. Therefore, it is both difficult and unnecessary to illustrate the analytical framework completely in a single a section or sub-section. However, in order to offer a context for the following data collection design, it is necessary to briefly introduce the analytical framework in terms of the kinds of data designed to address the three research sub-questions and why.

The theoretical framework for the first sub-question, *what knowledge is learned in the professional practicum of the professional master's programmes?* is based on the knowledge of professional education from Eraut, Jarvis, and Billett, as reviewed in Chapter Two (Knowledge in Professional Education, p.34). The key purpose of this question is to identify and classify the particular knowledge learned by the students on the programmes. Therefore, this question is designed to be answered by data from interviews with the students. In the interviews, students would be asked what knowledge, skills, abilities, and/or competencies they learned from the programmes.

The second sub-question, *how did the students learn the knowledge in the programmes?* aims to investigate how the professional practicum is designed and what the students did to complete it. The theoretical framework is based on Bines' professional course models (in Course Design, Chapter Two: Literature Review, p.51) and Wen's three modes of professional practices (in China's New Professional Master's Programmes, Chapter Two: Literature Review, p.27). This question is designed to identify the course mode of China's new professional master's programmes first and then investigate the professional practicum. Therefore, it is designed to be addressed by two sources of data. One source is the documentary data, i.e. the course programmes, to find out how the knowledge in the programmes is designed to be transmitted. The other data source is the interview data from students to find out how the knowledge is actually acquired in practice. The students would be asked in their interviews to describe what they did in their professional practicum.

The third sub-question, *why is the acquired knowledge sought after by the labour market?* is an innovation of this thesis, because the issue crosses several research fields, so there are few theories that could directly underpin it. The framework is primarily enlightened by Taylor's and Watson's model of the stakeholders of professional education (in The Stakeholders in Professional Education, Chapter Two: Literature Review, p.19). Therefore, interviews and text accounts from the different stakeholders' perspectives are designed to address this question.

China's higher education system is different from the Western model. Probably due to the inheritance of the central-planned economy in the last century, China's higher education system have been supported mainly through public funds, and the development of higher education has traditionally been driven by national demands and government policies (details will be presented in The Context of the Findings, Chapter Four: Data Presentation, p.134). Therefore, in contrast to some western studies that consider the issues from the perspective of individual employers, the third sub-question aims to explore why some kinds of knowledge are important to industries and the labour market from a macro and comprehensive viewpoint. From this viewpoint, the initiatives of the government and higher education sector are as important as the demands of individual employers and needs of individual students. Based on a review of China's professional education (Professional Education in China, Chapter Two, p.23), five perspectives have been identified in this thesis: government policy, course design, the labour market, academic staff, and students.

Consequently, for the data design, the discourse in government policy can represent the voice of the government, and policy documents are taken as the relevant documentary data. The course programmes set out clearly how the courses are designed, so this kind of documentary data is also designed to be collected. The perspective of the labour market refers to the kinds of knowledge demanded by the labour market. The job requirements in job advertisements are designed to be the documentary data. The interviews with academic staff are designed to generate data from their accounts of the implication of the programmes, the students' practicum and their employment prospect, and the role of knowledge in industry. The perspective of students is designed to be addressed by the students' interview data. The students' interview questions concern their graduate job prospects and the role of knowledge in their graduate job prospects.

Ideally, the voice of the employers, such as the CEO of a company, a HR manager, or a director of an R&D department, would be attractive interview data to interpret why certain kinds of knowledge are important to sample industries. Therefore, I aimed to interview some CEOs, HR managers, or directors. However, there was no research funding and no project partners, and access to these people could not be guaranteed during the fieldwork. I realized the difficulties of interviewing individual employers before my fieldwork, so I designed a feasible alternative. The job requirements of job advertisements clearly indicate the kinds of knowledge and skills required by jobs in the labour market. They can therefore represent the demands of the labour market in this research. However, I still planned to interview employers at the research design stage, because I wanted to collect data that was as rich as possible. In the end, I was not able to access any employers, which will be explained in the following section Fieldwork and Data Collection.

Data Collection Design

As stated, in the analytical framework above, this research employed interviews and documents as the data sources. This sub-section outlines the design of data collection. The actual collection process will be outlined in Fieldwork and Data Collection in this chapter (p.104), and the specific sources of data will be profiled in Data Profile and Processing in this chapter (p.120).

Interview Design

This study's primary data source is from interviews. According to Yin (2013, p.106), the interview as a source of evidence in the case study has two strengths. First, the interview focuses directly on the case study topics, which are targeted; secondly, it can provide explanations as well as personal views, perceptions, attitudes, and meanings, which are insightful (Yin, 2013, p.106). The research questions of this study largely involve the interpretations and perceptions of different groups of people, hence interviews are the best tool to address the subsidiary questions, i.e. what knowledge is acquired in professional practicum (by interviewing students), how the knowledge was acquired (by interviewing students), and why the acquired knowledge is necessary (by interviewing students and academic staff).

The semi-structured interview is the instrument for data collection. It can conduct the interview within a designed framework, unlike unstructured interviews that are not planned. The semi-structured interview also differs from structured interviews, which are often used to generate quantitative data. Semi-structured interview questions can generate data concerning the participants' own thoughts. The interviewer can also ask new questions or follow-up questions. Therefore, semi-structured interview can allow further and more thorough understanding of the issues by the interviewees. The semi-structured interview can thus generate rich and detailed data.

According to Bryman (2012, p.471), in semi-structured interviews, the researcher has a list of questions or fairly specific topics to be covered, often referred to as the interview guide. In this case study, as there were different groups of interviewees, namely students and academic staff, different interview guides were prepared for each group (see in Appendix A: Interview Question Guides, p.329). The interview questions and answers from the fieldwork are described in Data Profile and Processing of this chapter (p.120).

According to Bryman (2012, pp.418-421), in qualitative research, data collecting carries on until theoretical saturation has been reached. This means that interviews have formed the basis for creating categories, and no new categories have emerged, hence there is no need to continue with data collection regarding the categories; instead, the researcher should move on and generate the categories that are building up (Bryman, 2012, pp.418-421). This case study takes the theoretical sampling approach of a purposive sample. A specific number of interview participants is not part of the research design. How and how many interviews were conducted will be set out in Fieldwork and Data Collection in this chapter (p.104).

Pilot

A pilot assessed the prepared question guides. Six master's students, studying at or graduates of B University, tested the student pilot interview guide. Three people, one academic staff member in B University and two senior scholars at China's HEIs (higher education institutions), tested the academic staff pilot interview guide. The interview guides were appraised for their clarity and the answerability of each question, and the testers offered a general impression of the whole interview, such as whether they are comfortable with the questions and the coherency of the questions. The question guides were then revised based on the pilot feedback. The wording of the questions was improved to make them clearer. For instance, a question about the students' knowledge acquisition was designed as '*what did you learn in the professional practicum*', which seemed to be too broad for the respondents to answer. Based on the pilot feedback, it became two separate specific questions: '*what professional knowledge and specialist skills did you learn in the professional practicum*' and '*what general abilities, such as team skills or interpersonal communication capability, did you learn in the professional practicum*'.

Documentary Data Collection Design

Documents are the other source of evidence for three reasons. First, Yin (2013, p.106) points out that documents can be the source of evidence in the case study because of four strengths:

- It can repeatedly be reviewed, which makes it stable.
- It cannot be created as a result of the case study, which means the evidence is unobtrusive.
- It can contain the exact names, references, and details of an event, which makes it specific.
- It can cover a long span of time, many events, and many settings, which makes it broad (Yin, 2013, p.106).

In addition to the strengths above, there are two other reasons for collecting documents as data sources in this research. First, some official information and stances (not personal perceptions) already exist in the official documents. For questions like '*what knowledge is designed to be learned in the course*' or '*how is the course designed to be delivered*', the course programme documents (Chinese: 培养方案 *pei yang fang an*) clearly outline them. Therefore, to answer these questions, documentary data is more reliable and accurate than interview data.

Moreover, the third research sub-question was designed to be addressed by accounts from different stakeholders. To interview all the representatives of the stakeholders might be ideal but not realistic. The accessibility and convenience of interviewing different stakeholder individuals vary greatly. For example, it was impossible to access any policy makers in this case study, neither was it easy to access the employers in this case study, as at first hoped. There are few opportunities to interview course designers who normally hold high positions in the university, and their interview data might not be as rich or appropriate as that of students, in any case. Therefore, the related documents offer an alternative in the above circumstances.

This case study is designed to collect the following documents as data sources:

- 'the official documents deriving from the state' (Bryman, 2012, pp.549-550), such as the policy documents relevant to the professional master's programmes, and
- 'the official documents deriving from private sources' (Bryman, 2012, pp.550-551), for example, the related regulations or course programmes of the university.

The specific document data are detailed in Data Profile and Processing in this chapter (p.120).

To summarise, this section outlined the *plan* for collecting the evidence to address the research questions, taking a case study. The specific case was defined and profiled. Different types of data were designed to address each of the three sub-questions. The interviews and documents were designed as the sources of data.

Fieldwork and Data Collection

This section gives details of the fieldwork in order to show how the data were collected. The first sub-section summarises briefly the entire fieldwork and follow-up work. The following two sub-sections set out how the interview and documentary data were collected. (The ethical issues involved in the fieldwork are discussed in the final section Ethical Considerations.)

A Summary of Fieldwork and Follow-up Work

I independently conducted the fieldwork at B University in China from June to September in 2014. Some follow-up tasks, such as collecting on-line documents, were completed in the following October and November. At the case study university, the participating schools and individuals were cooperative and supportive. The fieldwork progressed smoothly and successfully. Sufficient qualitative data were generated and collected during the fieldwork and follow-up work.

The fieldwork was carried out from June to September 2014. What I did are listed as follows:

- I did the pilot of interview questions. As mentioned in the previous sub-sub-section Pilot (p.102), a pilot tested the prepared question guides in interview design. During the fieldwork, before formal interviews started, six master’s students and three academic staff were requested to test the prepared interview questions. The interview question guides were then improved based on their feedback and prepared to be used in following real interviews.
- I gathered background information to the case. The case of this research is defined as the engineering professional master’s programmes at B University. The background information is significant for the fieldwork investigation and data interpretation. In addition to gathering

information online before the fieldwork, I also did some observations at the sample schools of the case university and had informal chats with some students and academic staff at the case university. I built up an overview of the professional master's programmes at the case study university.

- I recruited participants. I found the related administrative staff and asked them to recruit volunteer students. I also directly sent interview requests to the targeted academic staff. The specific procedures are set out in Interviews and Data Generating in this chapter (p.110).
- I prepared for the interviews. After the volunteer students and academic staff had confirmed their participation, I arranged appropriate locations (for example, I booked a seminar room on campus) and mutually convenient times for the interviews. Then I printed out the prepared interview question guides, ethical documents, and other related materials, which were given to the participants before use in the interviews. Moreover, based on Chinese cultural traditions, I also prepared snacks as treats and/or small gifts for the participants to express my gratitude after every interview.
- I conducted twenty-one face-to-face interviews at B University. The face-to-face interviews happened in late June, early July, and early September, because the summer vacation for postgraduate students and supervisors normally takes place in the hottest season, i.e. late July and August. Some interviews were concentrated in certain dates for two reasons: they were convenient for the participants, or I could only book

a proper seminar room on those particular dates. This meant I had to arrange several interviews on the same day in different time slots. The process and content of the interviews will be discussed in detail in Interviews and Data Generating (p.110) and Interview Data Profiles (p.120) in this chapter.

- During the fieldwork, I conducted two email-based interviews (data number: I-22-E and I-23-E). One academic staff participant could not take part in the face-to-face interview because she was abroad for the entire second half of the year, but she was willing to participate via email. The other was a student participant who was working far away from B University and did not have any free time to complete the face-to-face interview. The email-based interviews will be discussed in detail in Interviews and Data Generating (p.110) and Document Data Profiles (p.120) in this chapter.
- I collected documentary data. The government documents and the master's course programme documents were collected during the fieldwork. The specific procedures and document contents are discussed in detail in Document Data Collection (p.118) and Document Data Profiles (p.122) in this chapter.
- I transcribed the interview data and preliminarily processed them. As explained in Data Collection Design (Chapter Three, p.100), this case study took the theoretical sampling approach, so the data collecting carried on until theoretical saturation was achieved. Therefore, in the fieldwork, the interview recordings were transcribed as soon as possible

afterwards, and the interview data were sorted and given preliminary codes.

- During the fieldwork, I tried to make contact with employers to have rich and varied data sources by interviewing employer representatives, such as CEOs, HRs, or directors, in addition to collecting documentary data from job requirements. In the fieldwork, two plans progressed simultaneously. Regarding the interviews, I first gathered some information about the kinds of enterprises orientated towards employing the investigated students, and then I sent email requests to these enterprises. I also asked the participating academic staff whether they had any industrial partners who could represent the employers and participate in my interviews. One academic staff member recommended a possible participant who had been his PhD student and now worked for a company that collaborated with his school. I tried to contact this person by email and left mobile phone messages many times, but got no reply.
- I prepared to collect job advertisements. I contacted a staff member in the Careers Centre of B University to ask about the following information: what kinds of graduate job advertisements specifically targeted at the sample students, and how to access these advertisements through the intranet of B University. Graduate recruitment normally happens in the autumn, not summer, so collecting of the advertisements happed in the following October and November.

In the fieldwork, some tasks progressed sequentially and others simultaneously.

This research has no funding, and the city where the case study university is located is expensive in terms of the cost of living. Therefore, limited by my personal financial resources, I could not stay there as long as I would have wished. Consequently, some follow-up tasks that did not have to be done there were completed in October and November, 2014:

- I conducted three email-based interviews (data numbers: I-24-E, I-25-E, and I-26-E). All three email-based interview participants were academic staff. During the fieldwork, I sent request emails to them, but they replied they were busy examining postgraduate students at that time, and they could only participate in email-based interviews when they had some spare time. In the end, I received their answer emails in November. Their late replies did not significantly affect my data processing and analysis for two reasons. First, I already did some face-to-face interviews with academic staff, and sufficient data had been generated to address the research questions. Secondly, it turned out the data codes generated from the three email-based interviews had no significant variations from the earlier face-to-face interview data codes.
- I collected job advertisements as documentary data. As explained, the job advertisements aimed at the professional master's graduates at B University were used as documentary data to represent the viewpoint of labour market demands. The job advertisements were normally posted during September and October, when the master's students look for their graduate jobs. Therefore I collected them after the fieldwork in China.

This sub-section outlined the fieldwork activities from June to September, 2014 and the follow-up work in the months after. The next two sub-sections set out how the interview data and documentary data were collected in detail.

Interviews and Data Generating

Sample Schools Selection

At B University, fifteen schools offer professional master's courses in several engineering disciplines. The sample schools were selected from them based on the following three criteria. First, the selected schools had to have a comparatively well-established and developed master's education, as described in detail in The Context of the Findings (Chapter Four: Data Presentation, p.134). Secondly, the master's engineering courses offered in the selected schools had to be in relatively typical and common subjects, such as materials engineering, automation, mechanical engineering, or automotive engineering. They correspond to the typical and common industrial labour market in China. Thirdly, accessibility was also a key consideration. I was able to access the students and academic staff in the schools selected. However, some other schools did not respond to my research request to the related authorities.

Based on the criteria above, five schools were selected as the 'sample' or 'the unit of analysis' according to Yin (2013, p.32). They were:

- The Materials Science and Engineering School
- School of Automation Science and Electrical Engineering

- School of Aeronautical Science and Engineering
- School of Mechanical Engineering and Automation
- School of Transportation Science and Engineering

The engineering disciplines in these schools cover material, automation, electrical engineering, aeronautics, mechanical engineering, and automotive engineering. The knowledge base and the curricula of these five schools have some overlaps, such as mathematics, mechanics, and automation. The differences in the knowledge and curricula offered by the five schools are much less than the differences between, for example, pharmacy, history, finance, languages, and education.

The graduates of these schools are orientated towards working in typical engineering industries in China today. For example, an aircraft or a vehicle needs an engine, mechanical systems, controls, and materials, which involve all the disciplines and schools above. Graduates from the same school could find jobs in different engineering industries. For example, the mechanical engineering graduates could find jobs in the aviation industry or automotive industry. Meanwhile, the graduates of the different schools could also find jobs in the same industry. For example, graduates of materials engineering or automation could be employed in the automotive industry. In terms of engineering industries, the fields involving five schools need to be considered as integrated. The reason for selecting five sample schools was not to make comparisons between them, but the five sample schools all together form a 'sample' to represent the typical and common engineering disciplines and industries in China today.

This case study aimed to investigate the professional master's courses offered by these sample schools by interviewing the students and academic staff involved and collecting their course programmes as documentary data. Some related information about the five schools is presented in The Context of the FindingsThe Context of the (Chapter Four: Data Presentation, p.134).

Participant Recruitment

The interviews targeted the full-time professional master's students who are in their second year and graduating in the next year (in China master's programmes take 2.5 to 3 years). The related administrative staff of the sample schools helped to recruit suitable informants. Then the volunteer students contacted me about participating in the interviews. The interviews also targeted the supervisors, course tutors, and/or course designers of the professional master's programmes. I contacted the targeted academic staff, by email or in other ways, explaining my research objectives. Six volunteer academic staff members participated in interviews.

As established in Interview Design (Chapter Three, p.100), in qualitative research, data collecting carries on until theoretical saturation has been achieved; when the data from interviews have formed the basis for creating categories and no new categories emerge, there is no need to continue with data collection (Bryman, 2012, pp.418-421). Consequently, no specific number of interview participants was designed beforehand. Instead, the fieldwork took the theoretical sampling approach of the purposive sample. The interview records were transcribed, sorted, and preliminarily coded as the fieldwork progressed. The interviews stopped when the collected evidence was sufficient to address the research questions appropriately.

In the end, there were twenty-six interviews, as shown in Table 3-1. Twenty interviews (nineteen face-to-face interviews and one email-based interview) were with students from five schools. Six interviews (two face-to-face interviews and four email-based interviews) were with the academic staff from five schools. Detailed information of each interview is available in Appendix B: Data Information (p.333). The specific content of the interview data is given in Data Profile and Processing (Chapter Three, p.120).

Table 3-1 The number of interview participants from the five schools

School	Students	Academic staff
The Materials Science and Engineering School	4 face-to-face interviews	1 email-based interview
School of Automation Science and Electrical Engineering	5 face-to-face interviews	1 email-based interview
School of Aeronautical Science and Engineering	3 face-to-face interviews	1 email-based interview
School of Mechanical Engineering and Automation	4 face-to-face interviews	1 email-based interview
School of Transportation Science and Engineering	3 face-to-face interviews 1 email-based interview	2 face-to-face interviews

As stated in Data Collection Design (Chapter Three, p.100), besides collecting job advertisements as documentary data, this research also aimed to interview some representatives of employers, such as CEOs, HRs, directors, about the knowledge requirements of the labour market. During the fieldwork, interview request emails were sent to the companies or organizations orientated towards employing the investigated students. However, there were no responses. I also asked the participating academic staff whether they could suggest any industrial partners who could participate in the interviews. One academic staff member recommended a previous PhD student who now works for a company that collaborates with his school. However, this potential participant could not be reached in spite of being sent many emails and messages. Consequently, this case study used graduate job advertisements as documentary data to represent the demands of the labour market. The process of collecting the graduate job advertisements is described in Document Data Collection (Chapter Three, p.118).

The Face-to-face Interview Process

Twenty-one face-to-face interviews were conducted on B University campus during the fieldwork. Before each interview began, I orally introduced the research aim, and my identity and background to the participants. The *Information Sheet* was shown to them. The participants signed the *Participants Consent Form*. (The related ethical documents are explained in Ethical Considerations, Chapter Three, p.129 and displayed in Appendix E: Research Ethics Approval, p.381.) The question guide was also shown to the participants before the interview started, so they could have a rough idea about the questions and prepare to offer more precise and richer answers.

In the interviews, I asked the questions prepared previously but in a flexible way. For instance, the interviewees answered questions by illustrating or describing their experiences or perceptions, and I sometimes changed the order or asked some supplementary or follow-up questions based on their answers when necessary for clarification.

Regarding the interviews, I have some points to make. First, language use is an issue, because the interviews were conducted in a Mandarin Chinese speaking university, but this thesis is written in English. The academic staff and students interviewed have an English qualification, but they cannot use oral English to express abstract and complex meanings as accurately and fluently as they can in Mandarin. Using English may have resulted in losing some important information or falsely conveying information, which could have a negative impact on the data. Therefore, the interviews were conducted in Mandarin Chinese.

Secondly, the participating students were engineering students, and this brought some advantages and also disadvantages for the interviews. On the one hand, most students had well organized thoughts. Their expressions tended to be concise and clear, and they were able to answer the questions precisely. This made the interviews progress accurately, to the point of the questions. Their answers did not deviate from the question themes, so I was able to get effective answers efficiently. On the other hand, some of them tended to be over-succinct. They gave general responses or summarized their experience or perceptions but were not good at telling a story to illustrate them. In this situation, I normally encouraged the participants to offer some stories to exemplify their generalizations. Some of participants provided a couple of examples, while a few still only manged to describe their experiences or perceptions briefly. However, although some participants answered the questions succinctly, they still answered the questions effectively and to the point.

Thirdly, the time spent on an entire interview varied from half an hour to more than an hour. The question and answer time was recorded on a digital recorder, and the research question and answer time ranged from 15 to 40 minutes. I explain two points to take into consideration below.

First, it might be thought that the average interview recorded time might seem to be comparatively short. There are three reasons for this. First, only the actual research question and answer section of the interviews were timed. The other parts, such as greeting, introducing the research and explaining the interview procedures, or thanking the participants, were not recorded. Secondly, as mentioned above, some participants answered my questions concisely, clearly, and precisely. Their answers did not deviate from the themes, and useful data were generated efficiently. Thirdly, I studied at B University for an engineering bachelor's degree, so I have 'tacit knowledge' of the related issues. The participants were able to save a lot time by not having to explain some 'insider' jargon, such as '*qixi*' (refers to the 'School of Mechanical Engineering and Automation') and 'work for my boss' (means 'engaging in the supervisor's research projects'), and/or some engineering jargon, for example, 'rotary table', 'aerofoil profile', 'thermal insulation experiment', or 'IC engine'.

The second point to make is that the time range of the interviews varied because of the diversity of the participants' personalities. Some students were lively and conversed a lot, and they were good at telling their stories. By contrast, a few students were reticent or overcautious. As mentioned previously, some engineering research students behave like 'geeks' in today's popular terminology. They are not good at interpersonal communication and do not like to talk about their feelings. They prefer to give general, summary, or brief responses. (The difficulty of generating rich interview data from engineering students like them may be the reasons why so far there have been few studies based on interview data from engineering research students, as pointed out in the literature review.) In this situation, and based on my previous research experience in communicating with science and engineering students, I used my interview skills to encourage them to talk more and recount some stories. Some of my efforts worked, but some interviews with these kinds of participants sometimes still lasted a comparatively shorter time than other interviews.

I have research experience in interviewing science and engineering students before, and I anticipated this situation when I designed the research. I did not expect a massive amount data for each interview, only useful data. Some brief responses do not mean these interviews were not able to generate effective data. It turned out that some short answers exactly addressed the research questions.

Generally speaking, all the face-to-face interviews proceeded very well. They generated rich and effective data, as planned. The amount and content of the face-to-face interview data are profiled in Data Profile and Processing (Chapter Three, p.127).

Email-based Interviews

Five interviews were completed by email. I sent the emails explaining the aims, the procedures and the interview requests with the *Question Guide* (Appendix A: Interview Question Guides, p.329), *Information Sheet*, and *Participant Consent Form* (Appendix E: Research Ethics Approval, p.381) attached. The participants signed the *Participant Consent Form*, scanned it as a PDF document, and attached it to their reply emails. The participants then wrote down their answers below each question in the question guide word document and then attached the word document to the reply email. The data generated by email-based interviews are inevitably not as rich and intensive as the face-to-face ones. Nevertheless, the interview questions were answered, and sufficient evidence was generated.

Document Data Collection

Three types of documentary data were collected. This sub-section looks at how they were gathered. The specific content of the documentary data will be described in Data Profile and Processing (Chapter Three, p.120).

First, the government policy document was collected. It is a public document and available on-line. I searched for it online, downloaded it, and kept it as a PDF document.

Secondly, the course programme documents (Chinese: 培养方案 *pei yang fang an*) were collected. They are not confidential, but there are no published copies or electronic copies available on-line to the general public. During the fieldwork, I accessed them in two ways. One was by borrowing paper copies from the related authorities in the sample schools and scanning them to form an electronic copy of each page. The other way was by directly copying electronic copies from the related authorities. Finally, ten documents of course programmes, two from each of the five schools were gathered.

Thirdly, graduate job advertisements were collected. I contacted a member of staff in the Careers Centre of B University. I asked her for the following information: what kinds of graduate job advertisements specifically target at the sample students, and how to access the adverts through the intranet of B University. Graduate job advertisements were released by employers, aiming to recruit the investigated students. The investigated students normally look for graduate jobs from September to the end of the year, so the online job advertisements placed from September to November were identified as the source of the appropriate data and could be accessed through the intranet of B University. There are different employers' job advertisements on each URL (Uniform Resource Locator). I downloaded and kept the appropriate webpages as PDF documents.

In summary, this section set out the process of data collection in the fieldwork. At B University, five typical schools were selected as the unit of analysis. Then some targeted students and academic staff were recruited. Most participated in face-to-face interviews; five were interviewed by emails. The policy document, course programmes, and related job advertisements were collected to form the documentary data.

Data Profile and Processing

After the fieldwork, the data were sorted and processed systematically to address the research questions. This section first describes the interview data and documentary data respectively. The second sub-section summarises which parts or types of data were used to address each research question. The final sub-section outlines the techniques and strategies for processing the data to produce the findings.

Interview Data Profiles

All twenty-one face-to-face interviews were transcribed (in Chinese) and kept in Word documents. For the five email-based interviews, the participants attached the Word documents with their answers directly to their emails. Therefore, all twenty-six copies of interview data were kept as word documents, amounting to 118,844 words in Chinese in total. In order to facilitate the data analysis, the twenty-six interviews were numbered from I-1-F to I-26-E (F refers to face-to-face interviews, and E refers to email-based interviews), as shown in Appendix B: Data Information (p.333).

Concerning the content of the interviews, the questions in the interview guides are in Appendix A: Interview Question Guides (p.329). The following paragraphs outline the answers and responses from the student and academic staff interviews.

Three broad issues were discussed in the student interviews: first, the professional practicum regarding

- Whether the professional practicum was enterprise-located;
- How long and how often the students went to the workplace;
- What they did during the professional practicums; and
- The relevance of the professional practicum to the student's subjects of study.

The second issue concerned the knowledge learned in the professional practicum. The students set out the information they had learned, the skills they had accumulated, and the people or events they had encountered in the practicum, combined with their experience of it.

Thirdly, as this research focuses on job prospects, the following questions were asked in the interviews:

- Did the employer in your professional practicum workplace expect you to work there after graduating?
- Are your graduate job prospects positive or negative?
- What are the underlying reasons affecting your prospects?
- Has the experience during this professional practicum increased your confidence about your future employment? If so, why?

For the academic staff interviews, the questions covered three issues: first, the attributes and significance of the new full-time professional master's programmes; secondly, their views of their students' professional practicum; thirdly, their perceptions of students' employment, labour market demands and industry needs. However, although the interview guide was shown to them in advance, they did not answer the questions as systematically as expected, which caused some difficulty in sorting out the data, but it turned out this did not affect the findings.

Document Data Profiles

All the collected documents were kept as PDF documents and also numbered from D-1 to D-14 (details are in Appendix B: Data Information, p.335). The documentary data have three types.

First, the government policy document (data number: D-1), entitled《教育部关于做好全日制硕士专业学位研究生培养工作的若干意见》 (*jiao yu bu guan yu zuo hao quan ri zhi shuo shi zhuan ye xue wei yan jiu sheng pei yang gong zuo de ruo gan yi jian*) [The Ministry of Education Guidance Suggestions for Full-time Professional Master's Programmes Education], was collected. It was enacted by the Ministry of Education of the People's Republic of China and published online in 2009. It is a guide for how to implement the newly introduced professional master's programmes for local education authorities and HEIs. It explains the importance of introducing the professional master's programmes, formulates the appropriate course delivery, and regulates how to carry out administration works. In this document, the first section covers the importance of introducing the new professional master's programmes, so it is used as the textual data for addressing the related research question.

Secondly, there were ten copies of course programmes (data number: from D-2 to D-11). There are five professional master's courses and respectively corresponding five academic master's courses in five schools. Every master's course has its own course programme. Course programmes are drawn up and enacted by the related authorities of B University. Course programmes prescribe the course aims, duration, study mode, course structure, curriculum inventory, credit requirement, dissertation, and assessment. In course programmes, the course aim section, consisting of several paragraphs, was taken as the textual data. It explains what demands of industry or a profession the course is designed to meet, and what types of graduates with what kinds of knowledge and skills the course is designed to deliver. This study also considers the aims of academic courses as a contrast, to identify the kinds of knowledge designed to be learned specially in the professional courses. Two other sections of course programmes were also used as textual data. One is the course structure with the curriculums and credit requirements, and the other is the requirement of practicum prescription.

Thirdly, three documents with graduate job advertisements (data numbers: D-12, D-13, D-14) were collected. Each document is a collection of a number of job advertisements, making 380 graduate job/post advertisements in total. The employers posted these job advertisements via the intranet of B University, and targeted the investigated master's students as potential recruits. In the advertisements, the job requirements for candidates cover the required education qualification, knowledge, skills, abilities, competencies, and other attributes. The required knowledge and skills in advertisements were adopted as the textual data representing the labour market demands.

The Data Prepared to Address the Research Questions

The three research sub-questions were addressed by two sets of interview data (students and academic staff) and the documentary data. Table 3-2 shows the specific parts of data or types of data prepared to address each one, as described below.

The related interview data from students addressed the first sub-question, *what knowledge is learned in the professional practicum?* The documentary data, i.e. the course design, and the related interview data from students addressed the second sub-question, *how did the students learn the knowledge in the programmes?*

The five types of data, representing five perspectives, addressed the final sub-question: *why is the acquired knowledge sought after by the labour market?* First, the textual data extracted from the policy document shows the viewpoint of the government. Secondly, the job requirements in the graduate job advertisements represent the demands of the labour market. The academic staff's interpretation is the other supplementary information about their perception of the labour market demands. However, their responses about the labour market and industries were ‘interwoven’ with other topics in the interviews, which were difficult to separate. Therefore, for simplicity, the academic staff’s accounts of the labour market and students’ employment are discussed together with the fourth type of data. Thirdly, the stance of the course design is embodied in course aims, which is the textual data from the course programmes. Fourthly, the academic staff’s interview data was used to interpret the importance of the acquired knowledge. Finally, the related students’ interview data addressed the labour market issues from the students’ own perspectives.

Table 3-2 The data prepared for research sub-questions

Research sub-questions			Data source			
			Documents	**Data number**	**Interviews**	**Data number**
i	What knowledge is learned in the professional practicum?				the related extracts in student interviews	I-1-F, I-2-F, I-3-F, I-16-F, I-4-F, I-5-F, I-6-F, I-7-F, I-8-F, I-9-F, I-10-F, I-11-F, I-12-F, I-13-F, I-14-F, I-15-F, I-17-F, I-20-F, I-21-F, I-23-E
ii	How did the students learn the knowledge in the programmes?		the course design of the professional course programmes	D-2, D-4, D-6, D-8, D-10	the related extracts in student interviews	I-1-F, I-2-F, I-3-F, I-16-F, I-4-F, I-5-F, I-6-F, I-7-F, I-8-F, I-9-F, I-10-F, I-11-F, I-12-F, I-13-F, I-14-F, I-15-F, I-17-F, I-20-F, I-21-F, I-23-E
iii	Why is the acquired knowledge sought after by the labour market?	from policy maker	the policy document	D-1		
		from employers	the graduate recruitment advertisements	D-12, D-13, D-14		
		from course designer	the course aims in both professional and academic course programmes	D-2, D-3, D-4, D-5, D-6, D-7, D-8, D-9, D-10, D-11		
		from academic staff			the related extracts in academic staff interviews	I-18-F, I-19-F, I-26-E, I-25-E, I-22-E, I-24-E
		from students			the related extracts in student interviews	I-1-F, I-2-F, I-3-F, I-16-F, I-4-F, I-5-F, I-6-F, I-7-F, I-8-F, I-9-F, I-10-F, I-11-F, I-12-F, I-13-F, I-14-F, I-15-F, I-17-F, I-20-F, I-21-F, I-23-E

Data Processing and Analysis

Qualitative research, particularly the case study, has no well-established and defined data analysis methods as quantitative research has; instead, it has strategies and the principles which fit the research purposes (Cohen et al., 2007, p.461; Bryman, 2012, p.565; Yin, 2013, pp.132-133). Thus, this research did not mechanically apply any particularly 'paradigm' to analyse the data, but borrowed strategies or techniques from analytical induction, content analysis, and grounded theory. To respond to the research questions, this research flexibly employed multiple tools or techniques of qualitative analysis to process the data, such as coding, tabulating, and typological analysis. This sub-section briefly presents the procedures and approaches of the data analysis.

The first step was to break down the data. Both the interview data and documentary data were read thoroughly to identify the paragraphs or sentences that could address the corresponding research questions. For example, in each of the students' interview data, there are different parts in answer to the three research sub-questions. The different parts of the data needed to be selected according to their relevance to each research question. Then the types of data, from the different sources, were sorted in line with the research sub-questions and issues.

Except for the graduate job advertisements, all the other selected and sorted data were translated from Chinese into English at this step. The graduate job advertisements were not translated until the final codes had been generated.

The job advertisements amounted to 380, translating them all from scratch would be a considerable workload. Moreover, according to the purpose of this study, it was not necessary to translate each advertisement in its entirety. Therefore, the job advertisements were not translated at this stage.

Next, for each research issue where the data were sorted together, the data were read thoroughly and intensively several times, and then coded by my induction. Based on the codes, the data were processed further in several ways. Some data were categorised, and then further coding generated the characteristics for each classification; for example, the different types of knowledge or the different types of professional practicum (see Chapter Four: Data Presentation, p.134). Some data were tabulated for different purposes. The first purpose was to categorise information around a theme clearly, for instance, the professional practicum design (see Chapter Four: Data Presentation, p.134). The second purpose was to make a contrast with its counterpart to identify some differences, e.g. the knowledge specially designed for professional master's courses compared to that for both professional and academic courses (see Chapter Four: Data Presentation, p.134). Thirdly, the data was to be correlated with other factors to show some trends, e.g. the relationship between the different types of knowledge and the different types of professional practicum (see Chapter Four: Data Presentation, p.134).

Finally, the processed data were analysed based on the established conceptual frameworks of this research. The findings were linked to existing theories or evidence to develop the existing knowledge. Limited by the thesis space, the specific analytical process cannot be articulated in every detail here. The following Chapter Four: Data Presentation and Chapter Five: Data Analysis give the findings and results of the analysis.

To summarise this section, it describes the interview data and documentary data in terms of their volume, order numbers, and content. Then it respectively specifies the three research sub-questions are addressed by what types of data. Finally, it outlines the processing and analysis data.

Ethical Considerations

This section considers the ethical issues. All the participants in the fieldwork, students and academic staff, were adults (the interview participants are profiled in The Detail Information of Interviews, Appendix B: Data Information, p.333). None of the interview questions were sensitive, controversial, or privacy-related. None of the collected documents were confidential. Therefore, this study did not have any particular ethical problems other than protecting the confidentiality of the respondents, and only involved the normal procedures of research ethics. The ethical issues were considered at the research design stage. Before the fieldwork, I received ethical clearance from the School of Education, University of Nottingham. The established ethical principles were implemented strictly until the data had been processed. The related ethical issue documents are displayed in Appendix E: Research Ethics Approval (p.381). The following paragraphs set out five ethical considerations.

First, this research was designed and undertaken to comply with a series of protocols: *Ethical Guidelines for Education Research*[13], *Code of Conduct of the University of Nottingham*[14] and the related parts of the *Data Protection Act 1998*. Additionally, the fieldwork took place at a university in China, so it was also conducted in a legitimate and morally appropriate way in China and at B University as well.

The second issue concerns the access to the participants and data. Access to the unpublicised documents was authorised by the related authorities of B University. All the recruited participants were volunteers and unpaid. All the face-to-face interviews were conducted smoothly in a mutually-respectful ambience.

Thirdly, the rights and the interests of the participants were respected at all times. My identity, the PhD research and the aim of the interviews were explained to the participants before each interview began. All the participants knew the research aim and understood their roles fully. The participants were also told they were at liberty to withdraw at any time without reason, prejudice

13 BERA (2011) *Ethical Guidelines for Education Research*. London: British Educational Research Association. Available at <http://www.nottingham.ac.uk/educationstudentintranet/researchethics/reading-list.aspx> (Access: 7 August 2015).

14 University of Nottingham (2010) *Code of Conduct of the University of Nottingham*. Available at < http://www.nottingham.ac.uk/educationstudentintranet/researchethics/reading-list.aspx > (Access: 7 August 2015).

or negative consequences for them. During the fieldwork, no participant withdrew. The participants were respected all the time; no undue pressure was placed upon them. There was no harm or risk to them at all from participating in this research. The interviews were carried out at mutually convenient times, and they were negotiated to minimise the disruption to work schedules and not burden the participants. All the participants remained anonymous and will not be traceable in any publication. The interviews were recorded by digital voice recorder. The research information and data are kept appropriately and securely. All the necessary information was provided to each participant explicitly through the *Information Sheet* (in Appendix E: Research Ethics Approval, p.381). They were also asked to sign two copies of the *Participant Consent Form* (in Appendix E: Research Ethics Approval, p.381). Those who participated by email signed the *Participant Consent Form* on paper, scanned it, and attached the PDF document to their reply email. One copy of the consent form was retained by each participant and other by me.

Fourthly, the fieldwork was conducted in a Mandarin Chinese speaking university, so language use was an issue, since this thesis is written in English. Theoretically, the interview participants, namely the academic staff and master's students, all have an English proficiency qualification to enter university. Nevertheless, English is an acquired second language for them and is not spoken in their daily lives, so in practice, they cannot use oral English to express abstract and complex meanings as accurately and fluently as they can in Mandarin. Using English may have resulted in losing some profound information or falsely conveying information, which might have a negative impact on the data. Moreover, being asked to use English might have caused those who are unskilled in oral English to be nervous, anxious, or uncomfortable, which may affect their performance in interviews and further the amount and quality of interview data. For the reasons above, the interviews were conducted in Mandarin Chinese.

Finally, I studied in B University previously for undergraduate and postgraduate education, and I am acquainted with some of the staff. This connection enabled me to access the participants comparatively easily and conveniently. Also, the participants trusted me because of my 'insider' identity. My background provided a good basis for the interviews to generate rich data. Moreover, I am familiar with the context of the university and possesses 'tacit knowledge' about it. This is also an advantage for the data interpretation. Nevertheless, this connection could mean there was a 'subjective tendency' in the way I analysed the data or focused on something in particular, thus affecting the evidence. However, I recognised this concern. I took steps to avoid it by comparing my perspectives and findings with the related evidence and discussing the findings with people who were not involved in the investigated case but had related knowledge, to make sure the findings were not biased.

Summary

To summarise, this chapter set out the methodology and research methods. The methodology was qualitative, considering the features of qualitative research, the ontology and epistemology of this study, and the relationship between research and theory. The research was a case study, because the strengths of the case study fit the purpose of this research. The case was identified as the professional engineering master's courses of B University, and the case study university was profiled. The data was designed to be generated by face-to-face and email-based interviews and by documentary evidence. The fieldwork and follow-up work were outlined. The amount and contents of the data collected were described. The processing and analysis of the data are also outlined. The next chapter will present the findings.

Chapter Four: Data Presentation

Introduction

Chapters Four and Five are the data chapters. The purpose of this chapter is to present what have been found from the data in multiple dimensions, including in response to the three research sub-questions. Chapter Five will analyse the data addressing the research questions by connecting the findings to existing theories and developing them. In this chapter, the first section offers the background to the data before presenting the main findings in the order of the three research sub-questions. The second section presents the data concerning the knowledge learned from the professional practicums. The third section shows the data about how the knowledge was learned in the professional master's programmes. The fourth section presents the data about the role of knowledge in the labour market. The final section presents the data in some different dimensions beyond the research questions. In addition to this chapter, Appendix C: Interview Data Examples (p.337) displays the data extracts and the data codes of the related interview data, and Appendix D: Document Data Examples (p.374) has the related documentary data.

The Context of the Findings

Since this is a case study, the context of the case is important for interpreting the data. As established in Chapter Three: The Methodology and Methods, I gathered related information for the research object and the case before and during the fieldwork. This section presents the context information, for the following data presentation and data analyses can be understood better.

This section aims to provide the background of the institution and the local labour market that the research object is serving on both historical and contemporary dimensions, to clearly situate the findings and analyses. The first sub-section outlines the history and development of master's education in China as the background to the professional master's programme reform. The second sub-section introduces the professional master's programme reform. The third sub-section profiles the case study university and describes the implementation of the professional master's programme reform at B University. The fourth sub-section looks at the labour market appropriate to the research object of this research.

The Development of Master's Education in China

Unlike western higher education systems that emerged endogenously, the modern system of higher education in China was late-developing and exogenous, like China's modernisation. Higher education development has been driven by national demands and government policies, from its origins to today.

From very ancient times to the 1840s, China had its own system of higher education, which was very different from the contemporary one. The modern higher education emerged in the middle of the Qing Dynasty[15] (1860s) when the authorities realised China's science and technology lagged behind that of western countries and decided to develop them by improving the education system following the pattern of western countries (Hayhoe, 1989, pp.9-13).

In 1912, Qing Dynasty rule ended, and the Republic of China[16] was established. The modern higher education system was constructed gradually following the inheritance of the Qing Dynasty. Legislations were enacted to build a legal framework for higher education. For instance, in 1935, an act concerning the award of academic degrees (Chinese: 《学位授予法》 *xue wei shou yu fa*) was issued. It divided the degrees into Bachelor, Master, and Doctorate. The degree act marks the point when the Chinese academic degree system began (谷秀娟 Gu, 2007 and 石中英 Shi, 2000). A number of HEIs (higher education institutions) were established during that time. However, between 1912 and 1949, China was involved in wars continuously, and the higher education system was constantly obstructed and damaged. Consequently, in 1949 when the Republic of China's authority ended, there were only 205 HEIs and 117,000 students, approximately (周贝隆 Zhou, 1996). With regard to postgraduate education, only around 200 individuals had been awarded a master's degree, and no doctorates were conferred by the related authorities before 1949 (石中英 Shi,

15 Qing Dynasty (Chinese: 清朝 *qing chao*) was the last imperial dynasty of China, ruling from 1644 to 1912.

16 The Republic of China (Chinese: 中华民国 *zhong hua min guo*) was the official authority of China from 1912 to 1949.

2000).

Since 1949 when the People's Republic of China was founded, the new government has managed to improve the underdeveloped postgraduate education. A series of actions were taken in 1950s and 1960s concerning the development of postgraduate education. In 1963, a national work conference (Chinese title: 全国研究生教育工作会议 *quan guo yan jiu sheng jiao yu gong zuo hui yi*) was held to discuss postgraduate education. The conference drew up the temporary regulations for the implementation of postgraduate education in HEIs (Chinese title: 《高等学校培养研究生工作暂行条例（草案）》 *gao deng xue xiao pei yang yan jiu sheng gong zuo zan xing tiao li (cao an)*). The conference and the regulation enactment indicate that China started a postgraduate education system (谷秀娟 Gu, 2007). Between 1950 and 1965, there were 22,700 enrolled postgraduate students altogether (谷秀娟 Gu, 2007), which was a great progress compared with the past. However, it was still a small number; all the entrants were master's students (no doctorates), and there was no official degree awards (the master's degree title was nominal) (谢桂华 Xie, 2008).

From 1966 to 1976, postgraduate education, as with the other educational activities in China, was suspended because of the Cultural Revolution. During that time, the higher education system for recruiting students, schooling, administration, and so forth was in chaos. Consequently, the number of HEIs declined, the number of students diminished, and the quality of higher education fell (黄小平 Huang and 黄学溥 Huang, 2004). The destruction of higher education during that period has not been recorded specifically in the Chinese literature. Nonetheless, in practice, China had no higher education in the strict sense during the late 1960s and the 1970s.

In sum, from the 1860s, when modern higher education emerged in China to the end of 1970s, the development of postgraduate education was blocked time and again, and the few achievements were also destroyed time and again, due to wars, regime changes, or internal disorder. Consequently, modern China has a very weak historical foundation of postgraduate education.

In 1978, China began its Reform and Opening Up (Chinese: 改革开放 *gai ge kai fang*)[17] period to facilitate productivity, modernise the country, and improve people's living standards. Domestically, it implements economic reforms, switching from the central planned economy to the market economy, and also carries out a range of reforms in politics, society, culture, and other sectors. Internationally, it opens up trade and other links to other countries gradually. In line with the national agenda, a range of reforms were initiated to revitalize postgraduate education.

For instance, enrolment in postgraduate education was resumed in 1977. The regulations for awarding academic degrees (Chinese: 中华人民共和国学位条例

17 In late 1970s, the economy was in deep recession in China after many years of internal disorder. China was one of the least developed low income countries. In 1978, China started its Reform and Opening Up (改革开放 *gai ge kai fang*), initially led by Deng Xiaoping (1904 –1997) who was a key politician in China in the 20th century. The Reform and Opening Up has been successful and deemed as the key reason of China's growth since 1970s.

zhong hua ren min gong he guo xue wei tiao li) were enacted in 1980, and the code for practice (Chinese: 中华人民共和国学位条例暂行实施办法 *zhong hua ren min gong he guo xue wei tiao li zan xing shi shi ban fa*) was enacted in 1981. The official regulations and code mark that China's contemporary postgraduate education had resumed and started to be formalised (谢延龙 Xie, 2008). Subsequently, driven by a series of government policies in 1980s and 1990s, China's postgraduate education had been reformed and greatly improved. The type of postgraduate programmes was diversified; the postgraduate education had become systematised (谢延龙 Xie, 2008).

After the formalisation of postgraduate education during the 1980s and 1990s (and also based on the expansion of undergraduate education since 1998), China's postgraduate education has been expanding in magnitude since 2003. The development and expansion in the past three decades has brought some achievements. For example, the number of entrants, registered students, and graduates increased dramatically in 2007, compared with 1978, as shown in Table 4-1.

Table 4-1 The numbers of postgraduate students in 1978 and 2007

Year	New entrants	registered students	Graduates
1978	10,708	10,934	9
2007	418,612	1,195,047	311,839

Data source: the Ministry of Education of China

In 2007, Ms Qidi Wu (Chinese: 吴启迪), the Vice-Minister of Education at that time, announced that accumulatively more than 1,500,000 postgraduates had been awarded a Doctorate or a Master's Degree since 1978, and there were then 1,100,000 registered postgraduate students in China. The two figures indicate that China had the second highest number of postgraduate students (after the United States) in the world at that time (陈至立 Chen, 2007).

Almost at the same time, another ambitious goal was set: switching from large postgraduate education towards good quality and strengthened postgraduate education (Chinese: 研究生教育大国向研究生教育强国转变 *yan jiu sheng jiao yu da guo xiang yan jiu sheng jiao yu qiang guo zhuan bian*). In 2007, Ms Zhili Chen (Chinese: 陈至立), the State Councillor for education at that time, said:

> China's postgraduate education is facing a vital time, as it is switching from a large magnitude to high quality and strengths; the crux is improving the quality of postgraduate education (see in 陈宵飞 Chen and 林颖颖 Lin, 2007).

The aim was to upgrade graduates' skills and abilities to meet the demands of economic and social transition.

To achieve this goal, the postgraduate education section has undergone a series of reforms in recent years. For example, in 2010, a mechanism for postgraduate academic exchange (Chinese: 研究生学术交流平台 *yan jiu sheng xue shu jiao liu ping tai* [Postgraduate Academic Exchange Platform]) was set up. Funded by the government, it supports national academic exchange activities, such as Summer Schools for master's students; it enlarges the interaction between universities, subjects, and students; it creates new teaching modes; it shares high quality teaching and research resources; and it helps talented students to realise their innovative ideas in practice (Xie et al., 2012). In 2011, the reform to engineering PhD education (Chinese: 高等学校和工程研究院所联合培养博士研究生 *gao deng xue xiao he gong cheng yan jiu yuan suo lian he pei yang bo shi yan jiu sheng*) was introduced. It is designed to enhance the practical and applied research experience of engineering doctoral students. In the new PhD programmes, students are supervised in collaboration with the staff of engineering research institutes or R&D departments in companies, as well as their university supervisors. Additionally, to enhance international academic interaction and cooperation, since 2007, the central government and local governments have funded research students to study abroad to gain doctoral experience (Chinese: 国家建设高水平大学公派研究生项目 *guo jia jian she gao shui ping gong pai yan jiu sheng xiang mu*). Sponsored students can study abroad for doctoral degrees or study abroad with cooperative PhD supervision for one year; they are then obliged to work in China for a certain number of years after their overseas study.

To sum up, although China’s postgraduate education began in the nineteen century, genuine development of China’s postgraduate education did not start until 1978. Over recent decades, China’s postgraduate education has made tremendous progress and had notable achievements. Currently, driven by national demands and government policies, China’s postgraduate education is conducting a range of reforms to enhance quality and meet the needs of economic development.

The Professional Master's Programme Reform

As described above, the higher education sector has been conducting a series of reforms to improve postgraduate education in China since 2007. Among these reforms, professionalising master's programmes is a key one. A brand-new type of master's programme, entitled Full-time Professional Master's Programmes (Chinese: 全日制硕士专业学位 *quan ri zhi shuo shi zhuan ye xue wei*), was introduced in 2009.

Before the new professional master's programmes, academic master's programmes dominated China's master's education, and the number of students has expanded greatly since 2003. A few part-time professional master's programmes, such as MBA (Master of Business Administration), JM (Juris Master), MPA (Master of Public Administration), Ed.M (Master of Education), had been minor parts of the master's education system since 1990s. Professional master's education in China began with the introduction of the MBA in 1990 when the Office of State Council Academic Degrees Committee (Chinese: 国务院学位委员会办公室 *guo wu yuan xue wei wei yuan hui ban gong shi*) approved the launch of the pilot MBA programme. After several years of practice, in 1996, the Office of State Council Academic Degrees Committee enacted a practice code for professional degrees (Chinese: 专业学位设置审批暂行办法 *zhuan ye xue wei she zhi shen pi zan xing ban fa*). The code gives the regulations for professional degrees: they must have a vocational background and aim to deliver high-level vocational specialists. The professional degree system has three levels: Bachelor, Master, and Doctor, in line with the existing academic degrees. The code also specifies the degree title in Chinese (国务院学位委员会办公室 The Office of State Council Academic Degrees Committee, 1996).

However, the development of professional master's programmes did not prosperous as well as the academic programmes. In the past, professional master's programmes only recruited the students with employment experience, but not new graduates. The past professional master's education only offered block release or day release courses, not full-time courses. In size, professional master's programmes only made up in a small proportion of master's education. For example, in 2009 (before the new professional master's programmes were introduced), there were 1,158,623 registered academic master's students but only 348,042 registered professional master's students[18].

Against this background, the new Full-time Professional Master's Programmes were introduced in 2009. The new programmes admit fresh graduates without any employment experience and offers full-time courses. The new professional master's programmes resemble the conventional academic programmes in terms of admission, registration, sponsorship, duration, much of the curriculum, and final assessment. For example, the new programmes admit students based on students' performance in the national master's admission examination

18 Data source: the Ministry of Education, <http://www.moe.gov.cn/s78/A03/moe_560/s4958/s4960/>, accessed: 11 May 2016.

(Chinese: 全国硕士研究生入学考试 *quan guo shuo shi yan jiu sheng ru xue kao shi*), in the same way as students are admitted to academic master's programmes. Students take about one academic year of taught modules and another one and half years (or two years) for the practicum and dissertation. The new professional master's programmes differ from academic programmes in their education orientation. The academic programmes stress theoretical knowledge and research skills, while the new professional programmes aim to develop students' applied knowledge, technological skills, problem-solving abilities, and project skills.

The new professional master's programmes have been expanding since it was first introduced. There were only 19 academic disciplines authorised to award the professional master's degree before 2009, and by 2011 the number had increased to 39 academic disciplines (国务院学位委员会 Academic Degree Commission of the State Council, 2011). Moreover, the number of entrants to professional programmes are increasing, while the entrants to academic programmes are decreasing, as shown in Figure 1-2 (in Chapter One: Introduction, p.8). By 2015, 322,028 new students were admitted to academic master's programmes, and 252,272 new students were admitted to professional master's programmes.

The Case Study University and Its Professional Master's Programmes

Some information about B University is given in Defining, Bounding, and Profiling the Case (Chapter Three, p.93) to explain why I chose B University as the case. However, in order to understand the data fully, this sub-section describes the case study university in more detail. As detailed in Chapter Three: The Methodology and Methods, I gathered the information about the case study university before and during the fieldwork (A Summary of Fieldwork and Follow-up Work, p.105). The main source of information was the official websites of B University and sample schools. However, for the purpose of anonymity, the URL (Uniform Resource Locator) of websites is not given in this thesis.

B University is a state-funded public university with two campuses located in a mega city in mainland China. B University was founded in 1952 from a merger of the aeronautical departments of eight top universities in China at that time. It was aimed to be a top research university in China when it was founded. B University was originally dominated by aeronautics and astronautics. Today, it has a highly esteemed reputation in science and engineering. In China B University is now a major research university sponsored by a range of funding from the government. By 2015, there were 61 undergraduate programmes and 128 postgraduate programmes offered by 28 schools, and 29,951 registered full-time students in B University.

B University has strong research strengths and close links with industries. As a powerhouse of research and innovation, B University has won 1,264 awards for research achievements in China, including 3 times won First Prize of National Science and Technology Progress Awards, and 6 times won First Prize of National Technological Innovation Awards. B University also has strong links with industries. More than 50 percent of research projects are collaborated with industries. Its main campus is located in the heart area of Z Science Park[19]. This area, called as China's Silicon Valley, is one of the prime technology centres in the world and has grown into a high-tech and new-tech industrial cluster. B University has partnerships with 185 other universities, research institutes, and companies in more than 30 countries. The cooperation covers the exchange of faculty and students, workshops, publications, research projects, and educational programmes.

Regarding postgraduate education, B University is one of the first universities that have established postgraduate education in the full sense in contemporary China. In 1981, B University was one of the first HEIs that could award master's and doctoral degrees in China. In 1996, it was one of the first HEIs that piloted professional master's engineering education. Today, B University has PhD programmes in 21 disciplines[20], academic master's programmes in 38 disciplines and professional master's programmes in 12 disciplines. It has 8 national key disciplines. In a recent national academic assessment, 2

19 Z Science Park is a pseudonym.

20 In China, postgraduate disciplines (Chinese: 学科 *xue ke*) have three levels: (1) the group of disciplines (Chinese: 学科门类 *xue ke men lei*), there are 13 groups, such as, Economics, Education, Arts, Science, Engineering; (2) disciplines (Chinese: 一级学科 *yi ji xue ke*), each group has a number of disciplines, for example, Engineering has Mechanical Engineering, Electrical Engineering, Information and Communication Engineering, and so on; (3) sub-disciplines (Chinese: 二级学科 *er ji xue ke*), each discipline has several sub-disciplines, for instance, Mechanical Engineering has Automotive Engineering discipline, and so on. The inventory of disciplines is enacted by the Academic Degree Committee of the State Council and the Ministry of Education. Postgraduate degrees can be awarded at both discipline and sub-discipline level.

postgraduate disciplines ranked at the top one and 13 disciplines ranked in the top ten. Up to September 2015, B University had 13,418 full-time students for postgraduate programmes with a degree awarding and more than 11,000 part-time students for postgraduate programmes without a degree awarding.

From September 2010 to June 2013, the Ministry of Education conducted and supervised a pilot of the professional master's programme reform (Chinese: 专业学位研究生教育综合改革试点工作 *zhuan ye xue wei yan jiu sheng jiao yu zong he gai ge shi dian gong zuo*) before nationwide implementation. It helped HEIs to understand the regulations for the professional master's programmes, improve course criteria and evaluation, and innovate course delivery. B University and 63 other universities participated in the pilot scheme. Finally, the pilot work done at B University was assessed by the related authorities. It showed B University can offer good quality professional master's education.

B University introduced its Full-time Professional Master's Programmes in 2009. Since then, it has carried out a range of reforms. For example, it introduced robust programme criteria, improved the curricula, strengthened academic staff team, and explored new teaching approaches. The size of professional master's programmes has been increased. In 2013, professional master's programmes enrolled 1,476 students, while the academic programmes enrolled 1,742 students. Almost half the new students were enrolled in professional master's programmes. The new professional master's programmes covered 23 professional areas, including 39 disciplines and 60 sub-disciplines, by 2013. For engineering disciplines, there were 21 engineering professional master's programmes at B University by 2013.

At B University, five schools were selected as samples for the reasons explained in Sample Schools Selection (Chapter Three, p.110). The five schools have well-established postgraduate education, and the engineering fields of the five schools together can represent typical engineering industries in China. In order to offer a context to the data, the following paragraphs review the five schools in terms of their education and research.

The Materials Science and Engineering School was established in 1954. It has departments of Materials Science, Material Physics and Chemistry, Materials Processing Engineering and Automation, and Polymer and Composite Materials. Material Science and Engineering is a national key discipline. The school has a national key laboratory and some B city key laboratories. It has a close link with the aircraft material industry, for example, collaborative laboratories and research projects. The school conducts a number of national or industrial key research projects.

The School of Automation Science and Electrical Engineering was established in 1954. It engages in a number of R&D projects for commercial or military aircraft in China. It has several national research awards. The school has three disciplines: control science and engineering (a national key discipline), mechanical engineering, and electrical engineering.

The School of Aeronautical Science and Engineering was established in 1952. It engages in education and research concerning airplanes, helicopters, airships, near space vehicles, and miniature aircraft, in six departments: Aircraft, Man-machine and Environmental Engineering, Aerodynamics, Aircraft structure and strength, Flight Mechanics and Flight Safety, and Dynamics and Control. The school has closed some gaps in aeronautical science and technology in China, for example, China's first light aircraft, first High Altitude and High Speed Unmanned Aerial Vehicle (UAV), and first coaxial rotor helicopter. Some national key research and aeronautical projects have been carried out in this school. The school has hundreds of teaching and research awards including more than 20 national prizes. Its faculty includes the top scientists and experts in aeronautics in China. It has two national key disciplines, the top two in China. It also has a number of key laboratories.

The School of Mechanical Engineering and Automation was founded in 1952. It engages in education and research of modern mechanisms, advanced robotics, advanced manufacturing technology and process equipment for aviation, integral forming and connection technology for high-performance integrated parts, mechanical and electrical control and testing technology, digital integrated manufacturing and information management, and some interdisciplinary studies. It has five disciplines: mechanical engineering, aeronautical and astronautical science and technology, materials science and engineering, marine engineering, and design science, the first three being national key disciplines. It also has key laboratories and conducts national key research projects. In 1996, it was one of the first HEIs providing professional engineering master's education in China.

The School of Transportation Science and Engineering was established in 2007 by merging the previous Department of Automotive Engineering, Department of Civil Engineering, and the Vehicle Operation Engineering discipline from the School of Aeronautical Science and Engineering. It engages in the education and research of aviation, automotive engineering, transportation, airport runways, and civil engineering. There are three professional master's programmes in the disciplines of architectural and civil engineering, transportation engineering, and automotive engineering. Automotive Engineering is a national key discipline. The school is involved in a number of national or industrial key research projects. It has close links with industry.

This sub-section offered contextual information about B University and the five samples schools where the data were generated in order to offer a context for the research object and findings. The specific design and implementation of professional master's programmes in B University will be presented in How Did the Students Learn the Knowledge? (Chapter Four, p.172)

An Overview of the Labour Market

China's Reform and Opening Up (Chinese: 改革开放 *gai ge kai fang*)[21] started in 1978 and continues today, through two different economic transitions. From the late 1970s to the early 21st century, the first transition was from the centrally planned economy to a market economy. Since the beginning of the 21st century, particularly in recent years, China has been in the second transition: economic restructuring (Chinese: 经济转型 *jing ji zhuan xing*). The economy is switching to a new paradigm based on knowledge, science and technology, and innovation, and features high quality, high efficiency, and high added value, but low energy consumption and low natural resource costs (see in 中华人民共和国中央人民政府 The Central People's Government of the People's Republic of China, 2006). China is transforming from being a 'manufacturing power' to being an 'innovation power'. The 'innovation-driven' (Chinese: 创新驱动 *chuang xin qu dong*) has become the new impetus for economic growth (see in 胡锦涛 Hu, 2012). The economy is driven by technological development to promote endogenous growth (赵晶 Zhao, 2012). In line with the economic restructuring, China's engineering industry is transforming from producing and manufacturing based on foreign contracts, to doing domestic R&D independently.

21 See the footnote number 17.

This sub-section takes the automobile industry as an example to illustrate the labour market background for three reasons. First, at the case study university, a couple of sample schools have traditionally focused on aeronautics and astronautics, but this does not mean their graduates will definitely seek jobs in the aeronautical and astronautical industries. On the contrary, their graduates are able to work in different related engineering industries. Due to space limitations, this sub-section cannot give details of all possible industries offering potential employment. A typical industry is taken as an example to illustrate the labour market. The automobile industry involves not only the automotive engineering linked to the education and research of one of the sample schools in this study but also the engineering disciplines in other sample schools, for example, mechanical engineering, electrical engineering, automation or material engineering.

Secondly, the automobile industry is a key sector in China's economy. China has the largest market and is the biggest producer of vehicles in the world. The industry contributed 13% of total domestic revenue and 6.13% of GDP in 2010; there are more than 40,000,000 people employed in directly related industries, making up more than 12% of urban employment[22].

22 See in 工信部：汽车成为国民经济支柱产业 税收和 GDP 贡献大 [The Ministry of Industry and Information Technology: Automotive Industry Is a Key Industry for National Economy and Contributes to Revenue and GDP Greatly] <http://news.xinhuanet.com/auto/2011-09/03/c_121962478.htm> accessed: 18th May 2014.

Thirdly, the automobile industry is a science and high technology-based industry. It needs a large number of R&D professionals with high levels of knowledge, skills, and education qualifications. It is therefore appropriate to consider in line with the professional master's education in this study. The automotive industry is an example to consider the background of the labour market.

Since 2001, when China joined in the WTO (World Trade Organisation), the automotive industry in China has grown rapidly. China became the largest automobile producer country in 2008. In recent years, China's vehicle market has continued to boom. For example, almost 19.7 million vehicles, about one-third of the global passenger vehicle production of 65 million, were sold in China in 2014, and passenger vehicle sales in China climbed by 9.9%. This figure is expected to rise by another 8%, to 21.3 million, in 2015[23].

However, automotive technology in China has not progressed as well as the car market. Automotive R&D has been through a difficult path in recent decades. To date, China's automotive industry is still struggling to improve its R&D, particularly technology development, to compete with its international peers. From 1984, when China's first Sino-western automotive joint venture was established with the American Motors Corporation till today, China's auto

23 CAAM, *2014 Worldwide Car Sales*, available on line, <http://www.caam.org.cn/zongheshuju/20150710/1005164775.html>, accessed: October 15, 2015.

industry R&D has undergone three phases: first, the market for technology; secondly, imitating and assimilating; and thirdly, original R&D (Zhang et al., 2016).

The first stage, the market for technology, began in the early 1980s. In line with the Reform and Open-Up scheme, China's government allowed foreign car makers to produce vehicles through Joint Ventures and sell cars in the Chinese market, in exchange for western advanced technologies. Driven by government policy, in the following 20 years, the early joint ventures dominated 90% of China's auto market, such as the Shanghai Automotive Industry Corporation – Volkswagen, and First Automobile Works Volkswagen. Nevertheless, the Chinese public questioned 'the market for technology' strategy, because the Chinese manufacturing did not access key technologies, just obsolete ones[24]. Thus, a discussion took place in 2005 to review the 'market for technology' strategy[25].

Meanwhile, during the late 1990s to early 2000s, besides the market for technology strategy driven by the government, some private Chinese companies, such as Chery, Geely, and BYD, made their own attempts at R&D.

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24 See in *Experts Question 'the Market for Technology' in Chinese Auto Industry*, available on line, <http://finance.people.com.cn/GB/1038/3822834.html>, accessed: October 13, 2015.

25 See in Tang, R., China's Auto Sector Development and Policies: Issues and Implications, available on line, <https://www.hsdl.org/?view&did=718658>, accessed: October 15, 2015, 2012.

They learned from and followed world-class products but lowered costs to build more affordable cars. However, sometimes, improper learning and imitation can bring trouble. For instance, General Motors sued Chery, claiming the design of the Chery QQ copied the first generation Daewoo Matiz (developed by a General Motors subsidiary, GM Daewoo)[25]. The legal issue is tricky, and this thesis will not discuss it, but this affair became a milestone in China's automotive industry. It triggered China's automotive industry to focus on how to do real R&D properly, originally and independently (Yang et al., 2006). Both private companies, such as Chery and Geely, and state-owned enterprises, such as Changan Automobile (Group) Co Ltd and SAIC Motor, started original R&D then (Thoma and O'Sullivan, 2011). They have made some progress. Some products, with a complete intellectual property rights, have emerged in recent years.

Behind these preliminary achievements, there has been increasing investments in R&D from domestic manufacturers and growing R&D human resources supported by HEIs in China. The universities delivered a large number of undergraduates and postgraduates to the automotive engineering industry during the late 1990s to 2000s. However, they still could not meet the demands of the labour market. For instance, their graduates were short of practical experience; there was a gap between the engineering education in universities and industrial demands. The HEIs needed to emphasise practical and applied research and deliver more applied professionals based on university-industry collaboration.

To summarise, this sub-section took the automotive industry as an example to illustrate today's engineering industries and represent the background of the labour market in China. In line with the economic transition, the engineering industries are also transforming to be driven by innovation and be R&D-based.

This section gave the background to the institution and the local labour market that the research object is serving on both historical and contemporary dimensions. It outlined the development history of China's master's education and profiled the professional master's programme reform in detail. It also described the case study university and sample schools where the data were generated. It finally illustrated the context of the labour market taking the automotive industry in China as an example. The following three sections present the data in line with the three research sub-questions.

What Knowledge is Learned in the Professional Practicum?

This section presents the data addressing the first research sub-question: *what knowledge is learned in the professional practicum?* As established in The Data Prepared to Address the Research Questions (Chapter Three, p.124), the related parts of the student interview data address this question. The related data were coded and then categorised based on characteristics of the codes. The knowledge acquired can be classified into six categories: knowing how to solve practical problems, knowing how to do in an industrial R&D project, knowing how to operate equipment or software in practice, knowing how to be a professional engineer, knowledge of the industry or profession, and knowledge of the workplace. The following sub-sections present these in order.

Related data extracts and data codes are in Appendix C: Interview Data Examples (p.345).

Knowing How to Solve Practical Problems

First, after the professional practicum, some students know how to put the theoretical knowledge they learned in university into practice to solve problems. At university, theories or principles are taught independently from each other. However, in practice they need to be applied in an integrated manner. The students accumulated the ability to connect separated theories together in practice from the professional practicum. A student summarised his experience of an aerofoil (a cross section of a plane wing) design task in the professional practicum:

> *The design theories are very basic. Moreover, they are some isolated 'pieces'. You need to apply them in the engineering practice. You have to connect them (the theories) together. You could understand them fully only when you have done a thing (industry-based design) systematically (in practice).* (Data number: I-6-F) [26]

Secondly, some students learned how to make a theoretical design feasible in

26 For detailed information about the quoted interview, such as when the interview was conducted, the participant was from which sample school, see Appendix B, as also for the following quotations.

practice. Sometimes, a design is feasible theoretically, but it could become problematic in its practical operation, for example, in its assembly. One student said:

> *For the mechanical design, there seemed to be no problem when you designed it theoretically. However, when you machine it and assemble it, many problems may appear. […] in our design, we were going to make a test rotary table with only one axle, and lots of parts were assembled on the rotary table. When we designed it, we did not consider the assembly issue. I thought a compact (structure) design would be good. However, later (in practice) problems occurred. The assembly was troublesome, and disassembling it will also be troublesome, if some parts are broken. […] Some designs are feasible in theory, but unfeasible in practical operation.* (Data number: I-3-F)

Thirdly, some students realised that coordination is important in a project design or a project plan. For example, in engineering, the components of a whole system are interrelated by some hidden functions, so how they coordinate should be considered carefully in R&D. Nevertheless, in the professional practicum, the students were not aware of this at first, because they lacked experience of completing a whole project in practice. They planned to develop the three components of a project individually. However, in practice, they found that the three components were interconnected and could not be completed independently. Consequently, their imperfect plan resulted in delaying the entire project. The students finally discovered that every part should be considered in connection with the other parts in a project (Data number: I-14-F).

Fourthly, some students learned that there could be unexpected on-site problems, even though the preparatory work had been done well in the university laboratory. They accumulated the ability to instantly solve unexpected on-site problems. For instance, one student said,

> *For example, at the on-site acceptance check, the light (in the device we had made previously) didn't work. Our client said, no, you must find the reason now. We definitely had to solve it instantly. Finally, it turned out that the transmission distance was longer (than we expected from the previous simulation). We used, for example, A signal system that fits a distance of ten metres for the transmission (in this project). However, in fact, the distance between the airport to the control panel is more than a hundred metres, which needs B signal. So the light did not work. […] I think the biggest gain is the (instant) problem-solving ability. As I said before, you may encounter various on-site problems that you could not imagine, but you need to solve the problem as soon as it appears.* (Data number: I-15-F)

Moreover, some students learned how to correct or how to improve their operations based on their failed experience. For example, a student said:

> *For example, a process, such as thermal insulation or whatever, is needed at a certain step in an experiment. If you know the right process before the experiment, your (experiment) result could be very good. However, in practice*

you have not been told (before), and you did it wrong (experiment failed). So you have to think about the reasons, check the related literature or ask other colleagues. Finally, you know what to do in this step (in practice). (Data number: I-9-F)

Knowing How to Do in an Industrial R&D Project

In a professional practicum, some students completed R&D projects independently or participated in an industrial R&D project. They got a sense of an industrial project. First, they became familiar with the technologies or the instruments applied in a practical project. As a student said:

For example, in the beginning, I just had a rough idea about the rotary table[27]*, i.e. what it is. I was not very clear about, for example, the structure of the hardware and software, and the system. However, when I made that robot (R&D project) […] I, in person, took charge of the whole system (development). So after that, I was familiar with the hardware, software, and system gradually. It is actually a process of becoming proficient.* (Data number: I-11-F)

Moreover, some students were able to plan a schedule and/or arrange the progress of an industrial R&D project after the professional practicum. For instance, a student said:

27 A rotary table is a mechanical device on a drilling rig that provides clockwise (as viewed from above) rotational force to the drill string to facilitate the process of drilling a borehole.

> *(After the professional practicum) First, the experience. If I have a project to do (now), I can soon confirm how long I need to complete it and what kinds of procedures, and whether I need other people's help in the procedures, i.e. which parts are unfamiliar (to me) and I need help with. At least now I can make a framework (to complete a project). However, in the past, for a project, I had no idea how to do it, or even where to start. Probably this is a great development.* (Data number: I-14-F)

Knowing How to Operate the Equipment or Software in Practice

First, from the practical work, some students acquired the motivation to overcome difficulties or solve problems using software (or other devices) and learned how to overcome or solve them. However, in the taught modules, without practising, the students lacked the motivation to overcome or solve problems. For example, a student explained:

> *For the software SolidWorks or ANSYS, you do not have enough motivation to learn, when you learn it from books or in class without practising. When meeting a difficulty in using the software, you do not want to overcome it. However, when you have a practical problem, you have to master the software and solve the problem. Based on the experience, you become more and more familiar with the software. So the practical problems are very helpful for studying software.* (Data number: I-1-F)

Secondly, although the principles of the equipment or software use were taught in class, students may still not know how to apply them. After the professional practicum, they know how to apply the equipment or software to realise a specific engineering function. For instance, a student said:

> *It is definitely different between learning in classes and in practical use (a computer language). It was taught without being connected specifically to an application in the past. An IF ELSE sentence is only taught in terms of what its function is. You only knew the function of the sentence. However, in practice you need to apply the sentence to realise a task that you expect. […] You need to consider how to use (the language) and realise it (the expected function) step by step.* (Data number: I-13-F)

Thirdly, the professional practicum offered students an opportunity to practice the software or other devices in a massive workload, which can enhance their *proficiency* of operation. As a student pointed out:

> *In terms of the specific operations, my ability has surely been enhanced. In engineering, there is 'proficiency' actually (embodied) in many things. In fact, writing the codes (of a program) is a process of proficiency. […] The proficiency of code writing, i.e. the practical ability of writing codes, is actually closely associated with the volume of codes you have written, […] so it must be better if you practice more.* (Data number: I-14-F)

Additionally, in the professional practicums, an on-site operation is monitored by the clients of a commercial project. The on-site situation and ambience are not as flexible and free as in the university laboratory. Therefore, students have to focus on their operations and complete their tasks quickly and accurately. An on-site operation in the professional practicums can reinforce the *speed* and the *accuracy* of the students' operational skills. For example, a student said:

> *On the spot, the clients were watching you. If they find anything not done or whatever else, you must fix it instantly. So, first, there is a time limit. It requires your ability to work quickly. Secondly, it requires your good accuracy. […] It is a comparatively pressured ambience.* (Data number: I-11-F)

Finally, some students actually operated the instrument or software of a real engineering project. Therefore, they acquired some hands-on skills. The students will be able to adapt to industrial requirements faster and more easily when employed in the future. The ability to adapt is also an important acquisition. For instance, a student said:

> *In fact, there is a difference between when you practiced and you didn't, […] when you go to the company which requires strong technological ability and hands-on ability, if you haven't had practice, I think it may take a long time to be 'ready-to-handle' (the skills required). However, we professional masters, at least, have a transition (time to accumulate the skills). At least, this kind of ability can be improved a lot.* (Data number: I-11-F)

Knowing How to Be a Professional Engineer

First, in a professional practicum, the students have an opportunity to access industrial professionals or even work with them. These industrial professionals become role models for the students. The professionals' work performance enables the students to find out the gaps between themselves and the skilled professionals and to foresee their future professional development. For example, some students found that the experienced professionals could instantly and accurately identify the problems that needed further analysis, and felt they should learn these skills from senior professionals. As one student concluded: 'the most directly impressive lesson is their sense of engineering problems; the professionals can identify lots of problems accurately' (Data number: I-1-F).

In particular, one student used the phrase, *professional quality* (Chinese: 专业素养 *zhuan ye su yang*), based on his experience, as he said:

> *In engineering, there is a 'professional quality' (Chinese: 专业素养). For example, when using a (circuit) board, you should test whether it has a short circuit before plugging in. I think details like this are the 'professional quality'. It is a 'habit' more than what you know of the principles of the (circuit) board or certain kinds of knowledge. I think the gap between an experienced engineer and a fresh graduate is his/her 'habits', i.e. their 'professional quality'. That cannot be taught. The 'habit' has to be accumulated (through practice).* (Data number: I-12-F)

The *professional quality*, namely the *habit* as he described it, actually means proficient operation in a normative and provident paradigm.

Knowledge of the Industry or Profession

From the professional practicum, some students learned *perceptual knowledge* of their industry or profession. First, through an enterprise-located practicum, some students discovered that industrial demands are sometimes different from the goals of university research. The industry has concern about practicability; universities stress theory breakthroughs. For example, a student said:

> *The university research finds a new material experimentally, ending by publishing an article about the properties of the material. On the contrary, in industry, a new material will be examined thoroughly in terms of whether its properties could fulfil the demands of practical usage.* (Data number: I-10-F)

Another student illustrated this with an instance about the automotive engine (Data number: I-17-F). The industrial concern is the durability and the reliability of an engine based on customers' needs. However, the university research focuses only on the data for power performance, torque, fuel consumption rate, and so forth. Furthermore, another student pointed out that university lessons or research overly stress breakthrough technologies, which mislead him into focusing only on cutting-edge knowledge, but neglecting *old* (developed and mature) technologies. Nevertheless, when he worked in a motor company in the professional practicum, he found mature technologies are still used commonly in that plant and whole industry. However, he was unfamiliar with those technologies (Data number: I-20-F).

Secondly, some students realised that the atmosphere and the feel of doing an industrial R&D project are different from doing research in university laboratories. Doing a commercial contract-based project is *pressured* and *criticised*, unlike laboratory research at universities. The industrial partner could *ruthlessly* point out any imperfection in the work and require the students to correct it perfectly. The students felt themselves 'at a disadvantage' and 'forced to do certain things by the contract'. Their words and intonation revealed that they found the clients fussy and annoying. However, they also admitted that '*anyway, they (clients) hoped to buy a better thing or a longer service for less money'* (Data number: I-11-F).

Thirdly, through an enterprise-located practicum, some students found out routine works, management and operations in companies/enterprises. They had no idea about them before. As a student said, now being an *insider* of a motor company, he knew the *secret* that 'some so-called big companies do not manufacture vehicles, and they just buy the parts and assemble them' (Data number: I-20-F). The information he discovered is not a *secret*, but this student had not learned that information at university before. In addition, they became aware of some professional concepts, for example, the prices of products or parts, supply chains, manufacturing processes, imported cars, after-sales quality analysis, or parts and supplier claims. These kinds of knowledge are not systemic, but they help the students establish a preliminary impression of the motor industry.

Finally, some students know about their professional development or career development path based on their practicum experience. When finding a graduate job, they can identify the advantages and disadvantages of different types of companies based on their work experience. For example, a student knows that a state-owned company is inefficient and employers are underpaid while a private company is efficient (Data number: I-21-F). They understood that '*if you work there, how you should develop yourself, how you should improve yourself, and in which direction you should improve*' (Data number: I-11-F). They got suggestions about their *future career directions* from senior colleagues in the workplace. After the professional practicum, they can plan their future career paths in the industry.

Knowledge of the Workplace

Similarly to the knowledge of an industry, through a professional practicum, some students became aware of the workplace, a situation that was unfamiliar to them before. First, the workplace is unlike the university where departments or offices mainly serve and support students. A company has a complex structure, and different departments have different functions and their own interests, which is 'tricky' for fresh graduates to appreciate. After a professional practicum, some students realised that coordination and cooperation with other departments or colleagues are important and complicated. The importance is explained in the following comments,

> *The difference between the company you stayed in and the university is that your university office/laboratory is smaller after all, just a few people in total,*

> *knowing each other in one room, but the company has many departments. For example, it has special departments for reception, for experimental equipment (management and) supportive work. In the process of an experiment (at the company), you have to coordinate with all the departments. If one department does not cooperate, then you cannot proceed. Like if I arrived there, but I did not find the reception person to register, and then, your experiment findings cannot be acknowledged. Alternatively, if you cannot find the person who keeps the equipment, you cannot start it. […] Everything needs coordination and communication.* (Data number: I-6-F)

The complicated interpersonal relations are an aspect of the coordination and cooperation. Inharmonious interpersonal relations may have a negative impact on the coordination and cooperation of work and ultimately, the efficiency of work. As a student's experience reveals:

> *I think from the interpersonal aspect, there is a quite different style in the university laboratory compared to the company. In the university laboratory, you do not need to think about many (interpersonal) issues, but in the company, you have to consider more. What you say may have an impact on different people. They have inner discords, whereas, in the laboratory, you do not need to think because all the people are peer students without deep grudges or self-interest issues. [Q: what kind of impact do you think?] Because I did the R&D work that actually needed a team. In particular, I did embedded development that involves many colleagues. If I had not had good interpersonal relations with them, they*

> *would not have cooperated with me. […] It can affect R&D efficiency, which I think is most important.* (Data number: I-16-F)

Secondly, some students found that a *proactive* personality is necessary in the workplace. In universities, supervisors or administrative staff supervise and support the students concerning their responsibilities or benefits. Even if students forget about these, they will be reminded by their supervisors or administrative staff. However, in the workplace, the employees' rights and interests sometimes need to be struggled for by themselves alone. Some students realised that an introverted personality does not match workplace needs, and they should behave more proactively than at university. For example, they '*urged'* the human resource staff to allocate them desktops, or they asked for an internal referral for a graduate job opportunity.

Thirdly, students saw the scenario of the workplace through the professional practicum. As a student put it, 'the most intuitive impression is a rough idea about the scenario of future work' (Data number: I-21-F). The 'scenario' here refers to the ambience, culture or management style in the workplace. Some students experienced it in person, working in enterprises and with colleagues, so they gained 'perceptual knowledge of the enterprise and staff' (Data number: I-17-F). For instance, they became aware that task management in companies is more reasonable, normative, and efficient than in the university laboratory, and attendance management is stricter than in the university laboratory.

Finally, some students mentioned some 'dark sides' of interpersonal relations in the workplace. They thought the interpersonal relationships were cold and calculating in the workplace, not as easy, nice, and mutually supportive as in the university. As they said, '*you really have to think carefully when talking*' (Data number: I-21-F). Furthermore, they thought their workplace colleagues were experienced at shirking responsibility. The students realised that shrewd resourcefulness is necessary in the workplace.

To sum up, this section presented the data addressing the kinds of knowledge learned in the professional practicum. The acquired knowledge was classified into six categories: knowing how to solve practical problems, knowing how to do in an industrial R&D project, knowing how to operate equipment or software in practice, knowing how to be a professional engineer, knowledge of the industry or profession, and knowledge of the workplace. Each category had examples and excerpts from the interview data. Table 4-2 summarises the six classifications and the sub-classifications of the knowledge learned by students.

Table 4-2 A summary of the knowledge categories

Knowing how to solve practical problems	how to integrate individual theories learned in university in practice to solve problems
	how to make a theoretical design feasible in its practical operation
	how to solve problems related to coordinating different parts of a project design or project plan
	how to instantly solve unexpected on-site problems
	how to learn by correcting or improving from an unsuccessful operation in practice
Knowing how to do in an industrial R&D project	how to apply technologies or instruments into an industrial R&D project
	how to plan the time schedule and progress of an industrial R&D project
Knowing how to operate the equipment or software in practice	how to overcome difficulties and solve problems in using software
	how to apply equipment or software to realise a specific engineering function
	the proficiency of operation
	instant and accurate operational skills
	adaptation to the hands-on industrial skills requirements
Knowing how to be a professional engineer	how to instantly and accurately identify the problems or issues which need further analysis
	how to have professional competencies, i.e. proficient operation with a normative and provident paradigm
Knowledge of the industry or profession	the industrial demands are sometimes different from the goals of university research
	the atmosphere and the feel of doing an industrial R&D project are different from doing research in the university laboratory
	what the enterprise is actually doing or how it is operated
	their professional development or career development
Knowledge of the workplace	coordination and cooperation with other departments or colleagues are important and complicated
	a proactive personality is necessary in the workplace
	a sense of the ambience, the culture and/or the management style in the workplace
	interpersonal relations are cold and calculating in the workplace, not as easy, nice, and mutually supportive as in the university

Source: interview data

How Did the Students Learn the Knowledge?

This section presents the data in answer to the second research sub-question, *how students learned the knowledge in the programmes*. The first sub-section profiles the structure of the professional master's courses. The second sub-section sets out the professional practicum design and the different types of practicum the students actually experienced. The final sub-section links the different types of professional practicum with the different categories of knowledge identified in What Knowledge is Learned in the Professional Practicum? in this chapter (p.156).

The Course Design of Professional Master's Programmes

This sub-section gives an outline of the course structure as the setting for the professional practicum. As established in The Data Prepared to Address the Research Questions (Chapter Three, p.124), the related texts from the course programme documents were employed to address this issue. According to the data, students in both academic and professional courses are required to complete a series of taught modules (Chinese: 学位理论课程 *xue we li lun ke cheng*) and the practical session (Chinese: 综合实践环节 *zong he shi jian huan jie*) in two and a half years. Table 4-3 shows the requirements of the curriculum and the credits in both the professional and academic master's courses.

Table 4-3 The course structure of academic and professional master's courses

	Academic master's courses		**Professional master's courses**	
	Module type	Credits	Module type	Credits
Taught modules	Compulsory General Modules	6	Compulsory General Modules	6
	Fundamental and Disciplinary Theoretical Modules	13-16	Fundamental and Specialised Theoretical Modules	6-10
	Cross-Disciplinary Modules	2	Specialised Technology Modules	4-6
	Elective Modules	0-4	Elective Modules	0-2
Practice session	Experiment	3	Experiment	3-4
	Seminars	1	Professional Practicum	3
	Literature Review and Research Proposal	1	Literature Review and Research Proposal	1
Credits in total		30-32		27-31

Source: *Course programmes* (document data D-2 – D-11)

Both the professional and academic master's students are required to complete taught modules in the first academic year. At this stage, the specific requirements slightly vary in the different schools. However, students normally have to accumulate at least 20 credits (about 10 taught modules) in the professional courses, but more than 25 credits (around 13 taught modules) in the academic courses. The taught module part of the courses has four sub-parts, as set out below.

- The Compulsory General Modules (Chinese: 公共课 *gong gong ke*) are the same for all master's students, such as English Language (or another foreign language) and General Research Methodology.

- The academic courses have Fundamental and Disciplinary Theoretical Modules (Chinese: 基础及学科理论课 *ji chu ji xue ke li lun ke*), while the professional courses have Fundamental and Specialised Theoretical Modules (Chinese: 基础及专业理论课 *ji chu ji zhuan ye li lun ke*). 'Specialised' (Chinese: 专业 *zhuan ye*) is used in the title of the professional modules rather than 'disciplinary' (Chinese: 学科 *xue ke*) as in the academic modules, in order to highlight the former one is orientated to be professional, practical, and applied. However, in fact, the taught module inventories of this part are quite similar in the academic and professional courses. For the sample schools and participant students, these modules usually involve advanced mathematics (for example, Matrix Theory[28], Numerical Analysis[29], or Mathematical Statistics[30]) and specialised engineering theories and principles (such as Machinery System Dynamics[31], Advanced Fluid Mechanics[32], or Modern Simulation Technology[33]).

- The Cross-Disciplinary Modules (Chinese: 跨学科课 *kua xue ke ke*) of the academic courses require the students to take a module in another

28 Matrix theory is the study of matrices, a branch of mathematics.

29 Numerical analysis is the study of algorithms, which use numerical approximation for the problems of mathematical analysis (as distinguished from discrete mathematics).

30 Mathematical statistics is the application of mathematics to statistics.

31 Machinery System Dynamics is the study of the dynamics mechanism and principles about machinery system.

32 Advanced Fluid Mechanics is the further study of Fluid Mechanics that is a branch of physics studying fluids (liquids, gases and plasmas) and the forces on them.

33 Modern Simulation Technology is the study of the technique of representing the engineering function by the computer programme.

discipline based on their supervisors' advice. Its counterpart in the professional courses is the Specialised Technology Modules (Chinese: 专业技术课 *zhuan ye ji shu ke*), which focuses on professional, practical, and applied technology principles, for example, Electric Vehicle Technology, or Helicopter Aerodynamics[34].

- The Elective Modules (Chinese: 选修课 *xuan xiu ke*) in both academic and professional courses allow students to take any module on the curriculum list based on their supervisors' advice.

There are some differences in the taught modules in the academic and professional course design. However, the module inventories between the academic and professional courses of the five sample schools were compared, and the number and titles of modules are similar. Moreover, there are no significant differences in the specific module contents. During the fieldwork, many students and academic staff pointed out that the professional master's students took the same modules as the academic courses students.

The practice session refers to all the other parts except for the taught modules and dissertation in the master's courses. It has three parts.

- The Experiment (Chinese: 专业实验 *zhuan ye shi yan*) requires students to complete a hands-on experiment (in the laboratory or fieldwork) that

34 Helicopter Aerodynamics is the study of the motion of air and its effect on helicopter in the flow.

is typical in their discipline, for example, Comprehensive Testing of Vehicles in the automotive engineering course.

- The academic courses have Seminars (Chinese: 学术报告 *xue shu bao gao*). It requires academic master's students to attend at least ten conferences/seminars/workshops related to their study field and submit a report, finally assessed by their supervisors. Correspondingly, the professional courses have a Professional Practicum (Chinese: 专业实习 *zhuan ye shi xi*). It will be discussed in The Design and Implementation of the Professional Practicum (Chapter Four, p.177).

- Both the academic and professional master's courses require students to submit The Literature Review and Research Proposal (Chinese: 文献综述与开题报告 *wen xian zong shu yu kai ti bao gao*) by the end of first year. It is similar to but more concise than the first year report in PhD courses in the British university context.

Besides taught modules and the practice session, both the professional and academic courses require students to complete a dissertation and pass an oral examination in order to be awarded a master's degree. The academic master's dissertation is similar to the PhD thesis but it is more concise; while, the professional master's dissertation must have an industrial background and applied and practical implications.

The Design and Implementation of the Professional Practicum

As profiled above, the professional practicum is the key difference between the professional and academic course delivery, so the professional practicum is supposed to be the main channel for learning the professional, practical, and applied knowledge identified in What Knowledge is Learned in the Professional Practicum? (Chapter Four, p.156). This sub-section considers the professional practicum from its design to its implementation.

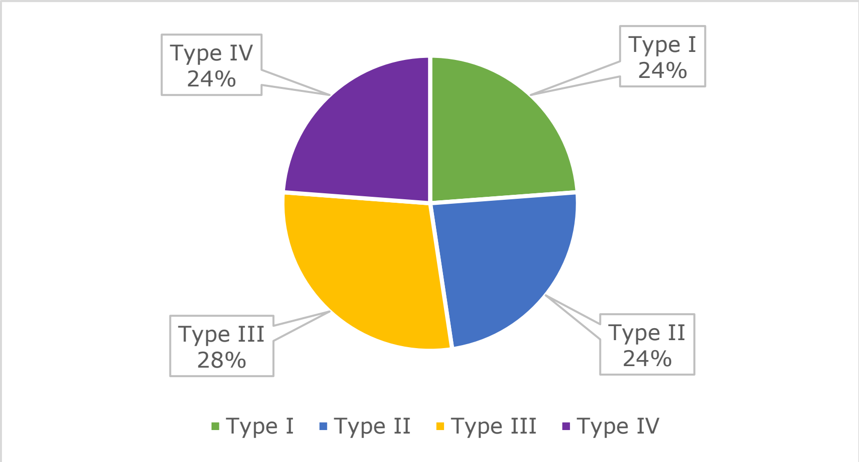
The Course Programmes (Chinese: 培养方案 *pei yang fang an*. Data number: D-2 – D-11) explain the aims of professional practicum and define its format, time range, and assessment. Table 4-4 illustrates the related data, showing the professional practicum is designed to be enterprise-located and to enhance students' comprehensive practical skills and ability to apply theories to solve practical problems.

Table 4-4 The professional practicum design

Significance	*Professional practicum is an important part of the full-time (professional) engineering master's programmes.* *The emphasis on the enterprise-located practicum for students is one of the features of the programmes in this field.*
Aim	*In line with the education orientation of the professional master's programmes, it aims at motivating the sense of innovation in technology; it involves various types of practices, to enhance students' comprehensive practical skills and the ability to apply theoretical knowledge to solving practical problems.*
Form	*Students are requested to complete the practicum in enterprises, in a mode that combines an external and internal practice base* (Chinese: 实习实践基地 *shi xi shi jian ji di*) *together.*
Time range	*No less than 0.5 years*
Assessment	*Students are required to complete the professional practicum report, assessed by the employer and the school, and the students can acquire 3 credits for a successfully completed performance.*

Data source: *Course Programme* (document data D-2 –D-11)

The following paragraphs discuss the implementation of the professional practicum. As established in Chapter Three: The Methodology and Methods (The Data Prepared to Address the Research Questions, p.124), the related student interview data are used to address this issue. The related interview data were coded and then categorised based on the characteristics of codes. Consequently, the students' professional practicum can be categorised into four types (type I, type II, type III, and type IV). As shown in Figure 4-1, the interviewed students are evenly distributed over the four types. The following paragraphs describe the four types of professional practicum. The related data extracts and codes are in Appendix C: Interview Data Examples (p.337).



Data source: student interview data

Figure 4-1 The percentage of students in each of the four types of professional practicum

Type I

The professional practicums took by the students in data numbers I-2-F, I-6-F, I-10-F, I-12-F, and I-16-F have similar attributes, and these five individual cases can be categorised as type I of the professional practicum. In this type, the students worked full-time, similar to employees, for months at industrial enterprises. The employers were domestic private companies and commercial research institutes, as shown in Table 4-5.

Table 4-5 The type of employers for type I professional practicum

Interview number	I-2-F	I-6-F	I-10-F	I-12-F	I-16-F
Type of employer	Domestic private company	Commercial research institute	Commercial research institute	Commercial research institute	Domestic private company

Data source: interview data I-2-F, I-6-F, I-10-F, I-12-F, and I-16-F

Normally, the enterprises involved had collaborative R&D projects with the students' school or supervisor. The students participated in or independently conducted R&D projects there. They applied their specialised knowledge and/or used the equipment, software, or data of the companies to complete R&D tasks. The two quotations from interviews illustrate the type I professional practicum:

> *[…] After the supervisor had a project meeting with them, we stayed there (the company) to do it (the research project). […] It was the supervisor's research project. We could go back (the university) when we had finished the project. […] I reckon I stayed there for one month. I went there many times. […] (Q: When you were there, did you go to the office every day? From 9 am to 5 pm?) Yes. (Q：Worked with their staff?) Yes.* (Data number: I-2-F)

> *[…] (I worked on my) one of my supervisor's research projects. It had a contract with a company. When we were doing the project, […] we communicated with them (the industrial partner), completed the research project, and finally submitted a report […]. I worked on this project for about one and half years. […] I went there (the company) every week. […] From Monday to Friday. […] From 9 am to 5 pm, not quite strictly, but I had to go to the company.* (Data number: I-6-F)

Type II

The interviewed students with data number I-4-F, I-17-F, I-20-F, I-21-F[35], and I-23-E can be categorised as type II professional practicum, according to their practice experience. This type of professional practicum is similar to postgraduate placement in British context. The students worked full-time in fixed internship posts at enterprises relevant to their master's subjects, but did not necessarily do R&D. The type of employer is different from the employers in type I professional practicum. There were three China-foreign joint ventures, a state company, and a commercial research institute, as shown in Table 4-6. The companies are generally larger and more formalised than those in the other types of professional practicums.

Table 4-6 The type of employers of type II professional practicum

Interview number	**I-4-F**	**I-17-F**	**I-20-F**	**I-21-F**	**I-23-E**
Type of employer	State company	China-foreign joint venture	China-foreign joint venture	Commercial research institute	China-foreign joint venture

Data source: interview data I-4-F, I-17-F, I-20-F, I-21-F, and I-23-E

However, the job responsibilities did not involve R&D tasks, but general assistance or administrative tasks that did not require their subject knowledge (only one case had relevance to the student's knowledge). Some quotations are

35 I-21-F did two different practices that can be categorised into type II and type III respectively.

given as examples to illustrate this type of professional practicum,

The school contacted them (employers). Then we applied for a placement when there was a vacancy. They (the employers) came here (the university) to conduct job interviews. Then we went to work there after the interview. […] I went to work every day, just like their formal staff. (Q: As an intern?) Yes. […] I worked with their team, doing some support tasks. (Q: was your work relevant to your speciality?) Yes, yes, relevant. (Data number: I-4-F)

I found (the practicum job) by myself. A previous student of my supervisor worked there, and he recommended the practice opportunity to me. […] (I worked there) for three months, from May to August. (Q: Did you go to there every work day?) Yes. […] Basically it was full-time (work). Maybe I could ask for one or two days off occasionally. (Q: As an intern?) Yes, they (the employer) had a placement. […] My tasks were trivial and not systematic […] if there were some assistant tasks, the official staff asked we interns to do them, like making a poster, etc. […] The work had no strict requirements (of automotive knowledge). It just happened to be that I was doing an automotive course and doing the job, […] it was fine that you do this job even without any automotive knowledge. (Data number: I-20-F)

I actually was not involved in any projects there. I was an assistant in their project management, following their progress. […] I have been there since 1st April, almost five months (so far). (Q: Full-time work every working day?) Yes. […] as an intern. […] (My job responsibilities were) finding all the previous *patents, reading through them, and writing a summary of them. Sometimes I did information searches online. Or when they planned to buy something (equipment or device), I found all the possible sellers online, made a list and then called them with enquiries, one by one, like the price, specific parameters, and then I wrote a report. (Q: So it did not particularly need an automotive background?) No.* (Data number: I-21-F)

Type III

The professional practicums that were done by students I-1-F, I-9-F, I-11-F, I-14-F, I-15-F, and I-21-F[36] could be categorised as type III professional practicum. It is similar to type I professional practicum, to some extent. The students engaged in R&D projects collaborated with industrial enterprises. Except for one state company, the other employers were commercial research institutes, as shown in Table 4-7.

Table 4-7 The type of employers of type III professional practicum

Interview number	**I-1-F**	**I-9-F**	**I-11-F**	**I-14-F**	**I-15-F**	**I-21-F**
Type of employers	Commercial research institute	Commercial research institute	Commercial research institute	Commercial research institute	Commercial research institute	State company

Data source: interview data I-1-F, I-9-F, I-11-F, I-14-F, I-15-F, and I-21-F

However, the students did R&D tasks mostly in the university laboratories but

36 See the last footnote.

did not work full-time in the companies. They went to the companies premises occasionally, irregularly and informally for the purposes: to attend project meetings, use the devices there, do on-site tests, and/or debug the software or hardware that had been made beforehand in the university laboratories. A few quotations illustrate this type of professional practicum:

> *(I did the practicum for) two months during last summer vacation. […] I went to a company that collaborated with my supervisor, on a research project. (Q: Did you work there every day?) There was not many requirements asked for you, but you had to handle the research project schedule by yourself. (Q: while you was doing the research project, no one supervised you from 9 am to 5 pm?) No. […] basically I did the supervisor's project collaborated with them, using the equipment and instrument there, to do that research project. […] I mainly carried out the testing tasks […] using their equipment (at the company).* (Data number: I-9-F)

> *I did the research project for my supervisor and also engaged in the research project I mentioned just now. (Q：were you at the company?) Yes, I was there many times […] for meetings. […] I went to the company to do the tests, like an experiment, as you said.* (Data number: I-15-F)

Type IV

Despite the course programmes requiring an enterprise-located professional practicum for the professional master's students, in the fieldwork almost onequarter of the students completed their professional practicums only in the university laboratories. Students I-3-F, I-5-F, I-7-F, I-8-F, and I-13-F can be categorised as this type. The students participated in research projects, and some of them independently conducted industry-based research projects. However, they never went to any company premises or met industrial partners. For example, in an interview a student responded:

Q: So you have been doing research in the university lab all the time?

A: Exactly.

Q: Haven't had any practice in a company?

A: Company? No.

Q: Has your supervisor asked you to attend any industrial meetings or to contact any industrial partners in any way?

A: Not yet.

Q: What kind of research projects are you doing for your supervisor?

A: What I am doing is not very systematic, recently I have been doing a project collaborated with a company.

(Data number: I-3-F)

During the fieldwork, some students and supervisors explained the reasons why some students did not do any company-based practicums. For example, one student was reluctant to have a practicum outside the campus because of some unresolved accommodation issues, or the supervisor had many laboratory tasks which needed his/her students to do, so he/she preferred his/her students to carry them out in the university laboratories instead of working for a company. This issue is related to the administration and supervision of the professional master's programmes but irrelevant to this research goal, so it will not be discussed in this thesis. These cases are still considered here as a 'control group', to be compared with other types of professional practicum in following analysis.

Table 4-8 summarises the four types of professional practicum. Types I and II have some similarities in the amount of work time, manners, and locations. Both of them are enterprise-located, full-time, and formal work. However, in type II, although the students worked formally in companies, they did not apply their specialised knowledge to the work tasks. For type I, III, and IV, the students did enterprise-based projects related to their knowledge background, but, type III students were only occasionally in the workplace, so they had less opportunity to see the industry and/or profession; type IV students had no opportunity to access the actual industry and/or profession at all.

Table 4-8 Comparison of the four types of professional practicum

	Working time and manner	Working location	Work responsibility	Relevance to course
Type I	full-time work, in a formal way	enterprise	enterprise-based R&D project	relevant
Type II	full-time work, in a formal way	enterprise	support or administrative work	irrelevant
Type III	occasional, irregular, and informal work	university mainly and enterprise sometimes	enterprise-based R&D project	relevant
Type IV	N.A.	university	enterprise-based R&D project	relevant

The Role of the Professional Practicum in Acquiring Knowledge

As established in Chapter Two: Literature Review (Research Gaps and Research Questions, p.80), the second sub-question aims to find out the roles of different practices in learning different types of knowledge, more than the practicum design or delivery itself. Thus, this sub-section further processes the data presented previously to find the relationship between the types of professional practicum and the sorts of knowledge acquired.

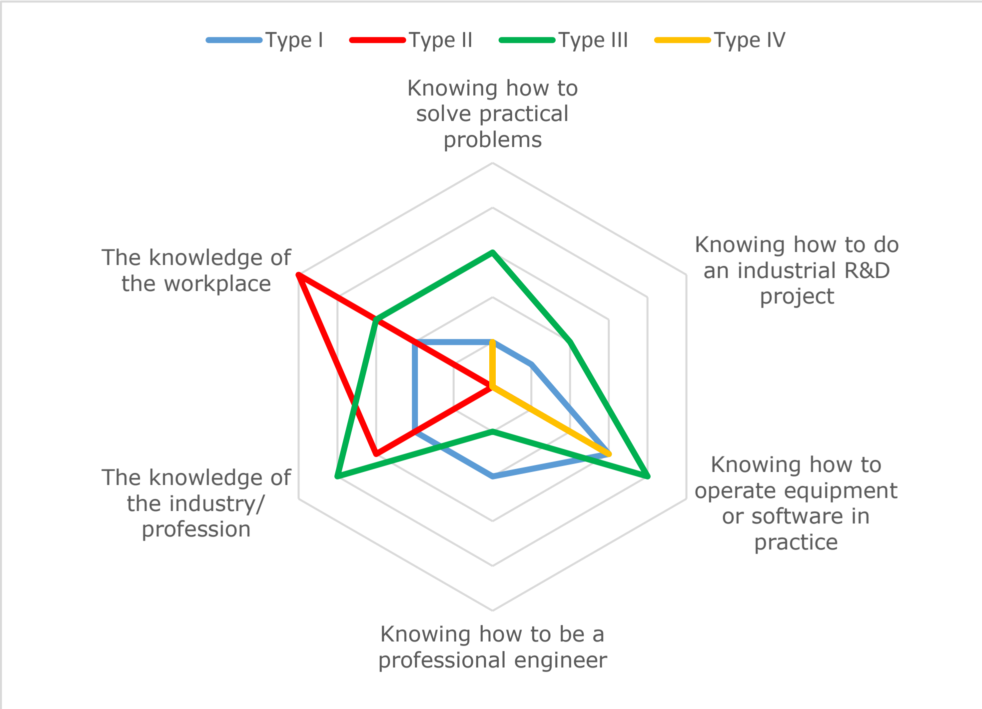
Table 4-9 illustrates the connection between the four types of professional practicum and the six categories of knowledge. The purpose of the table is not to be a numeral statistic but to illustrate a trend. Moreover, Figure 4-2 develops the table into a radar map to show the trend more clearly and easily.

Table 4-9 The relationship between knowledge categories and professional practicum types

Type	Interview number	Knowing how to solve practical problems	Knowing how to do in an industrial R&D project	Knowing how to operate equipment or software in practice	Knowing how to be a professional engineer	Knowledge of the industry/ profession	Knowledge of the workplace
Type I	I-2-F			√			
	I-6-F	√		√			√
	I-10-F				√	√	
	I-12-F				√	√	
	I-16-F		√	√			√
Type II	I-4-F			√			√
	I-17-F					√	√
	I-20-F					√	√
	I-21-F						√
	I-23-E					√	√
Type III	I-1-F			√	√		
	I-9-F	√		√			√
	I-11-F		√	√		√	
	I-14-F	√	√	√		√	√
	I-15-F	√				√	
	I-21-F					√	√
Type IV	I-3-F	√		√			
	I-5-F						
	I-7-F			√			
	I-8-F						
	I-13-F			√			

Data source: interview data

First, there is an obvious difference between the first three types and type IV. The students in type IV had no enterprise-located practicum at all, so they only acquired two categories of knowledge: how to operate equipment or software and how to solve practical problems. They did not learn anything about industrial R&D projects, the industry/ profession, or the workplace. As shown in Figure 4-2, type IV (the yellow line) appears as a polyline. The other three types are distributed comparatively evenly. This trend illustrates that the professional practicum can play a role in learning practical skills and industry-based professional knowledge.



Data source: interview data

Figure 4-2 The professional practicum types and knowledge categories

Second, type II is slightly different from types I and III. The students in the type II professional practicum worked as assistants or did administrative tasks, but seldom engaged in real R&D projects. They mainly learned about the industry/profession and the workplace. However, they gained little experience of how to solve practical problems, how to be a professional engineer, or how to carry out industrial R&D projects. However, the students in types I and III professional practicums acquired multiple types of practical and industry-based knowledge. As shown in Figure 4-2, type I (the blue line) and type III (the green line) are distributed more evenly than type II (the red line). Therefore, the different types of professional practicum can impact on learning the different categories of knowledge.

To summarise, this section presented multiple document-based and interview data. It addressed how the students acquired professional, practical, and applied knowledge. First, compared with the academic programmes, the significant difference in the professional programmes is the professional practicum. So the professional practicum is intended to give students the opportunity to learn professional, practical, and applied knowledge in the professional programmes. According to the course programmes, the professional practicum is designed to be industry-based and enterprise-located, while in practice, the professional practicum experienced by students can be categorised as four different types. Finally, it analysed the relationship between the different categories of knowledge and the different types of professional practicum. The professional practicum can play an important role in learning professional and practical industrial knowledge. The different types of professional practicum present different opportunities, resulting in students acquiring different categories of knowledge.

Why Is the Knowledge Sought After by the Labour Market?

This section presents the data in response to the last research sub-question: *why is the acquired knowledge sought after by the labour market?* As established in Chapter Two: Literature Review (Research Gaps and Research Questions, p.80), this issue is considered from five perspectives: government policy, the labour market, course design, supervisors, and students. Multiple sources of data were generated from these five perspectives. The data are presented in line with the five perspectives in each of the following five sub-sections.

Government Policy Discourses

As established in Chapter Three: The Methodology and Methods (The Data Prepared to Address the Research Questions, p.124), the government policy document is used here as textual data. It explains the reasons for introducing the full-time professional master's programmes from the perspective of policy makers. The related excerpts from the policy document are in Appendix D: Document Data Examples (p.379). The following paragraphs refer to pertinent parts and explain the issues.

First, from the aspect of macro development, introducing the new professional master's programmes aims to meet the demand for the high-level applied specialists necessary for economic and social development. As the policy document puts it:

> *At present, science and technology are making great advances. New knowledge, new theories, and new technology are on the fast increase. The area division of professions are becoming increasingly detailed. The technologies and the professionalisation involved a profession is on the increase. The specialists are demanded in large number, multiple qualifications, and high level.* […] *In recent years, with the rapid development of the economy and society in our country, a large number of high-level specialists with innovative capacity, entrepreneurial*

> *skills, and practical abilities have become an urgent requirement. Therefore, postgraduate education must be enhanced to serve national and social development needs, speed up adjustment, deliver more applied specialists, and closely link the specialist delivery with the actual demands of economic and social development.* (Data number: D-1)

Secondly, from the viewpoint of the higher education sector, the full-time professional master's programmes were introduced to match the reforms and development of postgraduate education itself. As the policy document states:

> […] *For a long time, postgraduate education in our country delivered mainly academic specialists able to research and teach independently. However, as postgraduate education is expanding and social demands are changing, more postgraduates have been employed in the practical industries rather than taking up teaching or research posts at universities.* […] *To improve our postgraduate education, we have to review and re-orientate our postgraduate education aims, and adjust and optimise the types and structures of programmes, to gradually switch from delivering academic specialists to delivering applied specialists, for the coordinated and sustainable development of postgraduate education in magnitude, quality, structure, and efficiency.* (Data number: D-1)

Finally, from the perspective of professional education itself, the full-time professional master's programmes were introduced to complete the professional education system. As the policy document points out:

> […] *Professional education should admit not only the on-the-job students with employment experience, to fulfil their needs: professional development and on-the-job training, but also admit fresh graduates, to meet their needs: to adapt social development, to improve professional competency, and to enhance employment competition. For different students, the study mode can be full-time or part-time. In our current professional education, part-time on-the-job students dominate, while full-time students without work experience are fewer. The current professional education does not reflect the status and role of full-time postgraduate education fully. Introducing full-time professional master's degree education orientated to mainly fresh graduates is significant, for improving professional education system, enhancing the capacity to deliver postgraduates with professional degrees, and meeting the multiple demands of society.* (Data number: D-1)

The policy document does not directly state why the knowledge transmitted from the programmes is necessary. However, the discourse implies that economic and social development requires master's graduates who possess professional, practical, and applied knowledge (but not pure research skills) in China. Driven by government policy, the full-time professional master's programmes were introduced to meet the needs of economic and social development. It aims to prepare master's graduates to fulfil labour market requirements. The next sub-section looks at what the labour market demands are.

Labour Market Demands

As established in Chapter Three: The Methodology and Methods (The Data Prepared to Address the Research Questions, p.124), this study uses the job requirements from job advertisements that the investigated students could potentially successfully apply for to represent the labour market demands. Appendix D: Document Data Examples (p.377) has some samples of job requirements. The following paragraphs outline the required and desirable knowledge (including skills and experience) from the collected job requirements.

First, employers require specialist knowledge in a field, i.e. concepts, principles, theories, or rationales, for example,

- 'familiar with IC engine (internal combustion engine) & Turbo-charging theory',
- 'possess automatic control theories', or
- 'have knowledge of aircraft conceptual design and aerodynamics'.

Secondly, they need the skills to operate specific instruments, equipment, software, or programs, for instance,

- 'can use measurement devices, such as CANoe[37], INCA[38], oscilloscope or multi-meter',

37 CANoe is a development and testing software tool from Vector Informatik GmbH.

38 INCA is a measurement, calibration and diagnostic software published by ETAS.

- 'proficient in Matlab[39] and Simulink[40]', or
- 'proficient in engineering software like CAD[41], CATIA[42], ICEM[43], and so on'.

Thirdly, the labour market demands the ability to design, develop, analyse, test, or simulate a specific object (a stuff or a process), by applying multiple technology principles or/and by operating hardware or software, for example,

- 'experienced in hybrid power simulation by Simulink',
- 'good knowledge of motor modelling and simulation technology, such as Ansys[44] software, Matlab, Labview[45], Simulink, dSpace[46], and so on', or
- 'thorough knowledge and understanding of single-chip system

39 MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language.

40 Simulink, developed by MathWorks, is a data flow graphical programming language tool for modelling, simulating and analysing multi-domain dynamic systems.

41 CAD (Computer - Aided Design) is the software used in art and architecture and engineering and manufacturing to assist in precision drawing.

42 CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Dassault Systèmes directed by Bernard Charlès.

43 ICEM surf is the modelling tool used in surface design.

44 Ansys is an engineering simulation software (computer-aided engineering, or CAE).

45 LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a system-design platform and development environment for a visual programming language from National Instruments.

46 DSpace is an open source repository software package typically used for creating open access repositories for scholarly and/or published digital content.

development, including both software and hardware'.

Fourthly, they also need an awareness of or experience of R&D projects, for example,

- 'knowledge of product development processes', or
- 'experience of projects is desirable'.

Finally, in China, employers commonly require English language skills. They also often demand some general office skills, for example, basic computer skills, oral and written skills, and *soft skills*, such as, communication, organisation, coordination, cooperation, teamwork, responsibility, accountability. Sometimes, they look for something uncommon, such as, 'a sense of engine', or 'can often travel'.

The knowledge (including skills, abilities, competencies, and experience) summarised above represents the labour market demands related to the professional master's programmes in this case study. The required knowledge (including skills, abilities, competencies, and experience) is different from the research skills that can be acquired in academic master's programmes. They stress a*pplication* and *practice*, for example, hands-on operating skills, integrative application ability, and project work experience. According to government policy, the full-time professional master's programmes are expected to meet labour market demands. Therefore, these practical, applied, and industry-based requirements should be the core orientation of the professional master's programmes. Against the background of policy and the labour market demands, the next sub-section looks at what knowledge in particular is designed in professional master's programmes to fulfil both policy expectations and labour market demands.

Course Aims

The course aims in the course programmes were collected as the textual data to address this issue, as established in Chapter Three: The Methodology and Methods (The Data Prepared to Address the Research Questions, p.124). This sub-section compares the course aims of five professional programmes with those of five academic programmes. The purpose of the comparison is to identify what kinds of knowledge can also be learned in academic programmes and what kinds of knowledge can only be learned in professional programmes. The comparison and data codes are tabulated in Appendix D: Document Data Examples (p.374).

From the comparison, there are some equivalent or quite similar texts in both the academic and professional course aims:

> […] *sound fundamental theoretical knowledge and systematic specialised knowledge of materials science and engineering, being aware of the development trends in this field, possessing advanced experimental facilities, testing methods, and evaluation technology* […]

> […] *sound fundamental theories and systematic specialised knowledge in the field, possessing comparatively broad knowledge* […]
>
> […] *sound fundamental theories and systemic specialised knowledge in aircraft design, having broad knowledge and strong self-study ability, possessing knowledge about the General Design of Aircraft, Physical Design, Aero-elasticity, Flight Mechanics, and Aviation Safety* […]
>
> […] *sound fundamental theories and systemic specialised knowledge in the field of machine science and manufacturing engineering, knowing in depth the advanced technology and development trends in this field* […]
>
> […] *high standards of morality and behaviour, commitment, honesty, and trustworthiness,* […] *good research ethics and professional ethics*
>
> (Data number: D-2 – D-11)

The coded data above appear in both the academic and professional course design. They are the knowledge that can be learned in both the academic and professional programmes. This knowledge covers the propositional concepts and theories and the ethical codes in their respective fields. A rough estimate shows that the same or quite similar texts take up nearly half of the text describing the course aims in each course programme. These kinds of knowledge can be also learned in the academic programmes, so they are not the focus of this thesis. The remaining texts of the course aims differ in the academic and professional programmes. They represent the knowledge designed to be learned specially in the professional programmes. These texts are prepared as the key data here. Table 4-10 extracts and sorts them (the names of specific professional concepts or theories are elliptical in square brackets).

Table 4-10 compares the knowledge designed in academic programmes with that of professional programmes. The knowledge designed in academic programmes stresses specialised concepts and theories, and research skills, whereas the knowledge designed in professional programmes pays less attention to these (but they still have their place). The professional programmes focus more on, for example, applied skills, industrial demands, practicability and applicability, professional abilities, or practical problem-solving abilities. These kinds of knowledge are specially designed to be learned in the professional master's programmes.

The text data that represent knowledge in the professional master's programmes were coded to generate seventeen preliminary codes, as shown in Table 4-10. The preliminary codes were then processed further to form five key codes: *employment*, *professional*, *industrial*, *application,* and *practical*. The five key codes represent the essence of the knowledge designed to be learned in the professional master's programmes.

As established in The Course Design of Professional Master's Programmes (Chapter Four, p.172), the professional practicum is the key difference between professional and academic programmes. The knowledge designed in professional programmes fits the aims of the professional practicum, which are shown in Table 4-4 (p.177). Therefore, the knowledge that is specially designed in professional master's programmes (not in academic programmes) is expected to be learned during the professional practicum. Some academic staff accounts further confirm this point, which will be discussed in the following sub-section.

Table 4-10 A comparison of the knowledge design between professional and academic master's courses

Case school	The aim of academic courses	The aim of professional courses	The codes of professional course aims
The Materials Science and Engineering School	[...] *possess the ability to conduct research* [...] *Have research output* [...]	[...] *be orientated to professional demands* [...] [...] *put emphasis on engineering application* [...]	professional demands engineering application
School of Automation Science and Electrical Engineering	[...] *possess the ability to conduct research* [...]	[...] *connected with employable qualifications* [...]. *It delivers applied* [...] *graduates* [...] *possessing* [...] *strong engineering practical abilities* *be capable of analytical calculation, development and design, and usage and maintenance of an actual control system, equipment or device*	employment qualification applied engineering practical abilities
School of Aeronautical Science and Engineering	[...] *be capable of conducting research* [...] *deliver research-orientated* [...] *specialists*	[...] *connected with job qualification* [...]. *It delivers applied*, [...] *graduates* [...] *can apply proficiently the related professional knowledge* [...] *be able to independently do engineering design, engineering research or engineering development related to modern aircraft design, and be able to apply advanced methods and modern technological approaches to solve engineering problems*	employment qualification applied apply professional knowledge
School of Mechanical Engineering and Automation	[...] *is aimed to deliver high-level specialists* [...] *for higher education institutions, research institutes or national key manufactories*.	[...] *is aimed to deliver* [...] *applied* [...] *specialists* [...] *for national key design or manufactories or other organisations*	applied non-research sector
School of Transportation Science and Engineering	*possess knowledge and theories, research skills and academic contribution*	[...] *applied* [...] *specialists* [...] *for enterprises and public institutions in transportation or automotive industry.* *The education process of the course meets the demands of transportation and automotive industry* [...]*, is orientated towards engineering practices, and puts emphasis on the practicability and applicability.* [...] *possess professional abilities and attainments required in the industry* [...] *be able to apply existing theories, knowledge and technologies* [...] [...]*solve professional problems properly*	applied industrial demands engineering practices practicability and applicability the professional abilities requested by industry apply existing theories, knowledge and technologies solve professional problems

Data source: document data, the *course programme*, data number: D-2 – D-11

Academic Staff Accounts

As established in Chapter Three: The Methodology and Methods (The Data Prepared to Address the Research Questions, p.124), the academic staff interview data are used here. The academic staff talked about the professional master's programmes and the professional practicum, and also the industry and the labour market. This sub-section considers these parts of interview data together. The related extracts of interview data are in Appendix C: Interview Data Examples (p.371).

First, the interview data with academic staff generated four key codes: *applied skills*, *practical skills*, *hands-on skills,* and *engineering problem-solving skills*. These codes represent the knowledge that could be learned from the professional practicum. The first code, *applied skills*, also coded from the course aims, was defined by the supervisors as the skills to:

- apply the existing theories or methods to solve technological problems in engineering (rather than research skills in science or technology breakthroughs),
- apply theories integrally, and
- transfer theoretical technologies, rationales, methods, and so forth into manufacturing or production.

The fourth code, *engineering problem-solving skills*, is also explained as *applying comparatively mature theories, technologies, and methods to solve* *existing problems in engineering*. Therefore, according to the academic staff's interpretation, *applied skills* include *engineering problem-solving skills*. As thus, *applied skills* can merge with *existing problems in engineering*. Together they can be interpreted as *the integrated application of existing or mature technologies, theories or methods to solve engineering problems, and the realisation of them in engineering function, product or manufacturing processes*.

The second key code, *practical skills*, is interpreted as *hands-on skills* by the supervisors. *Practical skills* and *hands-on skills* could be paraphrased as *skills for using instruments, equipment, devices, software/ programs, or workbenches*. In sum, the academic staff accounts of the knowledge in the professional master's programmes are consistent with the course aims and the labour market demands. The academic staff's perceptions also embody the course aims and the labour market demands in specific engineering disciplines. Their accounts further help the understanding of the knowledge designed to be learned in the professional master's programmes.

Secondly, the academic staff interpreted the context and the targets of the professional master's programmes. As one supervisor pointed out:

> *It (introducing the full-time engineering professional master's programmes) has a realistic context. It is significant, considering China has been the 'manufacturing power'.* (Data number: I-25-E)

As established in Government Policy Discourses (Chapter Four, p.191), the government policy proposes that the full-time professional master's programmes aim to meet the demands for high-level applied specialists for economic and social development. The academic staff's views concur with the policy objectives. Meanwhile, for the engineering master's education, the academic staff specified the *economic and social development* as *the context of manufacturing development*.

Thirdly, the academic staff explained why the acquired knowledge is sought after by the labour market. In the engineering industries, from theory to an actual product, there are two tasks (or *layers*, as they said). One (layer) is the research task, i.e. finding new theories or technologies, or theoretical research and design. The other one (layer) is the engineering task, namely applying existing rationales or methods integrally to develop a technology or product, and/or using current devices or equipment to manufacture it. The labour market now largely demands knowledge related to engineering tasks. As a supervisor said:

> […] *Because, for a product, from the start, i.e. the raw materials, to an actual product, it (production) not only needs a hard specialised scientific breakthrough, but also depends on engineering, such as the application of (scientific) achievements to engineering. It is an integrative application. That is to say, although a product involves some technologies that depend on the theoretical challenges during R&D, this does not mean it could be produced once those (theoretical) challenges had been resolved. There are other technological problems in engineering needing to be solved, such as the use of mechanical automation. So, the engineering application also includes how to manufacture*

> *the product in the context of our current industrial capacity, not only the (R&D capacity). There are in fact two layers: the technological and the scientific research layer. The technological layer refers to how to (actually) make it when theoretically you could. In the scientific research layer, I do not need to think about whether it could be made (in practice); I just find out it theoretically and methodologically. However, there is still a long way from 'finding a method' (to produce a new product) to a real product.* (Data number: I-18-F)

Furthermore, one supervisor explained the viewpoint above using a specific example from the automotive industry. His account further illustrates that, in the engineering industries, how to apply existing theories or technologies in production and manufacturing is just as important as innovative and original research:

> *In the automotive industry, taking the electronic vehicle, or say the new energy automobile, as an example, there are actually three key technologies concerned, i.e. the battery (technology), the electronic motor, and the vehicle control. They have been solved already. However, this does not mean we can produce electronic vehicles (only based on three key technologies). There are still other problems, such as, lightweight structure, the driving range (or called 'extend range') (of the battery), and so on. There are still a series of problems existing, like how to develop them into a finished automobile, and how to design, manufacture and process a vehicle running on the real road. All of these problems are associated with the practical application of technologies. These problems exist not because we do not possess the rationale of technologies. The*

> *crux is how to apply the technologies possessed to a new product, which is the abilities demanded of engineering (professional) master's students.* (Data number: I-18-F)

Another supervisor pointed out that the professional students can better meet labour market demands than academic master's students because of their related knowledge accumulation.

> *In China, postgraduates* […] *tend to be 'underachievers for a higher post, but unwilling to accept a lower post' after graduation. They are weak in the theoretical foundation for doing research jobs (compared with PhDs), but they lack the hands-on skills for doing engineering technology work. From this viewpoint, the full-time engineering (professional) master's programmes that put emphasis on engineering ability could fulfil the real demands of enterprises currently in China.* (Data number: I-24-E)

Students' Graduate Job Prospects

This sub-section summarises the students' job prospects in line with the four types of professional practicum (presented in The Design and Implementation of the Professional Practicum, Chapter Four, p.177), using the related interview data. The data extracts and data codes are in Appendix C: Interview Data Examples (p.363). The job prospects of the students from four types of practicum are compared at the end.

Type I

In this type, only one student had a negative attitude; the other four students were optimistic about their graduate jobs. Of them, two students were expected by their employers to work at their practicum enterprises after graduation. One student already had a job relevant to his professional practicum. Some questions and responses are quoted below.

Q: Did they (the employer) expect you to work there in the future?

A: Yes, right.

Q: You have done the practicum, and you have positive feedback from the employer. So does it increase your confidence in your future employment?

A: Yes, increased, a bit.

(Data number: I-2-F)

Q: Did they (the employer) expect you to work there in the future?

A: Yes, they asked me to. […]

Q: Considering the employer wants you, do you feel confident in your employment prospects?

A: Yes, I feel I have some strengths.

(Data number: I-6-F)

Q: So with your gains, do you feel they are helpful for your future job?

A: I think they are helpful. May be I will work in this industry. […]

Q: So in this industry, do you have confidence in your future employment?

A: I think I have.

(Data number: I-10-F)

As established in The Design and Implementation of the Professional Practicum (Chapter Four, p.177), the students in type I professional practicum worked at enterprises formally for a comparatively long time, and they did R&D projects. They learned various kinds of enterprise-based knowledge. Consequently, all four positive students reckoned their knowledge would be sought after by employers. Three of them thought they could easily adapt or be trained in a new workplace if employed, because of their professional practicum experience. As they said in the interviews:

Q: Do you feel the skills and experience accumulated from the practicum can help your employment prospects?

A: Yes, they surely help.

(Data number: I-2-F)

Q: What do you think are your strengths?

A: I reckon, first, the degree, the most direct one. You are definitely higher (in education qualification) than undergraduates. Moreover, for the skills you possess and the demands of industry, you can better match their demands. […] The postgraduates, after all, did R&D projects, so they basically possess the skills (to do R&D). They (employer) could train you comparatively easily. It is surely due to what you have learnt.

(Data number: I-6-F)

Q: What do you think are your strengths?

A: I think I just learned these things (doing R&D projects) for one year and I learned many things. So I reckon if I am required to learn something new, I also could (master it efficiently), I think.

Q: You learned good learning skills through your practicum?

A: Right.

(Data number: I-10-F)

Only one student had a negative view of his job prospect, due to his idea that the overall employment situation is not positive. His idea of a reduction in good jobs probably came from the university or his supervisor, and it might not be accurate. Universities and supervisors tend to overstress the difficulties of finding graduate jobs as a precaution, in order to force students to study seriously. In fact, the employment situation after higher education has been stable in recent years in China. However, he admitted that he would have an advantage if a job required experience of engineering R&D projects. As he said,

Q: Since you possess 'perceptual knowledge', 'professional quality', experience, and skills, now do you have confidence in your future employment prospects?

A: No.

Q: why not?

A: Because the employment situation (for higher education all over the country) has not been very good recently.

Q: Do you think you have any strengths others do not have?

A: Yes, but everyone has strengths. Those who do not have engineering experience may have theoretical strengths, strengths in different aspects.

Q: After all, you did the industrial practicum for a long time, do you think industrial employers will appreciate your engineering experience?

A: Yes, if they need (the candidate to do) R&D projects, then my engineering experience should be an advantage.

(Data number: I-12-F)

Type II

Of the five students who experienced this type of practicum, all but one had a positive attitude to their potential graduate jobs. One of the positive students was subsequently employed in the company where he did his professional practicum. For example, they said:

Q: Did they (the employer) give you something, like feedback?

A: Yes, they asked if I would like to work there in future, like this.

Q: Through the practicum, did you become more confident about future employment?

A: Yes, I did.

(Data number: I-4-F)

Q: Did you become more confident about your future employment chances through the practicum?

A: It should be helpful to my future employment.

(Data number: I-17-F)

According to the students' accounts, their professional practicum experiences have helped or will help their future employment opportunities. However, their reasons are slightly different from type I practicum students. The students of type II think their confidence derived from their *work experience*, such as the knowledge of the workplace, rather than R&D or engineering experience. The difference probably is connected with the disparities between their professional practicum and their knowledge acquisition. The students of type II did administrative or assistant tasks in their professional practicums but did not engage in R&D projects. Consequently, they accumulated little applied or practical experience or hands-on skills, but mostly gained knowledge about the industry/profession or workplace. Therefore, they ascribed their positive attitudes to their work experience:

> *In the practicum, you must can gain lots of experience. After all, it is real work. No matter whether it is successful or failed, it is an experience, which will be a great help to your future real job. I think so.* (Data number: I-4-F)

> *Because you get familiar with some parts of a job. It is surely, for example, when you start a new job, you need something like training, […] but since you have had this practicum experience, you know something about the operation of a company.* (Data number: I-17-F)

> *At least I think my job prospects have been broadened. Previously, I only focused on car companies. However, after I went there (the practicum company), I found it was not bad to make automotive parts. So I started to apply for jobs in the automotive parts industry. […] And I reckon with this practicum experience, I will have a pretty good chance to get one. A key strength is, compared with those without (the practicum experience), after all, I learned something there (the practicum company) and worked in the purchasing department. It (working at an important commercial department) sounds sensitive I think. (Q: So you think your advantages come from first your practicum experience and secondly the department you worked in?) Exactly, and the people I met there. Maybe, they have more connections with other industrial colleagues, so I could get more (job) information from them.* (Data number: I-20-F)

The only student with a negative job prospect ascribed his attitude due to the lower national ranking of his course subject. However, he still admitted that the professional practicum experience would be helpful in finding a job.

> *Q: How do you feel? Do you have any confidence you will get an ideal graduate job?*
>
> *A: No, not at all.*
>
> *Q: Why not?*
>
> *A: How to say it … actually the […] subject (the discipline of the student's course) is not very good … it is not at the top ranking nationwide (in national academic subject assessment). Anyway, I feel employment … now it is difficult to find a job […]*

Q: Do you think your practicum experience has been helpful to your future graduate job?

A: In fact, this practicum … the most direct gain is you know roughly what the future workplace scene looks like […] which is psychological preparation. For a company, when you apply for a job, maybe you will be able to recognise whether a company is good (appropriate) or bad (inappropriate). You may be more experienced, not be deluded (misled) so easily. And now I know exactly what it is I don't want. […] I want to work in a company, and I want to work in a place that is efficient even if I have to work harder, […] it (the practicum) played a role in this respect. (Data number: I-21-F)

Type III

Two students of this type had a negative view of their possible graduate jobs, while three were positive. The positive students thought that the professional practicum experience could help their confidence and enable them to start a new job more quickly. For example, one student said that he was better in practice than the academic master's students who take more taught modules (Data number: I-11-F). Some questions and responses in the interviews are quoted below.

Q: Has your confidence in your employment chances increased?

A: It (the practicum) is helpful for employment. It surely increases one's confidence.

Q: Through what, do you think?

A: The experience accumulated from R&D projects is one reason. And when employers see you have this kind of experience, they probably think you are more reliable (employable).

Q: Like you can operate software?

A: Yes, they think you can get started (to do tasks) straightaway.

(Data number: I-1-F)

My confidence comes from the R&D project I did (worked on). (Data number: I-15-F)

The other two students with negative views, again, ascribed their attitude to the overall bad employment situation and their particular depressed industry or profession. As one of them explained:

The job … after all, the current situation is not very good. In recent years, according to the employment situation of previous graduates, it has become worse and worse. Plus, my course is in the material (discipline) that is provided in many universities all over the country. So the competition is quite fierce. (Data number: I-9-F)

Type IV

Although the students in type IV did not have an enterprise-located professional practicum at all, there were still three optimistic students among the five. However, two positive students thought they were confident about getting a job because of their master's degree title from B University. As one of them explained:

Q: After the project you did, do you have confidence in your future employment?

A: [sighs] It is supposed be comparatively better for the future to have a master's degree, particularly a master's degree from B university especially. But, because this year, (there are) more graduates than ever before. The employment (opportunities) should not be so optimistic. But it should be OK to find a job. It is not quite certain that we can find an ideal job. So, it is probably that we will just be able to find a job.

(Data number: I-7-F)

The other positive student could not explain his reasons:

Q: Do you have any confidence in the graduate job?

A: it should be fine. I reckon. After all it is a master's degree from B University.

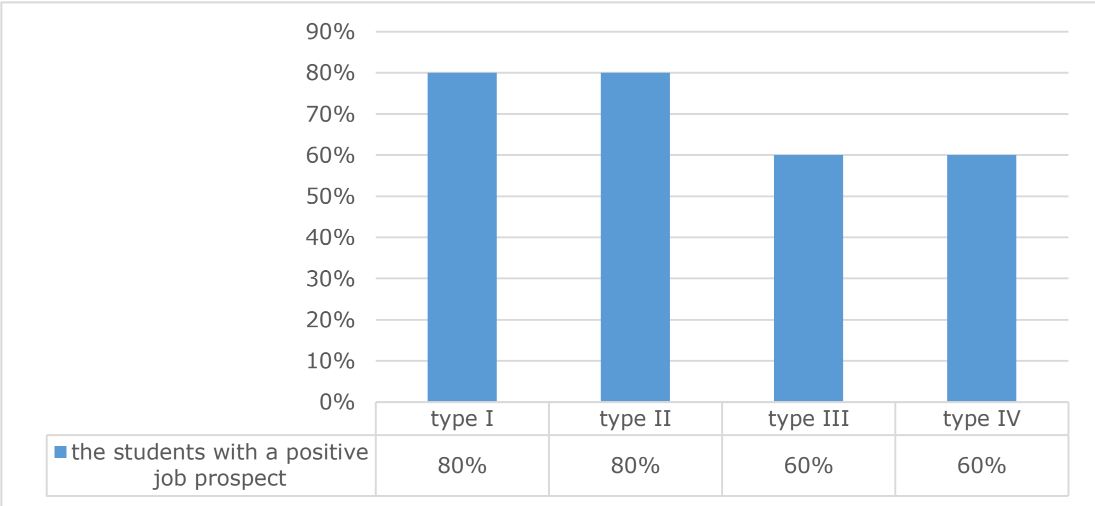
Q: do you know their (employers) requirements for graduates?

A: I am … not clear.

(Data number: I-3-F)

The perceptions concerning graduate jobs of type IV students were compared with the labour market demands (in Labour Market Demands, Chapter Four, p.194). It can be observed that this group of students did not have a clear understanding of the industry/profession, the workplace, or job requirements.

To sum up the perceived job prospects related to the four types of professional practicum, Figure 4-3 offers the proportion of students with a positive perception of their future job prospects from the four types of professional practicum. The purpose of this table is to show a trend rather than a mathematical statistic. Comparing the four groups, the students in type I and type II tend to be more optimistic about their job prospects than the type III and IV students. This tendency could be explained by type I and II students working in enterprises more regularly and officially than type III and IV students. Consequently, the first two types of students acquired more kinds of knowledge about actual work and have more confidence in getting graduate jobs than the other two groups.



Data source: the interview data

Figure 4-3 The students with positive job prospects in the four types of professional practicum

There is no obvious disparity in the percentages between type IV and types I, II and III. So based on the data, it can hardly be concluded that there is a definite and positive correlation between the professional practicum and a promising future employment. However, according to the students' accounts, negative attitudes often come from a pessimistic view of the macro situation of employment. The students with negative perceptions did not ascribe them to disappointment with the professional practicum. Therefore, the knowledge learned by the professional practicum could and may contribute to their graduate job prospects.

To summarise this section, it presented the data addressing the role of tye acquired knowledge in the labour market from five perspectives. The government policy discourses outlined the aims and motivation behind the need to deliver high-level applied professionals to fulfil labour market demands. The job requirements specify the knowledge demanded by the labour market in certain industries and professions. The course aims specify the types of knowledge and graduates designed to deliver to fit market needs. The academic staff offered some integrated accounts connecting the overall objectives with the role of knowledge in the engineering industries. Finally, the students indicated the role of knowledge in their graduate job prospects, as they perceived it.

The Differences by Gender, School and Type of Practicum Employer

This final section is used to present other dimensions of the data in addition to the established research questions, in order to see further possibilities of this research and the data beyond the existing theoretical and conceptual framework. This section considers the data to see whether there are any disaggregated differences by gender, school, and type of employer where the practicum took place. It discusses the data based on comparisons from the perspectives of gender, school, and the types of practicum employers. The following three sub-sections set these out.

The Differences between Genders

Of the twenty students interviewed, there was only one female student (data number: I-13-F). The female participant was from the School of Automation Science and Electrical Engineering. This female participant happened to be one of the weakest cases in this study, because she completed her professional practicum in Type IV, carrying out the tasks allocated by her supervisor in the university laboratory rather than going to any industrial company. Based on her interview data, she accumulated knowledge about how to operate the equipment or software in practice. She had a positive attitude to getting a graduate job, but she could not explain this with any specific reasons. Therefore, based on the data of this case study, any difference between genders cannot be interpreted.

According to the literature review, so far, few studies have considered the knowledge of professional master’s education by gender. In the existing literature, there are human capital studies focusing on the differences between the salaries of men and women. The differences between the human capital of men and women is worthy of study, and the difference between the knowledge acquisition of male and female is also worthy of exploration, but neither is the focus of this thesis. This study explored the role of knowledge of professional master's education in human capital at an initial stage. There have been few foundations for exploring gender differences to date. Nevertheless, this comparison is a possibility for the future research.

The research design is based on an analytical framework from existing theories and findings. Therefore, in the fieldwork, the interview participants were recruited based on a single criterion: the students had to be in their second academic year when they do or have done their professional practicums, as established in Chapter Three: The Methodology and Methods (Participant Recruitment, p.112). Gender was not a factor considered in the recruitment of interview participants. For face-to-face interviews, including students and academic staff, there was only one female participant. For email-based interviews, the gender of participants could not be identified.

Gender equality is highly respected in higher education in China and at the case study university as well. Distinguishing between applicants based on gender is not allowed in the admission for students in HEIs. (It was also improper in recruiting participants for the purpose of this research.) However, in practice, there are far fewer female students than male on engineering master's programmes. This might be due to cultural traditions or other reasons. Female participation in STEM (science, technology, engineering and mathematics) education is a constantly important topic in higher education studies but not the focus of this thesis. For this study, there were no public statistics about the gender of the master's students in the sample schools. However, based on observations from the fieldwork, female students are considerably underrepresented compared to male students in the engineering professional master's programmes. Therefore, it is not surprising that there was only one female participant in face-to-face interviews, and the gender was not particularly considered in the research questions and design. Nevertheless, it is worthy of research in the future, especially in STEM higher education study.

The Differences between the Schools

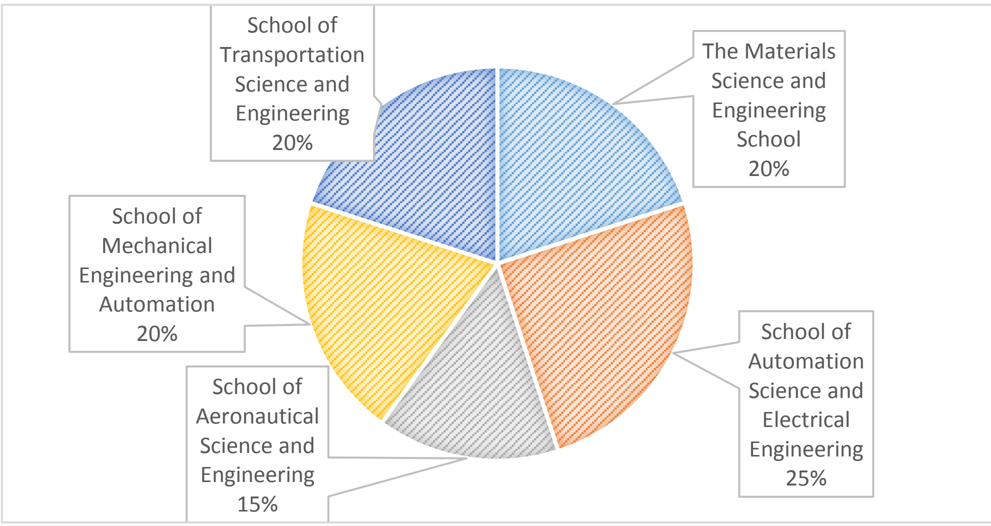
As established in Chapter Three: The Methodology and Methods (Sample Schools Selection, p.110), the sample schools were selected based on three criteria: a comparatively well-established and developed master's education system, relatively typical and common engineering disciplines, and the accessibility of participants. Finally, five schools were selected: The Materials Science and Engineering School, School of Automation Science and Electrical Engineering, School of Aeronautical Science and Engineering, School of Mechanical Engineering and Automation, and School of Transportation Science and Engineering. The five schools together construct the *sample*. Nevertheless, in order to see more possibilities beyond the established research questions and framework, this sub-section considers the differences in the student interview data from the five schools.

Table 4-11 The interview students from the five sample schools

School	The Materials Science and Engineering School	School of Automation Science and Electrical Engineering	School of Aeronautical Science and Engineering	School of Mechanical Engineering and Automation	School of Transportation Science and Engineering
Student number	4	5	3	4	4
Percentage	20%	25%	15%	20%	20%

Data source: interview data

Of the student participants, four students came from The Materials Science and Engineering School, five were from the School of Automation Science and Electrical Engineering, three were in the School of Aeronautical Science and Engineering, four students were from the School of Mechanical Engineering and Automation, and four were in the School of Transportation Science and Engineering, as shown in Table 4-11 and Figure 4-4. The interviewed students came from five sample school comparatively proportionately.



Data source: interview data

Figure 4-4 The interview students from the five schools

The Difference between the Professional Practicum Types according to School

With regard to the professional practicum, the students from five schools took four types of professional practicum, as shown in Table 4-12, but no school covered all four types of professional practicum.

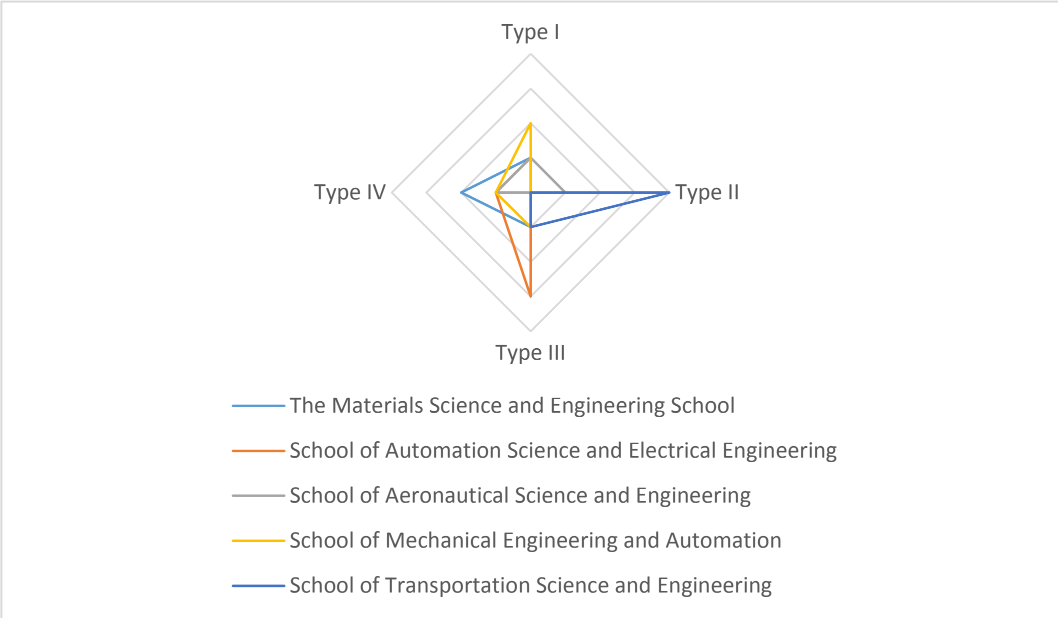
Table 4-12 The types of professional practicum in the five schools

Schools	Type I	Type II	Type III	Type IV
The Materials Science and Engineering School				I-7-F
				I-8-F
			I-9-F	
	I-10-F			
School of Automation Science and Electrical Engineering			I-11-F	
	I-12-F			
				I-13-F
			I-14-F	
			I-15-F	
School of Aeronautical Science and Engineering		I-4-F		
				I-5-F
	I-6-F			
School of Mechanical Engineering and Automation			I-1-F	
	I-2-F			
				I-3-F
	I-16-F			
School of Transportation Science and Engineering		I-17-F		
		I-20-F		
		I-21-F	I-21-F	
		I-23-E		

Data source: interview data

Note: Case I-21-F took two different professional practices of different types.

The radar map in Figure 4-5 shows the trend more clearly. Each line represents one school, and each line is located a part of the map but the distribution is not even. The trend in the radar map reveals that the students have opportunities to take two or three types of professional practicum in each schools.



Data source: interview data

Figure 4-5 The types of professional practicum in the five schools

The different schools have different administrations and/or sources of industrial partnerships, so the practice opportunities that they offer students are different and limited. Why there are differences in the professional practicum types in the schools is a good research topic, but it involves the management/administration of higher education that is a different research field from this research. Therefore, it will not be analysed further in this thesis. Nevertheless, the relationship between different practices and difference schools could be an interesting topic for future research.

The Difference in Knowledge Acquisition Categories between Schools

With respect to knowledge acquisition, the students from the five schools learned multiple kinds of R&D knowledge, as shown in Table 4-13.

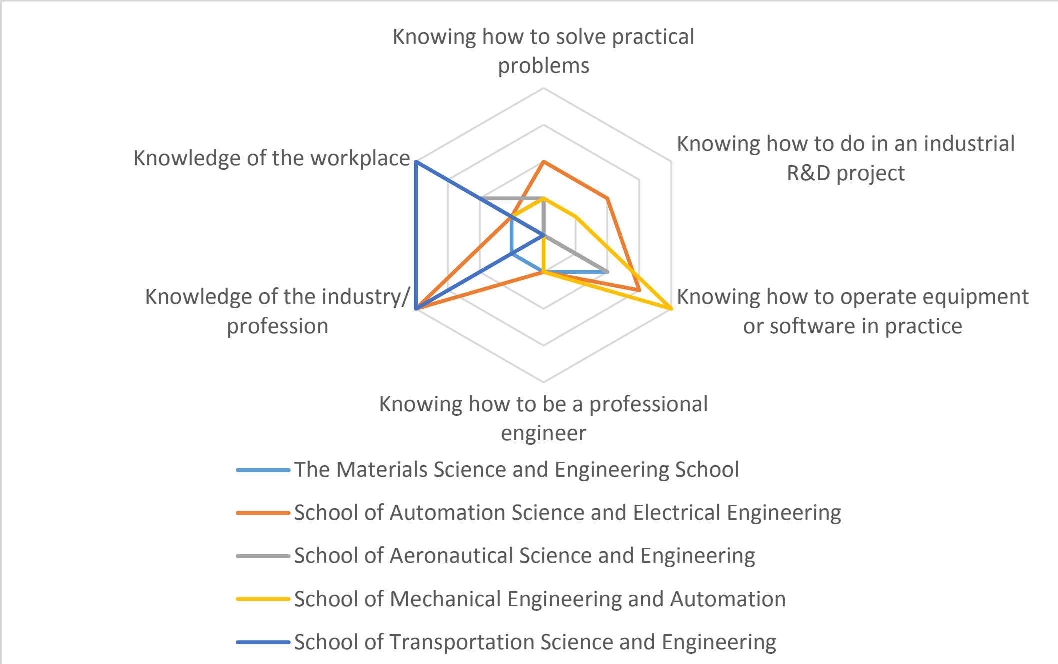
Table 4-13 The knowledge categories and different schools

School	Interview number	Knowing how to solve practical problems	Knowing how to do in an industrial R&D project	Knowing how to operate equipment or software in practice	Knowing how to be a professional engineer	Knowledge of the industry/ profession	Knowledge of the workplace
The Materials Science and Engineering School	I-7-F			√			
	I-8-F						
	I-9-F	√		√			√
	I-10-F				√	√	
School of Automation Science and Electrical Engineering	I-11-F		√	√		√	
	I-12-F				√	√	
	I-13-F			√			
	I-14-F	√	√	√		√	√
	I-15-F	√				√	
School of Aeronautical Science and Engineering	I-4-F			√			√
	I-5-F						
	I-6-F	√		√			√
School of Mechanical Engineering and Automation	I-1-F			√	√		
	I-2-F			√			
	I-3-F	√		√			
	I-16-F		√	√			√
School of Transportation Science and Engineering	I-17-F					√	√
	I-20-F					√	√
	I-21-F					√	√
	I-23-E					√	√

Data source: interview data

In a few schools, the knowledge accumulated by the students is comparatively narrow and fewer than other schools. For example, students from the School of Transportation Science and Engineering learned two kinds of knowledge, while students from other schools learned more types of knowledge. The knowledge learned by students in different schools is related to their professional practicum types. As mentioned previously in The Difference between the Professional

Practicum Types according to School (Chapter Four, p.222), different schools tend to have different strengths in offering practice opportunities, so the students of different schools might accumulate different categories of knowledge based on their practical experience. Nevertheless, as established previously in this sub-section, the differences in the professional practicum types of the different schools involve the management/administration of higher education, and the differences will not be analysed further in this thesis. The different categories of knowledge accumulation are based on different types of practice, and the differences in the professional practicums of the five schools is not the research focus of this thesis. Therefore, although some differences in knowledge acquisitions can be identified, it is not feasible to investigate them further in this thesis. However, it could be a possible future study.

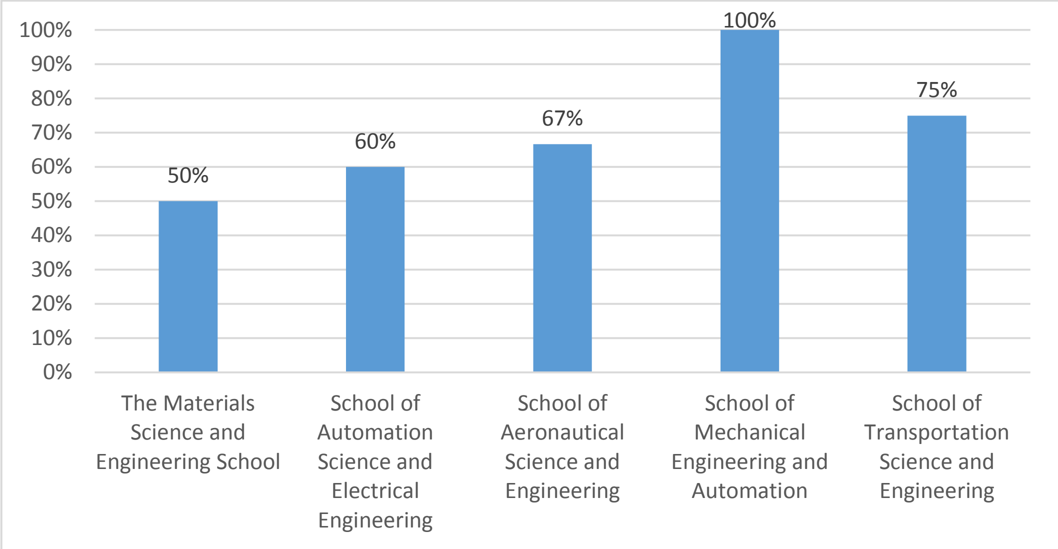


Data source: interview data

Figure 4-6 The knowledge categories and different schools

The Difference in Graduate Job Prospects between Schools

As shown in Figure 4-7, the percentage of students with a positive prospect of graduate jobs is different between the five schools. In the School of Mechanical Engineering and Automation, 100 percent of the students had a positive attitude to their prospects for graduate jobs. In the Materials Science and Engineering School, only half the investigated students had a positive outlook on their prospects of graduate jobs. This figure in the other three schools was around 70%.



Data source: interview data

Figure 4-7 The percentage of students with positive job prospects in the five schools

As inferred previously in Students' Graduate Job Prospects (Chapter Four, p.206), the professional practicum types and their knowledge acquisition may have an impact on students' graduate job prospects. Furthermore, as explained previously in The Difference between the Professional Practicum Types according to School (Chapter Four, p.222) and The Difference in Knowledge Acquisition Categories between Schools (Chapter Four, p.224), different schools may have different strengths in terms of their industrial partnerships and may be able to offer different types of practices, so students may learn different categories of knowledge based on different types of practicum. This means the differences in students' job prospects between the different schools might be connected to the difference in practices and industrial partnerships. Constrained by the existing theories and conceptual framework, this probable link could not be considered further, but it could be a fruitful future research direction.

To sum up, there are differences in the five sample schools, in terms of professional practicum types, knowledge categories, and the students' graduate job prospects. In practice, different schools have different administrations and/or sources of industrial partnerships; the practice opportunities that they offer students are different and limited. This might explain the differences in professional practicum types between the five schools. Moreover, according to the findings in the previous sections, the types of professional practicum may have an impact on the students' knowledge categories and their graduate job prospects. Consequently, the different knowledge categories and the students' graduate job prospects might be due to the differences in the professional practicums offered in the five schools. Why there are differences of practice opportunities and industrial partnerships between schools is a good research topic, but it involves the management/administration of higher education that is a different research field from this research. There is little discussion of this in the existing literature so far, and these differences are not included in the conceptual framework of this thesis. Therefore, they will not be analysed further. Nevertheless, these issues could be an interesting topic for future research.

The Differences between Practicum Employers

As mentioned previously in The Design and Implementation of the Professional Practicum (Chapter Four, p.177), the students took types I, II and III of professional practicums in industrial enterprises. Their practicum employers were domestic private companies, commercial research institutes, China-foreign joint ventures, and state companies.

Table 4-14 compares the types of employer in three types of professional practicum. Type II professional practicum resembles the fixed internship or placement, so most happened in major companies, such as joint ventures. Type III professional practicums largely happened in commercial research institutes. The work hours and work locations of research institutes were not as demanding as those in the commercial companies. That might be the reason why the students of type III professional practicum went to enterprises occasionally but not every day like those in type I professional practicum.

Table 4-14 The types of employer in types I, II and III professional practicums

	Domestic private company	Commercial research institute	State company	China-foreign joint venture
Type I	I-2-F I-16-F	I-6-F I-10-F I-12-F		
Type II		I-21-F	I-4-F	I-17-F I-20-F I-23-E
Type III		I-1-F I-9-F I-11-F I-14-F I-15-F	I-21-F	

Data source: interview data

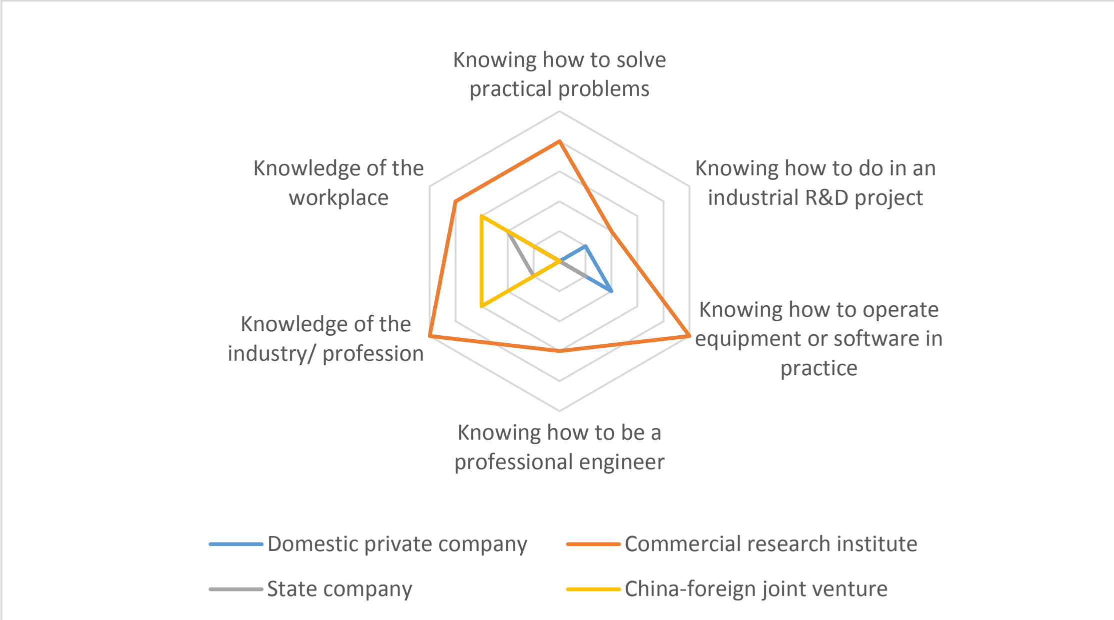
Table 4-15 shows there are some differences in the knowledge categories of the different types of employers in the professional practicums. Figure 4-8 shows this more clearly. The students who were placed in commercial research institutes acquired broader and more categories of knowledge than those with the other employers.

Table 4-15 The types of employer and categories of knowledge

Type of employer	Interview number	Knowing how to solve practical problems	Knowing how to do in an industrial R&D project	Knowing how to operate equipment or software in practice	Knowing how to be a professional engineer	Knowledge of the industry/ profession	Knowledge of the workplace
Domestic private company	I-2-F			√			
	I-16-F		√	√			√
Commercial research institute	I-6-F	√		√			√
	I-10-F				√	√	
	I-12-F				√	√	
	I-21-F						√
	I-1-F			√	√		
	I-9-F	√		√			√
	I-11-F		√	√		√	
	I-14-F	√	√	√		√	√
	I-15-F	√				√	
State company	I-4-F			√			√
	I-21-F					√	√
China-foreign joint venture	I-17-F					√	√
	I-20-F					√	√
	I-23-E					√	√

Data source: interview data

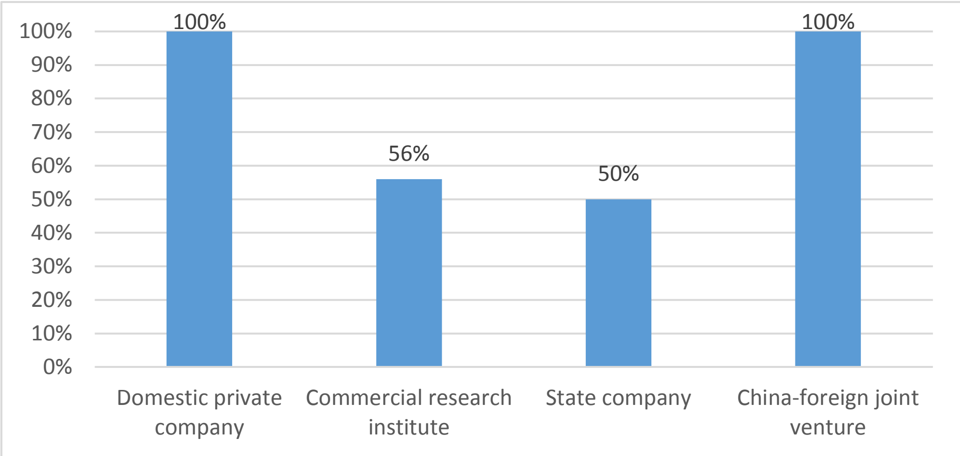
The accumulation of practical and applied R&D knowledge may have a connection to the types of practicum employers. It is an interesting possible link, but it cannot be explained based on the findings of this research. So far, there have been few studies considering the role of enterprise types in knowledge acquisition, and a possible connection is not within the conceptual framework of this thesis. A possible link could be a research direction for the future.



Data source: interview data

Figure 4-8 The types of employer and categories of knowledge

Figure 4-9 shows the percentage of students with a positive outlook on their potential graduate jobs in relation to the four types of practice employers. There are disaggregated differences between the different types of employers. 100 percentage of the students who had their professional practicums in domestic private companies and joint ventures have a positive attitude to their prospects for graduate jobs, whereas about only half of the students placed in commercial research institutes and state companies had a positive view of their prospects for graduate jobs. The difference implies a possible link between the type of practicum employer and the students' perceptions of their prospects for graduate jobs. However, whether this is the case cannot be explained by the data from this research. Again, so far, there have been few studies considering the role of employer types in students' perceptions of their prospects for graduate jobs, and this issue was not part of the conceptual framework of this thesis. It is an unexpected finding from the research data. The possible link could be a research direction for the future.



Data source: interview data

Figure 4-9 The percentage of students with a positive job prospect in four employer types

To sum up, as there were differences between the schools, so were there some differences in different types of practicum employers, in terms of professional practicum types, knowledge categories, and students' perceived graduate job prospects. The differences in the practicum employers in the five schools might be due to differences in the administration/sources of industrial partnerships. The differences in knowledge acquisition and perceived job prospects according to the type of practicum employers were unexpected findings in this research. However, limited by the theoretical framework and the analytical framework, any such links cannot be explained by the data from this research. They will not be discussed further in this thesis, but again, these issues could be interesting topics for future research.

To summarise this section, it presented various dimensions of the data beyond the established research questions and framework. It considered any differences according to gender, school, and type of employer where the practicum took place. Through these comparisons, certain differences were discerned. Some of the differences could be explained, while there were insufficient existing theories and evidence to explain other differences. Although they seem to be irrelevant to the research questions, these unexpected findings could enrich our understanding of the research object, the data, and the issues, and offer more possibilities to explore the research topic that have not been considered in the existing theories and research questions.

Summary

This chapter presented the data generated in this case study. First, information related to the research object, the case and the data were presented to offer a background to understanding the data. Then the following three sections presented the data in response to the three research sub-questions. From the related interview data, six categories of knowledge learned by the students emerged. Then, based on the documentary data and student interview data, how knowledge was acquired according to both course design and in practice was investigated. The professional practicum emerged as having four types. Moreover, it explored the relationship between the different categories of knowledge and the different types of professional practicum. After that, it discussed the role of the acquired knowledge based on multiple data from five perspectives: government policy, the labour market, course design, academic staff, and students. The final section discussed the data from further perspectives than the established frameworks. It offered some possible alternative dimensions to study the issue in the future. Based on the data presented, the next chapter will analyse them and connect the findings to existing theories to develop knowledge in the related areas.

Chapter Five: Data Analysis

Introduction

As mentioned previously, Chapters Four and Five are data chapters. Chapter Four showed what were found from the data. The purpose of this chapter is to interpret the findings by linking them to the existing theories and to develop the theories reviewed in Chapter Two: Literature Review. The following sections analyse the data, focusing on their implications and connections with the existing theoretical framework, in the order of the three research sub-questions. The first section interprets the findings about the knowledge learned in the professional master's programmes. The second section discusses how knowledge was acquired in the professional practicum. The third section analyses the role of the acquired knowledge in the labour market. Based on the findings of the three research sub-questions, the final section discusses the findings concerning the main research question and develops the related theories.

The Knowledge in Professional Master's Programmes

This section analyses the data presented in What Knowledge is Learned in the Professional Practicum? (Chapter Four: Data Presentation, p.156). It discusses the knowledge learned in the professional practicum to develop the existing theories concerning the knowledge acquired in professional education. The first sub-section sets up the theoretical framework for the knowledge of professional education grounded in the existing theories. Based on this framework and the findings, it establishes three types of knowledge acquired in professional master's education. The second sub-section develops a map of professional knowledge for this specific case study based on the existing professional knowledge maps.

Three Types of Knowledge in Professional Education

Table 5-1 is a theoretical framework of the knowledge acquired in professional education. Based on the literature review (Knowledge in Professional Education, Chapter Two, p.34), it tabulates the key points of the theories from Eraut (1992, pp.100-113), Jarvis (1983, pp.74-79), and Billett (2009). Combining this table with the *tacit knowledge* proposed by Polanyi (1966, p.4), three types of knowledge in professional education emerge, which are:

- Type I, propositional or conceptual codified knowledge,
- Type II, process or procedural tacit knowledge or skills, and
- Type III, personal or dispositional tacit knowledge or attitude,

as shown in Table 5-1. Based on this framework, the following paragraphs analyse the related research findings.

Table 5-1 The theoretical framework for knowledge typology in professional education

	According to Eraut (1992, pp.100-113)	According to Jarvis (1983, pp.74-79)	According to Billett (2009)
Type I	**Propositional knowledge** includes the discipline-based theories and concepts, the generalisations and practical principles in the applied field of professional action, and the specific propositions about particular cases, decisions, and actions. All are codified knowledge used for the construction of syllabi in conventional higher education.	**Knowledge** (in the narrow sense) includes knowledge that (academic disciplines), knowledge how (psycho-motor elements), knowledge of persons, moral values and professional ideology.	**Domain-specific conceptual knowledge** is a kind of 'knowing that', e.g. concepts, facts, propositions from surface to deep, which can be spoken about and written down.
Type II	**Process knowledge** refers to knowing how to conduct the various processes that contribute to professional action, and knowing how to access and make good use of propositional knowledge. There are five types of process: acquiring information, skilled behaviour, deliberative process, giving information, and controlling own behavior.	**Skills** (bracketed with knowledge) is a special ability that is often gained only through training. It combines the theoretical 'knowledge how' to carry out the procedure with the 'knowledge that', consequently the practitioner can think through the undertaken process and use different techniques if required.	**Domain-specific procedural knowledge** is a type of 'knowing how', which is the knowledge that we used to do things. It is specific to strategic procedures but cannot be easily declared or easily represented.
Type III	**Personal knowledge** is an intuitive and implicitly learned impression. It covers the people or situations encountered, the communications received, and the events or activities experienced. It is acquired through experiences, social interaction, trying to get things done, participation, or observation.	**Attitude** (bracketed with knowledge in the narrow sense) is cognitive and affective orientations towards the phenomenon in question and a behavioural tendency towards it, for example, a belief, ideology, or a commitment.	**Dispositional knowledge** includes interests and beliefs, e.g. values, attitudes, which could be described as 'knowing for', related to both canonical knowledge and instances of practice and their level of importance.

Type I Propositional or Conceptual Codified Knowledge

The first type of knowledge is propositional codified knowledge or conceptual codified knowledge, for example, the concepts or theories from a coherent and systematic knowledge body. Based on the findings related to course design (Course Aims, Chapter Four, p.197), some concepts, principles, or theories are designed in both the academic and professional master's programmes, for example

> […] *sound fundamental theories and systemic specialised knowledge in aircraft design, having broad knowledge and strong self-study ability, possessing knowledge about the General Design of Aircraft, Physical Design, Aero-elasticity, Flight Mechanics, and Aviation Safety* […]
>
> […] *sound fundamental theories and systemic specialised knowledge in the field of machine science and manufacturing engineering, knowing in depth the advanced technology and development trends in this field* […]
>
> (Data number: D-2 – D-11)

According to Eraut (1992, pp.100-113), the propositional knowledge that comes closest to traditional academic territory is used for the construction of syllabi in conventional higher education. Based on the findings related to course design (Course Aims, Chapter Four, p.197), some concepts, principles, or theories are designed in both the academic and professional master's programmes, which concurs with Eraut's views.

As reviewed in Chapter Two: Literature Review (Other Scholars' Views of Knowledge in Professional Education, p.46), Jarvis (1983, pp.74-79) divides this kind of professional knowledge into five types: 'knowledge that', 'knowledge how', knowledge of persons, moral values, and professional ideology. Based on the findings (Course Aims, Chapter Four, p.197), the knowledge designed in the academic and professional programmes covers the other four classifications except for 'knowledge of persons'. Jarvis (1983, pp.74-79) does not offer a definition of 'knowledge of persons', but takes educational knowledge as an example to explain it as the understanding of the dynamics of classroom interaction, sensitivity in interpersonal relations in respect of the teacher-learner relationship. Thereby, the *persons* here could be understood as the service objects, for example the students in classroom, in the education profession. By analogy, in engineering professions, *knowledge of persons* could be replaced by, for instance, *knowledge of machines*, which refers to the capacity of humans to understand or operate machines and master technologies (for example, see in MacKenzie, 1998). Therefore, if *knowledge of persons* is replaced by *knowledge of machines*, the knowledge designed in both the academic and professional programmes (Course Aims, Chapter Four, p.197) covers the five types of knowledge proposed by Jarvis.

The knowledge designed in both the academic and professional programmes (Course Aims, Chapter Four, p.197) also includes Billett's domain-specific conceptual knowledge, i.e. concepts, facts, propositions from surface to deep, that can be spoken about and written down (Billett, 2009).

Meanwhile, some specialised academic knowledge, such as concepts, principles, or theories also appear in job requirements (Labour Market Demands, Chapter Four, p.194), for example,

- *'familiar with IC engine (internal combustion engine) & Turbo-charging theory',*
- *'possess automatic control theories', or*
- *'have knowledge of aircraft conceptual design and aerodynamics'.*

(Data number: D-12 – D-14)

These suggest that the labour market also demands this type of codified knowledge. Nevertheless, as mentioned previously, this type of knowledge could also be learned in academic master's programmes; it is not an exclusive aspect of professional programmes. So this type of knowledge is not the key focus of practical learning or the practicum. It is mentioned here to complete the knowledge framework. However, it is not the focus of this research and will not be discussed further.

Type II Process or Procedural Tacit Knowledge or Skills

The second type of knowledge is defined as *process knowledge* by Eraut and as *procedural knowledge* by Billett. However, both identify it as *knowing how to do*. Jarvis refers to it as *skill*s, which is closer to everyday language.

According to the findings of the course aims (Course Aims, Chapter Four, p.197), the applied skills, i.e. applying the existing theories or technologies in practice, and the practical skills, i.e. the ability to solve practical problems, belong to this type of knowledge. They are specially designed in the professional programmes and delivered by the professional practicum, but not in the academic programmes.

Also, as presented in Chapter Four (Labour Market Demands, p.194), the knowledge and skills required for jobs cover this type of process or procedural tacit knowledge, for example, the skills for operating a specific instrument, piece of equipment, software or program, or the ability to design, develop, analyse, test or simulate a specific object (a thing or a process) by a combination of several technology principles or the operation of hardware or software.

According to the student interview data in Chapter Four (What Knowledge is Learned in the Professional Practicum? p.156), the knowledge learned by students in the professional practicum is wider than that identified in the course design and job requirements. The knowledge learned was classified into six broad categories, with some sub-categories. Of these, four categories (with their sub-categories) belong to Type II knowledge, process or procedural tacit knowledge or skills, as below:

- knowing how to solve practical problems
    - how to integrate the individual theories learned in university in practice to solve problems
    - how to transfer a theoretical design into a feasible practical operation

    - how to solve the problems related to the coordinating issue in a project design or a project plan
    - how to instantly solve unexpected on-site problems
    - how to correct or improve and learn from a failed operation in practice
- knowing how to do in an industrial R&D project
    - how to apply the technologies or employ the instrument in an industrial R&D project
    - how to plan the schedule and the progress of an industrial R&D project
- knowing how to operate the equipment or software in practice
    - how to overcome difficulties and solve problems using the software
    - how to apply the equipment or software to realise a specific engineering function
    - operating proficiently
    - having instant and accurate operating skills
    - being able to adapt to industrial hands-on skills requirements
- Knowing how to be a professional engineer
    - how to instantly and accurately identify problems or issues that need further analysis
    - how to have professional competence, i.e. proficient operation within a normative and provident paradigm

As reviewed in Chapter Two (Eraut's Knowledge of Professional Education, p.38), Eraut (1992) proposes five types of process. The findings in this study, i.e. four categories of knowledge above, covers three of the five processes directly, namely:

- knowing how to solve practical problems and knowing how to operate the equipment or software in practice - skilled behaviour
- knowing how to do in an industrial R&D project - deliberative processes
- knowing how to be a professional engineer - controlling one's own behaviour

For the other two types of process, 'acquiring information', proposed by Eraut, does not explicitly appear in the findings. However, it is implicitly embodied in the students' discourse. For example, the students learned new knowledge from their mistakes or from senior professionals (Knowing How to Solve Practical Problems, Chapter Four, p.157).

The process of 'giving information to clients', proposed by Eraut, is not included in type II knowledge in this study. In this case, the students' professional practice is mainly industry-based R&D projects, so communication with clients is necessary, but not a key activity, at least, not as important as in teaching or nursing. Sometimes, communication may take place with fellow-workers or industrial partners who could be deemed *clients*, but this kind of communication is less about professional skills and more about personal capability. For example, industrial clients are concerned about whether an R&D professional can use his/her professional knowledge to solve technology problems or design a product, more than his/her communication skills. Of course, communication or interpersonal skills can help them work efficiently and smoothly, as presented in Chapter Four (Knowledge of the Workplace, p.167), but are not vital factors in completing their R&D tasks. Thus, communication skills are categorised as type III knowledge in this research (it will be explained in the following sub-section).

In a word, except for 'giving information to clients', the findings of this research cover four of the five types of process knowledge proposed by Eraut (1992). The findings specifically reflect the process knowledge (Eraut, 1992) in professional engineering master's education, with both consistency and inconsistency. Similarly, the findings also cover 'the ability of thinking the undertaken process and using different techniques' proposed by Jarvis (1983, pp.74-79). Meanwhile, the 'domain-specific procedural knowledge' proposed by Billett (2009) is fully included in the findings.

Type III Personal or Dispositional Tacit Knowledge or Attitude

In Table 5-1, type III knowledge is referred to *personal knowledge* by Eraut, *dispositional knowledge* by Billett, and *attitude* by Jarvis. The three terms are not as convergent as those in the previous two types. However, all three terms are personal, dispositional, motivational, emotional, perceptual, or cognitive, in the form of impressions, perceptions, or attitudes. A little of this kind of knowledge can be codified, for example, profession ethics codes, but most is tacit and personal.

According to the relevant findings (Course Aims, Chapter Four, p.197), the course design rarely focuses on this type of knowledge, except for a few professional ethics codes. The labour market nevertheless does desire this type of knowledge. For example, in job requirements, candidates are required to have an awareness or experience of R&D processes or production processes, or the ability to communicate, coordinate, cooperate, or work in a team (Labour Market Demands, Chapter Four, p.194). The students investigated learned this type of knowledge in the professional practicum. As presented in Chapter Four (Knowledge of the Industry or Profession, p.165, and Knowledge of the Workplace, p.167), two categories of acquired knowledge (with their sub-categories) belong to this type of knowledge:

- The impression of an industry or a profession
    - industrial demands are sometimes different from the goals of university research
    - the atmosphere and feel of doing an industrial R&D project is different from doing research in the university laboratory
    - what the enterprise is doing or how it is operated
    - their professional development or career development
- The impression of the workplace
    - coordination and cooperation with other departments or colleagues is important and complicated
    - a proactive personality is necessary in the workplace
    - a sense of the ambience, culture, or management style in the workplace

  - interpersonal relations are cold and calculating in the workplace, not as easy, nice, and mutually supportive as in the university

First, regarding the *form* of knowledge, these two categories of knowledge are about the perception or impression of the industry, the profession, or the workplace. They are not 'hard knowledge', such as how to design or how to operate something. They are 'soft skills', to some extent, such as interpersonal communication or team skills. In the interviews, the students did not express these ideas explicitly, for example, that they learned how to work in a company or how to get along with colleagues. However, their discourse revealed that they had acquired these perceptions and impressions. Considering this kind of knowledge *per se* is tacit, it is understandable that the students cannot learn it systematically and refer to it explicitly. Thereby, the intuitive and implicit perceptions and impressions acquired by students precisely match the theories suggested by Eraut, Billett, and Jarvis.

Secondly, the *content* of the two types of knowledge above intrinsically are the differences between universities and industries or the workplace. The students had no official employment experience before the practicum, so the events, circumstances, people that they encountered in the workplace were new to them. Therefore, they compared their new work experience with their previous experience at university. Based on this comparison, the belief, the value, and/or attitude to an industry and/or the workplace have been constructed. The findings reflect Eraut's *personal knowledge*, Billett's *dispositional knowledge*, and Jarvis's *attitude* in the professional master's engineering education.

In summary, based on the theoretical framework of knowledge in professional education, the findings of this research suggest three particular types of knowledge in professional education. The data from the course design illustrate type I knowledge, propositional or conceptual codified knowledge. The data addressing what knowledge was learned illustrate type II knowledge, process or procedural tacit knowledge or skills, and type III knowledge, personal or dispositional tacit knowledge or attitude. The findings of three types of knowledge in professional education are compatible with the related knowledge theories from Eraut, Billett, and Jarvis. The findings also develop their theories, through specifying them in professional master's engineering education and in China's context.

A Knowledge Map for Professional Master's Engineering Education

Eraut develops maps of knowledge for headteachers, social workers, and so forth (Eraut's Maps of Professional Knowledge, Chapter Two: Literature Review, p.41). Based on Eraut's maps, a knowledge map of professional master's engineering education is developed, as shown in Table 5-2. The purpose of this map is not to list the knowledge in the syllabus, but to show what has been learned in practice, in the professional master's programmes. It is a condensed summary of the types of knowledge mentioned in the previous sub-section. As reviewed in Chapter Two (Eraut's Maps of Professional Knowledge, p.41), Eraut provides maps of knowledge for headteachers and social workers. This map extends Eraut's knowledge map study to engineering R&D professionals.

Table 5-2 A knowledge map of the professional master's students in engineering R&D

Propositional or conceptual codified knowledge	
Academic concepts and theories Principles of design and development Ethical and professional codes	
Process or procedural tacit knowledge (knowing-how, skills)	
Knowing how to solve practical problems	How to integrate the individual theories learned at university into practice to solve problems
	How to transfer a theoretical design into a feasible practical operation
	How to solve coordinating problems in a project design or plan
	How to instantly solve unexpected on-site problems
	How to correct and learn from a failed operation in practice
Knowing how to do in an industrial R&D project	How to apply the technologies or employ the instrument in an industrial R&D project
	How to plan the schedule and the progress of an industrial R&D project
Knowing how to operate the equipment or software in practice	How to overcome the difficulties and solve problems when using software
	How to apply the equipment or the software to realise a specific engineering function
	Proficiency of operation
	Instant and accurate operational skills
	being able to adapt to hands-on industrial skill requirements
Knowing how to be a professional engineer	How to identify instantly and accurately problems or issues that need further analysis
	How to have professional competence, i.e. to operate proficiently in a normative and provident paradigm
Personal or dispositional tacit knowledge	
Knowledge of the industry or profession	Industrial demands are sometimes different from the goals of university research
	The atmosphere and feel of doing an industrial R&D project is different from doing research in the university laboratory
	What a company is doing or how it operates
	Professional development or career development
Knowledge of the workplace	Coordination and cooperation with other departments or colleagues is important and complicated
	A proactive personality is necessary in the workplace
	A sense of the ambience, the culture, or the management style in the workplace
	Interpersonal relations are cold and calculating in the workplace, not as easy, nice, and mutually supportive as in university

The knowledge map and the analysis in the last sub-section together can address the first research sub-question, *what knowledge is learned in the professional master's programmes*? Types II and III are the key responses to this sub-question. Type I knowledge (propositional or conceptual codified knowledge) is designed to be learned in both the academic and professional programmes and is required by the labour market, but the academic programmes can also deliver it. So type I knowledge is not the key acquisition in the professional master's programmes. However, type II knowledge (process or procedural tacit knowledge) and type III knowledge (personal or dispositional tacit knowledge) are designed specifically for the professional master's programmes and sought after by the labour market. Moreover, they are learned by the students in the professional master's programmes through the professional practicum.

To sum up this section, the findings not only address the first research sub-question, but also reinforce and develop Eraut's, Billett's, and Jarvis's theories about knowledge acquired in professional education. The existing theories hypothesise certain types of tacit knowledge, and the research findings confirm and reflect them in professional master's engineering education. Additionally, based on the findings, this section framed a map of knowledge for the professional master's students who are going to be R&D engineers. The map adds professional engineering knowledge to Eraut's knowledge mapping research.

The Professional Practicum: Learning Knowledge by Practising

This section interprets the findings for the second research sub-question: *how did the students learn the knowledge in the professional programmes*? As established in Research Gaps and Research Questions (Chapter Two, p.80), the purpose of this question is not to explore the learning methods, but to consider the role of practice in learning practical and applied tacit knowledge and to link the previous and following sub-questions. Therefore, it is a comparatively brief issue in this study. In this section, the first sub-section examines the course model of the professional master's programmes based on Bines' course model theory of professional education. The second sub-section discusses the professional practicum and its function in learning knowledge based on the relevant research findings. The third sub-section considers the data in the light of Eraut's findings about practical learning.

Course Structure

As reviewed in Chapter Two (Course Design, p.51), Bines (1992, pp.12-17) proposes three course models in professional education: the apprenticeship/ pre-technocratic model, the technocratic model, and the post-technocratic model. Based on the findings (The Course Design of Professional Master's , Chapter Four, p.172), in this case, the curriculum matches the second model, namely the technocratic model, for the reasons below.

According to Bines (1992, pp.12-17), there are three elements in the technocratic model:

- the development and transmission of systemic knowledge based on academic disciplines,
- interpreting and applying the knowledge in practice by multiple professional activities in their context,
- and supervised practice in the workplace.

In this case, first, the taught modules develop and transmit the systemic knowledge in academic disciplines. The first section of this chapter defined knowledge that has been taught as propositional and conceptual codified knowledge (Type I Propositional or Conceptual Codified Knowledge, p.238). In addition, from observations during the fieldwork and the interview data, most taught modules were same in the academic and professional programmes. So this case matches Bines' first element. Secondly, in the professional programmes, students were able to interpret and put their knowledge learned in taught modules into practice, partly in the experiment module, but mainly in the industry-based professional practicum. This accords with the second element. Thirdly, the professional practicum exemplifies supervised practice in the workplace.

Therefore, the course structure of the professional master's engineering programmes specifies Bines' technocratic model in professional engineering master's education. The evidence suggests the professional master's programmes belong to the category of professional education discussed in the

Western literature. The findings fit Bines' technocratic model of professional master's education and offer empirical evidence for the model. They extend the theories of professional course structure to master's engineering education in the context of China.

Professional Practicum

This sub-section discusses the professional practicum from two aspects. One is the mode of the practicum. As presented in Chapter Four (The Design and Implementation of the Professional Practicum, p.177), in this case, the students' professional practicum were categorised into four types:

- Type I: students worked full-time, like the formal staff, for months at industrial enterprises on collaborative R&D projects with schools of study or students' supervisors. The students engaged in R&D projects, applying their specialised knowledge and/or using equipment, software, or the data of the companies.
- Type II: students worked full-time in fixed internship posts at enterprises in the industries related to their subjects. Their job responsibilities did not involve R&D; they carried out some assistant or administrative tasks not requiring their specialised knowledge.
- Type III: The students engaged in R&D projects in collaboration with industrial enterprises. They carried out R&D tasks mostly in the university laboratories. They went to companies occasionally and informally to attend project meetings, use equipment, do on-site testing, and/or debug the software or hardware previously developed in the

university laboratory.

- Type IV: students engaged in industry-based research projects, but never worked in any enterprise.

As reviewed in Chapter Two (China's New Professional Master's Programmes, p.27), Chinese scholars produce a model of professional practicum that has three types of practices in a key research university that is comparable with the case study university of this research (文冠华 Wen et al., 2010):

- First, on-the-job students may complete the professional practicum in their affiliated enterprises.
- Second, some students may practice in enterprises that have collaborative research projects with their supervisors.
- Third, some students may practice in a Professional Practice Base located in collaborating companies, helping to solve their industrial problems.

However, they do not offer any empirical evidence for the above possibilities, so their implementation in fact is not clear. Their first mode of practice involves on-the-job students, which does not meet the requirements of the new full-time professional master's programmes. As established in China's New Professional Master's Programmes (Chapter One, p.6), the new full-time master's programmes mainly admit fresh graduates without any job or employment experience. Wen's mode of practicum might relate to a particular case context, but the findings of this study do not fit Wen's first mode of practice. Wen's second mode of practice resembles the type I and type III professional practicums identified in this research. Wen's third mode, Professional Practice Base, is encouraged by government policy, but it has not been developed completely in practice, and it was not identified in the data of this case study.

Compared with the practicum model suggested by Chinese scholars, the findings of this case study have identified four types of practicum model with both similarities and differences to the existing model. The findings offer empirical evidence in this field and enrich the theories about the practicum for the new full-time professional master's programmes in China.

The second discussion is about Bines' practicum design. As reviewed in Chapter Two (Practicum, p.53), Bines (1992, p.21) develops a framework of organisational, curricular, and structural issues in the practicum. According to the research findings (The Design and Implementation of the Professional Practicum, Chapter Four, p.177), the professional practicum is designed to be no less than half a year and enterprise-located. Several types of practice should be conducted to enhance the students' overall practical skills and their ability to apply theoretical knowledge to solving practical problems. These findings are in agreement with Bines' views of organisational issues and the 'what to be learned' aspect of the curriculum.

Regarding Bines' 'how to learn' aspect of curricular and structural issues, the practicum should be designed around 'a set of specific and sequenced tasks, activities and experiences, closely related to other course elements through supervision, tutorials, seminars and written assignments' (Bines, 1992, p.21).

However, in this case, the professional practicum is not designed as prescriptively as Bines suggests. This 'freestyle' course design reflects the dynamics of access to the industry, workplace, or project or other demands or needs within a specific time frame.

As shown in the findings (The Design and Implementation of the Professional Practicum, Chapter Four, p.177), there are different specific types of professional practicum, and some students carried out the tasks related to their academic disciplines. However, these tasks were not designed especially for the students by their supervisors or industrial professionals, but selected from actual industrial work. The 'freestyle' professional practicum, in this case, cannot guarantee that students can reinforce and apply their academic acquisitions through intentional and systematic practice. However, it plays a significant role in transmitting knowledge, as explained below.

First, the professional practicum can play a role in the learning of practical and applied tacit knowledge. As reviewed in Chapter Two (Practicum, p.53), Glenny and Hickling (1992) identify four elements that the students need to do or learn in the practicum of a teacher education programme through a case study. While, as analysed in the first section of this chapter, in this case, the students also learned sufficient knowledge (including skills, abilities, competences, sense, or impression) related to their professions. Additionally, Simpson and Jackson (2000) indicate some achievements of the practicum (Practicum, Chapter Two, p.53), which are also embodied in the research findings.

Secondly, the different types of professional practicum may have different impacts on acquiring different kinds of knowledge. As shown in Table 4-9 (Chapter Four, p.188) and Figure 4-2 (Chapter Four, p.189), the students who did industry-based R&D projects learned all kinds of knowledge in comparatively equal measures. However, the students who undertook some managerial or administrative tasks mainly learned about the industry/profession and the workplace, but few had engineering experience or hands-on skills. The students who had no enterprise-located professional practicum at all learned only a few of operational skills divorced from any knowledge of the industry, the profession, or the workplace. The evidence shows that the different forms of practice do have an impact on students learning different kinds of knowledge. This finding has been little considered in the existing studies so far.

In sum, although the prescriptively designed practicum has many strengths, as Bines assumes the work randomly selected from industries can also develop students' applied and practical tacit knowledge. In this case, the students acquired additional kinds of knowledge to that designed in course aims. So this style of practice is effective as well. How to learn in practice is a huge topic and a significant research issue, but the discussion there is sufficient; as established previously, how to learn is not the key focus of this research.

Practical Learning

As reviewed in Chapter Two (Learning by Practising, p.55), based on a research project, Eraut (2003) summarises twelve characteristics of graduate engineers' activities in the workplace, some of which are highly compatible with the findings of this research, as discussed below.

Eraut (2003) offers strong support for the benefits of having previous practical experience such as an industrial placement or a sandwich year, for engineers. My findings illustrate this in the inverse: the professional practicum may contribute to graduates hunting jobs (Students' Graduate Job Prospects, Chapter Four, p.206).

Eraut (2003) points out that interest in the job is important, and carrying out challenging, real-world tasks is thought by graduates to be the most effective way of learning. The findings of this study show that students develop the motivation to and learn how to overcome difficulties or solve problems in using software (or other devices) through practical work, whereas in taught modules, without an applied use, students lacked the motivation to overcome difficulties or solve problems (Knowing How to Operate the Equipment or Software in Practice, Chapter Four, p.161).

Eraut (2003) states that graduates believe that they learn most from doing things under supervision, followed by learning from senior engineers (observation, discussion, etc.). In this case study, students had the opportunity to access industrial professionals or work with them in the professional practicum. These industrial professionals became the role models for students and enabled them to see the gaps between themselves and skilled professionals and to understand their future professional development trajectory (Knowing How to Be a Professional Engineer, Chapter Four, p.163).

Eraut (2003) finds out that graduates often work on large projects with long time-scales but would like to understand more about how their tasks contribute to the overall project. In the case of this research, the students engaged in industrial R&D projects in the professional practicum, so they had some conceptualisation of industrial projects. They became familiar with the technologies or the instruments applied in a practical project, so they were able to plan schedules and/or organise the progress of an industrial R&D project after the practicum (Knowing How to Do in an Industrial R&D Project, Chapter Four, p.160).

According to Eraut (2003), a number of graduates found that they were engaged in too many simple, routine, even repetitive, tasks. However, they still recognised the general benefits of this kind of activity, particularly early on their employment. In the case of this study, some students carried out some supportive and assistant administrative tasks in type II professional practicum (The Design and Implementation of the Professional Practicum, Chapter Four, p.177). They still had a positive experience (Knowledge of the Workplace, Chapter Four, p.167, and Students' Graduate Job Prospects, Chapter Four, p.206).

The findings of this research agree with Eraut (2003)'s findings and add to his findings about practical learning, with respect to master's engineering education in China.

As reviewed in Chapter Two (Learning by Practising, p.55), based on the findings of the LiNEA Project, Eraut (2003) develops the earlier triangular relationship of learning factors: challenge, support, and confidence (Eraut et al., 2000) to produce a new one: challenge + value, feedback + support, and confidence + commitment. As established above, the factors relating to 'challenge', 'support', 'feedback', and 'confidence' are embodied in the findings of this study. For example, students developed the motivation to overcome difficulties or solve problems in using software (or other devices) and learned how to do these through practical work because of the challenges of application in practice; the senior industrial professionals supported the students, enabling them to visualise their future professional development trajectory; and the practicum experience gave the students confidence in hunting graduate jobs because they had been given positive feedback from their practicum employers. The evidence of this research concurs with Eraut's factors of learning by practising.

As reviewed in Chapter Two (Learning by Practising, p.55), based on the findings of LiNEA Project, Eraut (2003) also develops a triangle of work context: the allocation and structuring of work, encounters and relationships with people at work, and individual participation and expectations of their performance and progress. Eraut (2007) further explores the epistemology of practice, using three dimensions: first four key elements of practice—situational assessment, decision-making, actions and meta-cognitive monitoring; next, the mode of cognition and its dependence on time and prior learning; third is the context, its influence on the mode of cognition and its affordances for learning. Eraut (2007) also sets out the project's findings on modes of learning through a new framework with nine learning processes: being supervised, being coached, being mentored, shadowing, visiting other sites, conferences, short courses, working for a qualification, and independent study. Nevertheless, the findings of this study cannot directly reflect Eraut's learning processes, though they may have some implied connections. As established in Research Gaps and Research Questions (Chapter Two, p.80), the purpose of this entire study is to explore the role of knowledge, and the second research sub-question focuses on 'how to learn the knowledge' in terms of course delivery in *higher education*, but not the learning processes during real work. In this case, students' practices resemble 'learning by working', so there are likely to be some similarities and reference points. However, the work context factors that could influence people's knowledge accumulation is not the focus of this research, and the finding of this study cannot contribute to Eraut's learning processes. Nevertheless, the findings of this study suggest that the work context of students' practicum could be a fruitful future research direction.

To summarise this section, the knowledge specially learned in the professional programmes is type II knowledge (process or procedural tacit knowledge or skills) and type III knowledge (personal or dispositional tacit knowledge or attitude), as established in the first section of this chapter (The Knowledge in Professional Master's Programmes, p.236). These two kinds of knowledge cannot be taught by conventional didactics like type I knowledge (propositional or conceptual codified knowledge). They are normally acquired through 'non-formal learning' (Eraut, 2000) or 'learning through practice' (Billett, 2010). This section has shown how the practicum is designed and delivered in the professional master's programmes to transmit those kinds of tacit knowledge. First, the course structure in this case was analysed and compared with Bines' principles of professional course design. Then the modes of professional practicum in the programmes were compared with a model suggested by Chinese scholars. The functions of the practicum in transmitting practical and applied tacit knowledge were also analysed. The final sub-section considered some factors of learning through working. The findings reinforce some existing mechanisms of professional course design and delivery, and add evidence to them in terms of professional master's engineering education in China.

The Role of Knowledge in the Labour Market

This section considers the findings addressing the final and key research sub-question: *Why is the acquired knowledge sought after by the labour market?* The first sub-section analyses the evidence from five perspectives: government policy, course design, the labour market, academic staff, and students. The second sub-section links the findings with human capital theory in particular, and discusses how the findings develop human capital theory.

The Evidence from Different Perspectives

This study considers the research issue from the perspectives of government policy, course design, labour market demands, academic staff, and students. Chapter Four presented the data from the policy discourse, the course programmes, job requirements, the academic staff's interpretation, and the students' perceptions (Why Is the Knowledge Sought After by the Labour Market? p.190). This sub-section interprets the accounts from five perspectives, relating them to the specific context of China, in order to consider why the knowledge learned in the professional master's programmes is necessary and significant.

Government Policy Discourses

According to the findings in Chapter Four (Government Policy Discourses, p.191), the policy document clearly states that the programmes aim to meet the demand for the high-level applied specialists necessary for economic and social development; it also sets out why the newly introduced professional programmes, but not the previous academic ones, can play this role. This sub-sub-section further interpret this issue together with China's development.

As outlined in Chapter Four (The Development of Master's Education in China, p.135), in China, postgraduate education was resumed and has been formalised since the late 1970s, in order to deliver graduates who were going to be scientists, scholars, university professors, and so on. In the last two or three decades, economic growth and the development of science and technology in China has brought more industries and professions, and an increasing need for high-level applied specialists with a master's degree to work as industry professionals. It is the responsibility of postgraduate education to deliver these master's graduates. To meet the demand, from 2003, master's education in China has been steadily expanding and delivering sufficient numbers of master's graduates to the labour market. However, conventional academic master's programmes dominated master's education previously, and master's graduates mainly possessed theoretical knowledge and research skills.

In recent years, less than 20% of master's graduates have been employed by HEIs (higher education institutions) as university scholars (黄宝印 Huang, 2010). More master's graduates now find jobs in non-academic industries or professions. Therefore, before the new professional master's programmes were introduced, academic master's programmes dominated master's education; the problem was that the labour market needed applied professionals, while the academic master's education delivered graduates with mainly academic knowledge and research skills. Consequently, these graduates could not satisfactorily meet the requirements of non-academic industries or professions. Master's education dominated by academic programmes could not meet the changes in labour market needs. Master's education needed to be re-orientated; the concept of master's education needed to be adjusted; and the system of master's education needed to be optimised to transform it from delivering mainly research specialists to delivering more applied professionals. This is why the policy mentions that introducing the new professional master's programmes is important from the macro perspective of economic and social development.

As profiled in Chapter Four (The Professional Master's Programme Reform, p.142), before the full-time professional master's programmes, master's education in China had a few professional master's programmes after the 1990s, for instance, MBA (Master of Business Administration), JM (Juris Master), MPA (Master of Public Administration), Ed.M (Master of Education). However, the conventional professional master's programmes only offered some block release or day release courses to on-the-job students or students who had employment experience. However, not only did those already with jobs or employment experience need professional master's education for their professional development, but so did new graduates need. Fresh graduates need further study to enhance their professional competence and prepare them for the labour market. The professional master's programmes should have both full-time and part-time study modes. Consequently, the full-time professional master's programmes were introduced in 2009 to fill the gap, offering full-time courses for new graduates and being delivered in the same way as academic master's programmes. The master's education system, with various modes of master's programmes, has thus become more diverse to meet the various demands of the labour market. This is why the policy claims that introducing the new programmes is significant for the system of master's education as well as professional education.

The policy meanwhile also states the professional master's programmes were introduced to fulfil labour market demands. To some extent, it is based on the premise that an appropriate type of education programme can deliver the *right* kinds of knowledge, that is, the knowledge sought after by the labour market. The following four sub-sub-sections, starting with an analysis of labour market demands, illustrate this hypothesis by analysing the professional master's course delivery and knowledge accumulation.

Labour Market Demands

Based on the discussion above, the professional master's programmes were introduced to meet labour market demands, so what are the labour market demands today in China's economic context? The engineering industrial labour market was introduced in Chapter Four (An Overview of the Labour Market, p.151). Here, the labour market and China's economic development are considered together to interpret the needs of the labour market.

China has experienced the Reform and Opening Up (Chinese: 改革开放 *gai ge kai fang*)[47] since 1978, but through two different economic transitions. From the late 1970s to the early 21st century, the first transition was from the centrally planned economy to a market economy. China achieved remarkable economic success through this transition. For instance, the average annual GDP

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47 In late 1970s, the economy was in deep recession in China after many years of internal disorder. China was one of the least developed low income countries. In 1978, China started the Reform and Opening Up (改革开放 *gai ge kai fang*), initially led by Deng Xiaoping (1904 –1997) who was a key politician in China in the 20th century. The Reform and Opening Up aims to facilitate productivity, to modernise the nation and to improve people's living quality. Domestically it mainly implements economic reform, converting from the central planned economy to the market economy, and also conducts a range of reforms in politics, society, culture and other sectors. Internationally it opens up trade and other interactions to the other countries gradually. The Reform and Opening Up has been successful and deemed as the key reason for China's growth since 1970s.

growth rate was approximately 10% in those years; China has been the second-largest economy in the world since 2010 (朱剑红 Zhu, 2013). China has been called the 'world factory' (for example, Zhang, 2006) or 'manufacturing power' (for example, The Economist, 2012) since the 1990s.

However, this high-speed growth depended on a large, cheap labour force, the exploitation of abundant natural resources, and massive investment. However, in recent years, the advantages of demographic dividend and land dividend have declined; the factor-driven and investment-driven extensive growth pattern[48] cannot support China's growth any further (赵晶 Zhao, 2012). Therefore, China cannot continue with the previous development model; it also has to face international competition that has become increasingly more fierce against the background of the knowledge economy, globalisation, and the technological revolution.

Consequently, since the beginning of the 21st century and particularly in the last decade, China has experienced a second transition: economic restructuring (Chinese: 经济转型 *jing ji zhuan xing*). China's economic development is now converting to a new paradigm based on knowledge, science, and technology and innovation, and featuring high quality, high efficiency, and high added value, but low energy consumption and low natural resource costs (see in 中华人民共和国中央人民政府 The Central People's Government of the People's Republic of

48 Extensive economic growth refers to the economic development depending on the expansion of inputs of labour, reproducible capital, such as machines and livestock, and natural resources.

China, 2006). China is transforming from being a 'manufacturing power' to being an 'innovation power'. This strategy was reinforced in 2012 when 'innovation-driven' (Chinese: 创新驱动 *chuang xin qu dong*) became the new impetus of economic development (see in 胡锦涛 Hu, 2012). In this economic restructuring, the factor-driven and investment-driven growth paradigm is being replaced by a paradigm driven by technological development to promote endogenous growth (赵晶 Zhao, 2012).

In line with economic restructuring, China's engineering industries are also transforming from producing and manufacturing based on foreign contracts to domestic and independent R&D. Accordingly, the labour market of the engineering industries has changed its demands. In the past, some academic institutes needed masters with theoretical knowledge and purely theoretical research skills, but these graduates were not in demand by the engineering industries. However, today, the engineering industries want increasingly more master's graduates with practical, applied, and industry-based R&D knowledge.

As presented in Chapter Four (Labour Market Demands, p.194), the knowledge demanded by the engineering industries was classified into five categories. As discussed in Chapter Four, the first category of job requirements is specialised codified knowledge that can be learned in the academic master's progrmmes and is not the key issue in this thesis. Some requirements in the final category, such as English language skills, can also be learned in other higher education programmes, not only in this kind of master's programme. So these two categories of job requirements will not be considered here. Then, the remaining job requirements cover:

- the skills for operating specific instruments, equipment, software, or programs,
- the ability to design, develop, analyse, test, or simulate a specific object (a thing or a process) through a combination of technology principles and/or the operation of hardware or software,
- an awareness or experience of R&D or production processes, and
- the ability to communicate, organise, coordinate, cooperate, work in a team, and so forth.

The knowledge requirements above are professional, practical, personal, and tacit. They resemble types II and III knowledge discussed in the first section of this chapter. They embody the general labour market demands in the engineering industries specifically, against the background of economic restructuring towards an innovation-driven paradigm in China. They are supposed to be the target knowledge of the professional master's programmes. The following sub-sub-section analyses the knowledge design in the professional master's programmes.

Course Aims

As presented in Chapter Four (Course Aims, p.197), the course aims define the kinds of knowledge expected to be learned. First, according to the data codes in Chapter Four (Course Aims, p.197), *non-research employment* is the orientation of knowledge design, so the professional master's programmes aim to deliver students who can be employed in the sectors other than HEIs. By this token, the knowledge design of the programmes is consistent with the policy requirements. Secondly, other data codes, i.e. *professional*, *industrial*, *practical,* and *application*, represent the characteristics of the knowledge designed to be acquired in the professional programmes. They are also compatible with the knowledge demanded by the labour market. Thus, the analysis of course aims shows that the professional master's programmes aim at serving the labour market.

In particular, according to the data codes in Chapter Four (The Design and Implementation of the Professional Practicum, p.177), the professional practicum aims to 'enhance comprehensively practical abilities and enhance the ability to apply theoretical knowledge to solve practical problems'. As established in Chapter One (China's New Professional Master's Programmes, p.6), the professional practicum is the key difference between professional and academic programmes in their actual delivery. Therefore, the professional practicum 'shoulders' the responsibility for delivering the professional, industrial, practical, and applied knowledge designed in the professional programmes.

Finally, comparing the knowledge designed to be acquired (Course Aims, Chapter Four, p.197) and the knowledge acquired by students (What Knowledge is Learned in the Professional Practicum? Chapter Four, p.156) shows that students can acquire the knowledge stipulated in the course design.

In sum, in the newly introduced professional master's programmes, certain kinds of knowledge demanded by the labour market and national development are designed to be learned through a practical approach, namely the professional practicum. The course design and course aims are in harmony with government policy and could meet the labour market demands. In the implementation of the professional master's programmes, the students have learned the targeted knowledge through the professional practicum.

Academic Staff's Perceptions

As the findings (Academic Staff Accounts, Chapter Four, p.202) show, the academic staff's perceptions are in accordance with government policy and the course design. Moreover, the academic staff also explained how the knowledge delivered in professional programmes can meet industrial expectations by giving some engineering examples.

As established previously in Labour Market Demands (Chapter Five, p.265), in the context of China's development today, the engineering industries are turning to production and manufacturing based on R&D. Against this background, as a supervisor explained (Academic Staff Accounts, Chapter Four, p.202), there are two tasks from the initial idea to the final production stage in industrial R&D. As shown in Figure 5-1, the first step is the research task featuring science or technology breakthroughs. The second step is the engineering task featuring engineering realisation, such as applying existing principles or technologies to design a product, and/or using current industrial conditions to finally manufacture it. The supervisor interview data generated two concepts: *research task* and *engineering task*. They illustrate why the professional, practical, and applied industry-based knowledge is important in the current engineering industry against the background in China.

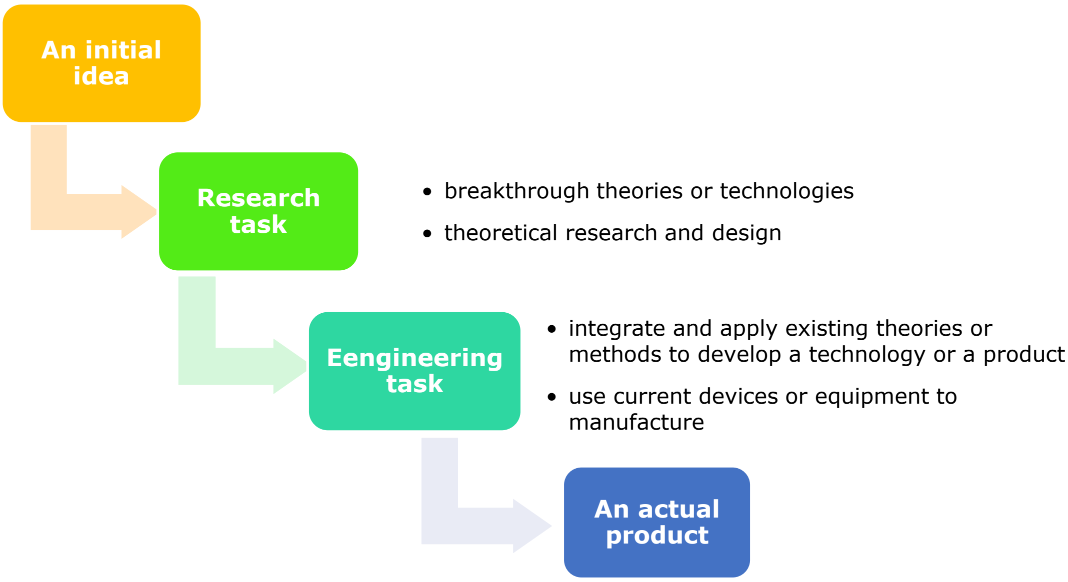

Figure 5-1 The research task and the engineering task in industrial R&D

In the past, the academic master's programmes dominated master's education. There were sufficient engineering master's programmes in many engineering disciplines, but they only delivered *engineering researchers* who were skilled in carrying out research in engineering fields. These graduates were able to meet the demands of research tasks, but not the demands of engineering tasks. The current engineering industries demand *research engineers* who can research and develop a product using existing theories, technologies and industrial conditions. This demand has become the new orientation of master's education in China. The new professional master's programmes with the aim of transmitting professional, practical, and applied industry-based knowledge, can play this role.

Additionally, according to the findings (Academic Staff Accounts, Chapter Four, p.202), the supervisors also defined the knowledge sought after by the industries as applied skills, practical skills, hands-on skills, and engineering problem-solving skills. Their definitions concur with those in the job requirements and the course design.

Students' Graduate Job Prospects

First, based on the findings (What Knowledge is Learned in the Professional Practicum? Chapter Four, p.156), the professional master's students learned several kinds of knowledge covering the types of knowledge in the course design and the job requirements.

Secondly, the professional master's students perceived their graduate job prospects in ways which reflected the role of knowledge in the labour market, to some extent. Their accumulation of practical and applied knowledge can help their employment in the future. According to the findings (Students' Graduate Job Prospects, Chapter Four, p.206), generally speaking, the students in the professional master's programmes have an optimistic outlook concerning their future employment. They agreed that that the knowledge learned in this kind of programme was able to make a positive contribution to their confidence in their future employment. First, they reckoned their knowledge will be sought after by employers. Secondly, the students who had work experience presumed they could more easily adapt to new work than those without a practicum. Thirdly, they thought that their workplace experience could help them to recognise an appropriate company to work for when they were seeking a job.

Table 5-3 summarises these interpretations from five perspectives. It tabulates the key points about the role of knowledge in the labour market.

Table 5-3 A summary of interpretations from five perspectives

<table>
<tr><th colspan="2">Perspectives</th><th>Interpretation</th></tr>
<tr><td colspan="2">Government policy</td><td>The programmes aim to meet the demands of high-level applied specialists for economic and social development</td></tr>
<tr><td colspan="2" rowspan="4">The labour market</td><td>The skills for operating specific instruments, equipment, software, or programs</td></tr>
<tr><td>The ability to design, develop, analyse, test, or simulate a specific object (a thing or a process) by a combination of technology principles and/or the operation of hardware or software</td></tr>
<tr><td>An awareness or experience of R&D or production processes</td></tr>
<tr><td>The ability to communicate, organise, coordinate, cooperate, work as a team, and so forth</td></tr>
<tr><td rowspan="5">University</td><td>Course aims</td><td>The knowledge orientated to non-research sector employment, which is professional, industry-based, practical, and applied</td></tr>
<tr><td rowspan="3">Academic staff</td><td>There are two tasks from an initial idea to an actual product:</td></tr>
<tr><td>Research task – science or technology breakthrough</td></tr>
<tr><td>Engineering task - apply the existing theories and methods to design a product, and/or use current production conditions to finally manufacture it</td></tr>
<tr><td>Students</td><td>The knowledge learned in the professional practicum of the professional master’s programmes makes a positive contribution to their confidence in seeking suitable graduate jobs</td></tr>
</table>

Links to Human Capital Theory

As reviewed in Chapter Two (Research Gaps and Research Questions, p.80), the relationship between higher education and the labour market is often explained by human capital theory, and there is strong econometric evidence to confirm this link. However, it is still not very clear why human capital can be used to explain this relationship. The definition of human capital offers some hints; human capital is defined as consisting of knowledge. Therefore, this research aims to explore the *why* inquiry from the viewpoint of knowledge in professional education.

As interpreted previously in The Evidence from Different Perspectives (Chapter Five, p.261), the data from five perspectives illustrate the role of acquired knowledge at three levels: for economic development, for engineering industry development, and for individual employment in the labour market. However, the data from the five perspectives did not specifically link perceptions of knowledge to human capital theory. The research participants nevertheless are not necessarily aware that they are human capital. This sub-section thus further interprets the findings, connecting them with human capital in terms of knowledge, and develops human capital theory in an interpretative way.

First, as reviewed in Chapter Two (Some Qualitative Traits of Human Capital, p.76), human capital is constituted of knowledge, skills, competencies, and other attributes (OECD, 1998; Belfield, 2000; De la Fuente and Ciccone, 2002; Brian, 2007). However, there have been few additional studies considering what kinds of knowledge (including skills, abilities, and competencies) are specifically involved. This study found three types of knowledge (Three Types of Knowledge in Professional Education, Chapter Five, p.236) to interpret human capital in the perspective of the knowledge formed in the professional master's programmes.

'Knowledge' (in its narrow sense) in human capital definition can refer to type I knowledge (propositional or conceptual codified knowledge), such as academic concepts and systematic theories. The 'skills' and 'competencies' in the definition of human capital can refer to type II knowledge (process or procedural tacit knowledge), for example, knowing how to solve practical problems, or knowing how to operate equipment or software in practice. The 'other attributes' in the human capital definition can be type III knowledge (personal or dispositional tacit knowledge), e.g. impressions of industry/profession and the workplace, as shown in Table 5-4.

Table 5-4 The development of human capital definition based on the findings

	The definition of human capital	**The further interpretation**
Human capital is constituted by	knowledge (in the narrow sense)	Type I: propositional or conceptual codified knowledge
	skills or competencies	Type II: process or procedural tacit knowledge (in the broad sense)
	other attributes	Type III: personal or dispositional tacit knowledge (*ditto*)

Secondly, according to the existing literature (Some Qualitative Traits of Human Capital, Chapter Two, p.76), Becker (1962) categorises human capital broadly into general human capital and firm-specific human capital. De la Fuente and Ciccone (2002) classify human capital into general skills, specific skills, and technical and scientific knowledge. They offer some broad classifications of human capital to identify the basic literacy for daily life and the systematic or professional knowledge (and skills, abilities, and competencies) for general and basic employment. Nevertheless, the specific kinds of higher knowledge (including skills, abilities, and competencies) for a profession, an industry, or a job have not been identified. In this case, human capital for engineering R&D can be specifically identified and classified based on the findings about knowledge.

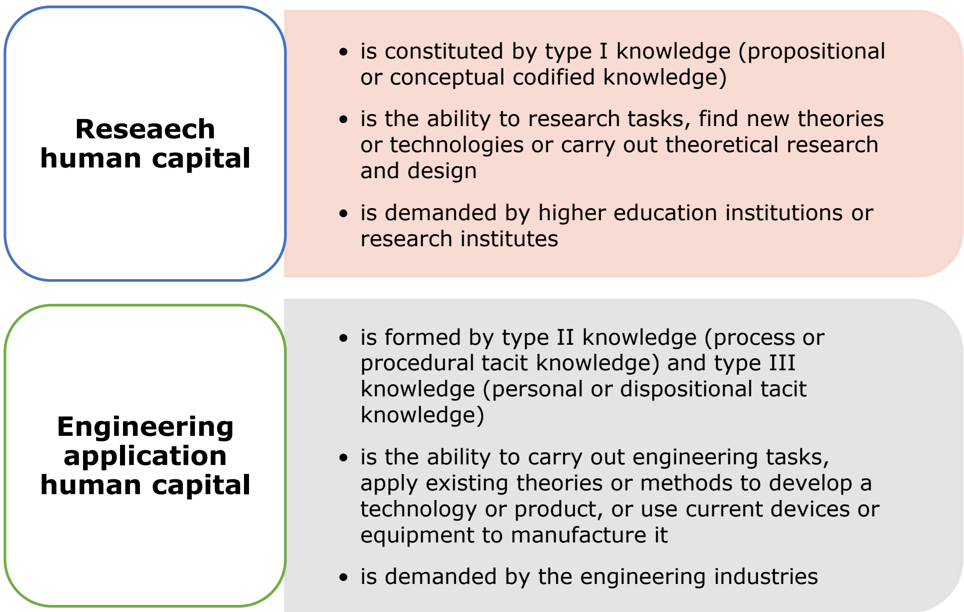

Figure 5-2 Research human capital and engineering application human capital

Academic knowledge is identified as necessary for breakthrough research tasks, while professional, practical, and applied knowledge is identified as essential for industrial R&D tasks. As shown in Figure 5-2, based on the findings, some employers, such as industrial companies or manufacturers, require human capital formed by type II knowledge (process or procedural tacit knowledge), e.g. operational skills, or the ability to combine technology principles and practical operations, and type III knowledge (personal or dispositional tacit knowledge), such as an awareness of an industry or production processes. By contrast, some employers, such as HEIs, prefer human capital that consists of type I knowledge (propositional or conceptual codified knowledge), for example, pure theories. So, based on the concepts developed from the findings, human capital in this context can be classified as research human capital and engineering application human capital.

Thirdly, as reviewed in Chapter Two (Some Qualitative Traits of Human Capital, p.76), human capital is formed by formal education, training, or other similar activities (Woodhall, 1997; Belfield, 2000; De la Fuente and Ciccone, 2002). However, they have not identified what kinds of education programmes can form what kinds of human capital. As the findings of this research show, the professional master's programmes with a professional practicum can form engineering application human capital consisting of type II knowledge (process or procedural tacit knowledge) and type III knowledge (personal or dispositional tacit knowledge). The findings further suggest that different types of professional practicum can have a different impact on acquiring different types of knowledge.

Finally, as assumed in Figure 1-1 (Chapter One, p.4), human capital could theoretically link knowledge, professional education, and the labour market together. However, as reviewed in Chapter Two (Human Capital, p.62), the existing studies often consider human capital only in terms of its economic contribution. For example, some studies found quantitative correlations between education investment and economic output. Nevertheless, the elements, namely investment and output, involved in the existing studies are something ‘outside’ human capital. Few studies focus on the ‘internal’ mechanism of human capital, for example, from the perspective of knowledge and education *per se*. The research findings illustrate a hypothesised connection between human capital and the relevant internal and external factors of human capital. The findings link human capital to knowledge, higher education, and the labour market together, by examining the professional master’s programme case in China. The linkage is outlined below.

In China today, professional, practical, and applied industry-based knowledge is important for the engineering industries and for the economy. Therefore, these kinds of knowledge can form the human capital demanded by the labour market. Consequently, the master’s graduates possessing these kinds of knowledge can be sought after by the labour market. Thus, the master’s education sector introduced a new type of professional master’s programme to meet labour market demands. In the new professional master’s programmes, the required kinds of knowledge are designed to be learned through practising. After study in the programmes, graduates possess knowledge that could form the human capital required by the labour market, so they have promising graduate job prospects.

To summarise, this section analysed the role of knowledge in the labour market based on the related findings. First, it further interpreted the perceptions from five perspectives, connecting them to the existing theories and evidence, and China's economic and industrial context. Then, it synthesised all the interpretations, connected to human capital, to enrich the definition, characteristics, formation, and function of human capital qualitatively.

The Findings Concerning the Main Research Question

The previous three sections of this chapter interpreted the findings in response to the three research sub-questions and also developed the related theories. This final section considers them together to address the main research question:

> *Why are the new professional master's programmes, specially designed with a professional practicum, expected to meet labour market demands in China?*

According to Glazer-Raymo (2005, pp.99-108), labour market demand is one of the impetuses for professionalising master's programmes. The relationship between higher education and the labour market is usually explained by human capital theory, and there has been sufficient econometric evidence to confirm this relationship. However, why can human capital theory explain this relationship? So far, few studies have considered this inquiry. Such a theoretical inquiry cannot be completely addressed in just a PhD thesis. It probably needs to be studied from different dimensions, at different levels, and through different approaches. It needs to be developed 'brick by brick'. This PhD research could be one of the first 'bricks'. It aims to address the inquiry by taking the professional master's programmes in China as an example, in order to 'lay some bricks' as the basis of this theoretical inquiry from the perspective of professional master's education against the background of China's economic growth.

Based on the existing theories, higher levels of education are accompanied by higher wages, lower unemployment probabilities, and higher labour force participation rates in the labour market because of human capital (De la Fuente and Ciccone, 2002, p.9). Students could increase their stock of human capital by investing in higher education and consequently be better rewarded in the labour market than those do not have higher education (for example, see in Paulsen, 2001 and McMahon, 2009). However, why can human capital play this role? So far, there have been few studies addressing this question directly.

However, some related theories have the potential to address this issue. For example, according to definitions of human capital, human capital consist of knowledge (for example, see in Becker, 1964, OECD, 1998 and Brian, 2007); human capital is accumulated in formal schooling (Becker, 2009, pp.17-21); higher education transmits knowledge and then equips the labour with higher knowledge and skills (OECD, 1996, p.23); and in the knowledge economy, the labour market prefers workers with higher knowledge and skills (OECD, 1996, p.16). Based on these existing theories, it could be inferred that knowledge could be a bridge linking higher education and human capital. Students could learn the categories of knowledge that are sought after by the labour market to form their human capital. Although this hypothesis can be deduced from existing theories, so far, there has been little evidence directly supporting it.

The overall findings of this research can address the why question. This research takes an inner perspective of higher education, namely the knowledge developed in professional master's education. Around this knowledge, the question has been developed as three sub-issues: what categories of knowledge were learned in higher education, how were these categories of knowledge learned in higher education, and why are these categories of knowledge learned in higher education sought after by the labour market? This issue and sub-issues cannot be addressed by general evidence. The knowledge needs a specific context, for example, a specific education programme and a specific labour market. Therefore, the new professional master's programmes were examined against the background of China's economic restructuring.

As established in Chapter One (Research Context, p.1), there are four key concepts in the existing theories about the relationship between higher education and human capital: knowledge, higher education, labour market, and human capital. The data from this research generated some peripheral concepts surrounding these four key concepts, for example, types I, II and III knowledge in professional master's education (The Knowledge in Professional Master's Programmes, Chapter Five, p.236), and research task and engineering task in engineering R&D (The Role of Knowledge in the Labour Market, Chapter Five, p.274).

The new peripheral concepts, the existing theories, the evidence gathered, and the specific context together suggest how knowledge is the bridge linking higher education and human capital. Based on the findings, the hypothesised framework, as shown in Figure 1-1 (p.4), has been developed as Figure 5-3 that is the findings addressing the main research question. The following paragraphs explain Figure 5-3 to set out the overall research findings.

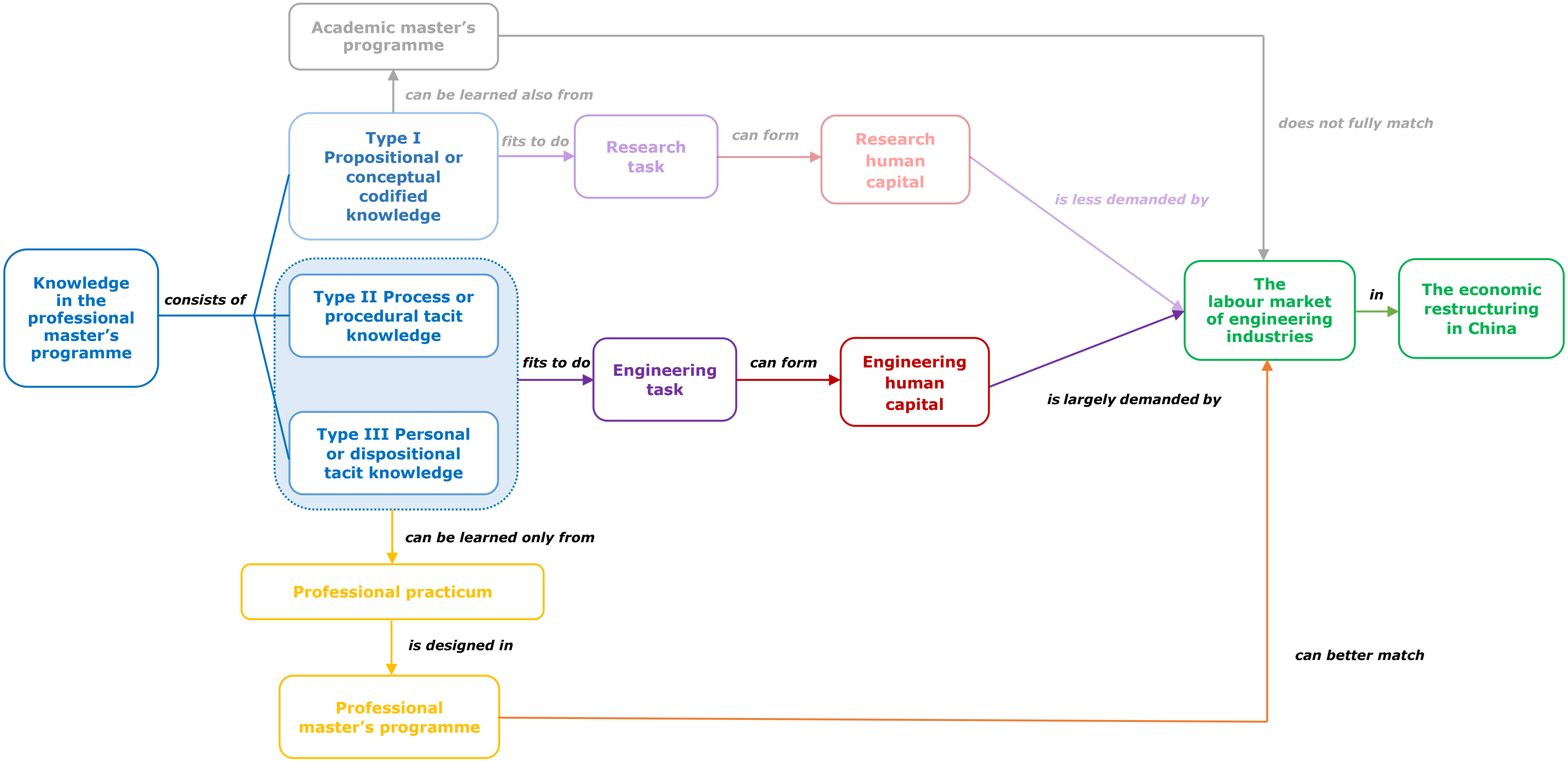

Figure 5-3 The integrated relationship between knowledge, human capital, professional master's education, and the labour market

Based on the findings of first research sub-question (The Knowledge in Professional Master's Programmes, Chapter Five, p.236), the knowledge learned by students in the professional master's programmes consists of three types:

- type I - propositional or conceptual codified knowledge
- type II - process or procedural tacit knowledge
- type III - personal or dispositional tacit knowledge.

Normally, type I knowledge is codified and can be learned in taught modules and/or by books. By contrast, types II and III knowledge are uncodified, tacit, and personal. These kinds of knowledge cannot be taught through lessons or books but need to be accumulated through appropriate practices.

However, in the academic master's programmes, the course design and delivery only stresses pure theoretical knowledge and research skills. It rarely focuses on practice or the accumulation of applied and practical knowledge. Therefore, the academic master's programmes can deliver type I knowledge (propositional or conceptual codified knowledge), but not type II knowledge (process or procedural tacit knowledge) and type III knowledge (personal or dispositional tacit knowledge).

However, against the macroeconomic background, the labour market increasingly requires types II and III knowledge. For instance, based on the findings of the third research sub-question (The Evidence from Different

Perspectives, Chapter Five, p.261), in China, with the economic restructuring towards an innovation-driven paradigm, the engineering industries now largely engage in producing and/or manufacturing based on independent R&D projects.

According to the findings of the third research sub-question (The Evidence from Different Perspectives, Chapter Five, p.261), as academic staff explained, engineering R&D projects involve two tasks: science task and engineering task. The science task focuses on science and technology breakthroughs, demanding pure theoretical researchers. The academic master's programmes can deliver the propositional or conceptual codified knowledge needed for breakthrough research. So the students studying in the academic master's programmes can accumulate research human capital. The needs of science tasks can be fulfilled by the academic master's programmes.

However, the engineering task applies the existing theories to engineering products or manufacturing. Therefore, professional, practical, and applied industry-based knowledge plays an important role in the engineering industries today. Consequently, apart from pure research specialists (e.g. scientists or scholars) with research human capital, the applied specialists who have type II knowledge (process or procedural tacit knowledge) and type III knowledge (personal or dispositional tacit knowledge) are highly sought after by the labour market. In other words, the students who have these kinds of knowledge can possess the engineering human capital demanded by the labour market.

Consequently, the academic master's programmes are unable to fully match the labour market needs today, because it does not offer industry-based practice and cannot transmit professional, practical, and applied knowledge. As a result, the new professional master's programmes were introduced to fill the gap. Based on the findings of the second research sub-question (The Professional Practicum: Learning Knowledge by Practising, Chapter Five, p.250), the newly introduced professional master's programmes are designed with an industry-based professional practicum, especially aimed at delivering professional, applied, and practical knowledge. Through types of industry-based practices in the professional practicum, students learned multiple categories of type II knowledge (process or procedural tacit knowledge) and type III knowledge (personal or dispositional tacit knowledge). According to the findings of the third research sub-question (The Role of Knowledge in the Labour Market, Chapter Five, p.261), these two types of knowledge are precisely those demanded by employers. The professional master's students potentially possess the 'appropriate' human capital. Therefore, based on the findings of the third research sub-question (*ditto*), they have positive prospects of their graduate jobs in the labour market.

In other words, the professional master's programmes designed with a professional practicum can deliver practical and applied tacit knowledge. These kinds of knowledge are sought after by the labour market. Therefore, the professionalized master's education can better meet the expectations of the labour market and further meet the demands of economic growth.

In sum, Figure 5-3 illustrates why human capital can explain the relationship between higher education and the labour market. Based on this diagram, I finally return to address the main research question:

> *Why are the new professional master's programmes, specially designed with a professional practicum, expected to meet the labour market demands in China?*

The answer is because knowledge plays a role. Different programmes can deliver different kinds of knowledge. Different types of knowledge (including skills, abilities, and competencies) can form different kinds of human capital. Different kinds of human capital can play different roles in the labour market. In this case, the professional master's programmes are designed with a professional practicum, so that they can deliver the practical and applied engineering knowledge demanded by the engineering industries in China for its economic restructuring. Therefore, the students who learned these kinds of knowledge possess the required human capital and have positive job prospects.

Summary

To sum up, this chapter interpreted the research findings, connecting them with the existing theories in line with the three research sub-questions and main question, and developed the related existing theories. The first section classified and mapped the knowledge learned in the professional master's programmes, based on the existing theories about the knowledge gained from professional education. The second section compared the four types of professional practicum with a Chinese model, linked the findings with some principles of professional course design and the practicum, and also discussed the role of the professional practicum in transmitting knowledge. The third section interpreted the role of knowledge in the labour market from five perspectives: government policy, course design, labour market expectations, academic staff, and students. It further connected the findings to human capital theory in terms of the knowledge that can constitute human capital. The final section considered all the data analyses together to address the main research question. Based on all the previous chapters, Chapter Six will review the research questions, findings, lessons learned and suggestions for future research to conclude this thesis.

Chapter Six: Conclusion

Introduction

The purpose of this final chapter is to conclude this research by referring back to what have been achieved and pointing out what might happen in the future. The first section recapitulates the research questions and main findings. The second section compares the findings with other studies to show how the findings contribute to knowledge. The third section sets out both the practical implications and the policy implications of this study. The fourth section identifies some limitations to this study. The fifth section discusses issues for further research. Finally, the author reflects on carrying out this study.

The Recapitulation of Research Questions and Findings

First, this section restates the research focus and research questions. Then, it summarises in turn the findings of the three research sub-questions and the main question. Finally, it shows how the findings address the research questions.

In practice, increasingly more master’s programmes have been reformed to be applied, practical or professional, but less academic or research-orientated. They are aimed at meeting labour market requirements better. For example, in 2009, the professional master’s programmes were introduced in China, and it has replaced almost the half of the research master’s programmes in terms of student enrolment in recent years. However, theoretically, so far, there have been few studies considering why professional master's programmes are thought to meet labour market expectations better.

In the existing literature, the related studies usually focus on the relationship between higher education and economic growth, while the connection between higher education and the labour market has been usually explained by human capital theory. The literature tends to concentrate on four concepts: knowledge, higher education, labour market, and human capital. The existing findings are often the relationship between any two of these concepts. These four key concepts and their single links can thus be used to construct a broad theoretical framework for this research. However, there have been few studies considering why human capital can connect higher education and the labour market and whether there is any integrative way the four concepts are linked together.

This research aimed at this *why* question from the inner perspective of higher education, i.e. knowledge and knowledge transmission. Based on the existing theories, this research hypothesised that knowledge could be a bridge linking education to the labour market underneath human capital; a conceptual framework was also established: an integrated link between knowledge, higher education, the labour market, and human capital. In short, this study aimed to find the interpretive and multilateral connections between the four concepts. The central point of the research is that knowledge constitutes human capital. Surrounding this key point, the research framework consisted of three issues: what knowledge is learned, how students learned that knowledge, and why the acquired knowledge is sought after by the labour market. The study examined

China's new professional master's programmes as an example, against the background of China's economic restructuring today. This research addressed the main question and its subsidiaries as follows:

> *Why are the new professional master's programmes, especially designed with a professional practicum, expected to meet labour market demands in China?*
>
> - *What knowledge is learned in the professional practicum of the professional master's programmes?*
> - *How did the students learn the knowledge in the programmes?*
> - *Why is the acquired knowledge sought after by the labour market?*

This research used a qualitative case study at a university in China. Twenty-six interviews with master's students and academic staff were conducted, and fourteen documents were collected. Multiple qualitative data analyses produced the findings in answer to the research questions.

First, this research identified the knowledge learned in the professional engineering master's programmes and classified it into six categories:

- knowing how to solve practical problems,
- knowing how to do in an industrial R&D project,
- knowing how to operate equipment or software in practice,
- knowing how to be a professional engineer,
- knowledge of the industry or profession, and

- knowledge of the workplace.

Meanwhile, based on the theoretical framework, knowledge in professional education was summarised as having three types:

- type I: propositional or conceptual codified knowledge,
- type II: process or procedural tacit knowledge, and
- type III: personal or dispositional tacit knowledge.

The knowledge categories in practice were then combined with the three knowledge types in the theoretical framework to construct a map of the knowledge base of professional master's graduates entering R&D engineering industries.

Secondly, the findings showed that students in the programmes experienced four types of professional practicum where they could accumulate practical and applied knowledge:

- Type I: students worked full-time for months at industrial enterprises engaging in R&D projects. They applied their specialised knowledge and/or used equipment, software or data of companies.
- Type II: students worked full-time in fixed internship posts at enterprises doing some assistant or administrative tasks.
- Type III: students engaged in industry-based R&D projects. They did R&D tasks mostly in the university laboratories, but

went to companies occasionally to attend project meetings, use devices there and/or carry out on-site tests, and/or debug the software or hardware created beforehand in the university laboratory.

- Type IV: students engaged in industry-based research projects, but they never worked in any enterprise.

The different types of practicum have different impacts on the learning of different categories of knowledge. The students who did not work at industrial enterprises at all have no knowledge of industrial R&D projects, the industry/ profession, or the workplace. The students who did some assistant or administrative tasks but did not engage in real R&D projects have mainly acquired knowledge of the industry/profession and the workplace but had little or no experience of how to solve practical problems, how to be a professional engineer, and how to do industrial R&D projects. By contrast, the students who engaged in industrial R&D projects and worked at industrial enterprises learned more types of practical and applied knowledge.

Thirdly, the findings illustrate the role of knowledge in the labour market from five perspectives: government policy, the labour market, course design, academic staff, and students. Their perceptions were linked together to interpret the role of knowledge. Some types of knowledge are sought after by the labour market, because they benefit industries and the economy. For example, in China today, professional, practical, and applied industry-based knowledge is important to the engineering industries and the economy. These types of knowledge are in demand by the labour market. Therefore, the master's graduates who possess them can be valuable and sought after by the labour market. Consequently, the higher education sector introduced the new professional master's programmes to transmit these kinds of knowledge and match labour market demands. In the programmes, students learned these kinds of knowledge through various practices. After learning through the programmes, the graduates possessed – some more than others - the kinds of knowledge desired by the labour market, and their abilities matched the job descriptions in their skill sector, so they had promising graduate job prospects.

The data were also analysed based on human capital theory. In terms of the composition of human capital, type I knowledge (propositional or conceptual codified knowledge) can constitute the 'knowledge' (in its narrow sense) in the definition of human capital, such as academic concepts and theories. Type II knowledge (process or procedural tacit knowledge), e.g. knowing-how or skills, equates to the 'skills' and 'competencies' referred to in human capital definition, for example, knowing how to solve practical problems, or knowing how to operate equipment or software. Type III knowledge (personal or dispositional tacit knowledge), e.g. an impression of industry, a profession or workplace, can form the 'other attributes' mentioned in the definition of human capital.

Based on the characteristics of its knowledge constitution, human capital could be classified as *research human capital* and *engineering application human capital*. Research human capital is formed by type I knowledge (propositional or conceptual codified knowledge); engineering application human capital consists of type II knowledge (process or procedural tacit knowledge) and type III knowledge (personal or dispositional tacit knowledge). In the labour market, some employers, such as HEIs or theoretical research institutes, prefer research human capital. By contrast, some employers, such as industrial companies or manufacturers, want engineering application human capital.

Different types of human capital are formed through different modes of education programmes. The academic master's programmes only have taught modules and research training, so it can form research human capital that consists of type I knowledge (propositional or conceptual codified knowledge). The professional master's programmes have a professional practicum, which can form engineering application human capital constituted by type II knowledge (process or procedural tacit knowledge) and type III knowledge (personal or dispositional tacit knowledge).

All the findings of this study together responded to the main research question: why are the new professional master's programmes expected to meet labour market demands better? The answer is because some kinds of knowledge play a particular role, as shown in Figure 5-3 (Chapter Five, p.283). As explained, knowledge learned in the professional master's programmes consists of type I knowledge (propositional or conceptual codified knowledge), type II knowledge (process or procedural tacit knowledge), and type III knowledge (personal or dispositional tacit knowledge). Type I knowledge can be learned in the academic master's programmes, but types II and III knowledge cannot, as they are practical and personal and need to be accumulated through practice. Academic master's programmes stress learning theories and research training but rarely practice or practical knowledge. Consequently, the students on these programmes had no access to types II and III knowledge. However, in China's economic restructuring today, the engineering industries and the labour market want types II and III knowledge. Graduates capable of the engineering tasks in industrial R&D are thus sought after by the labour market, while the academic programmes cannot match labour market needs. The new professional master's programmes were introduced to fill the gap, with an industry-based professional practicum to transmit applied and practical knowledge to students. Through four types of industry-based practices, the students learned types II and III knowledge, and potentially can possess the engineering application human capital sought after by the labour market. In other words, the professional master's programmes, transmitting the 'right' categories of knowledge through a practicum, can fit labour market needs and economic development expectations.

Knowledge Contributions

This section compares the research findings with other research to see how they align with or differ from previous studies. Finally, it shows this research's contributions to existing theories.

First, the findings about the knowledge acquired in professional master's education reinforce the related theories of Eraut (1992, pp.100-113), Jarvis (1983, pp.74-79) and Billett (2009), and develop their knowledge typology for professional education. In particular, a map of knowledge for engineering R&D professionals supplements Eraut's (1985; 1994, pp.76-82; 2004) knowledge mapping studies. The findings to some extent contribute to closing two research gaps: knowledge acquired in professional master's engineering education, and knowledge acquired in professional education in China.

Secondly, the findings about knowledge further clarify and detail the definition of human capital (OECD, 1998; Belfield, 2000; De la Fuente and Ciccone, 2002; Brian, 2007). The findings also enrich the classification of human capital (Becker, 1962; De la Fuente and Ciccone, 2002) based on the knowledge typology. The findings help to deepen the understanding of human capital in operation and in a qualitative way.

Thirdly, the evidence concerning the curriculum is in harmony with the professional course models proposed by Bines (1992). The professional practicum design is also compatible with Bines's (1992) framework. The implementation of the professional practicum enriches the model suggested by 文冠华 Wen et al. (2010). The effects of the practicum on learning knowledge are consistent with the findings of Glenny and Hickling (1992) and Simpson and Jackson (2000). In addition, the findings show that the different forms of practice can have an impact on the learning of different types of knowledge, which has been rarely considered in the existing studies.

Fourthly, the role of knowledge in the labour market was interpreted from five perspectives. Previous studies have identified the different stakeholders

(Watson, 1992; Taylor, 1997), but there have been few studies discussing professional education from the aspect of different stakeholders' concerns. Although this research did not investigate all the individual stakeholders (for example, the policy makers and individual employers), this thesis still makes some limited attempts to enlarge the research horizon of professional education.

Fifthly, the existing studies suggest that human capital is formed through formal education (Woodhall, 1997; Belfield, 2000; De la Fuente and Ciccone, 2002). However, this concept has seldom been considered from the inner perspective of higher education (including professional master's education). For example, there have been few studies considering how human capital is formed by professional education. The findings concerning the practicum imply that academic and professional master's programmes can form different sorts of human capital. It preliminarily explored the formation of human capital.

Finally, the existing studies have confirmed the benefits of higher education both in aggregate and for individuals because of human capital (Paulsen, 2001: pp. 55-94; Garcia-Aracil et al., 2004; Faggian et al., 2007; Herndon, 2008; McMahon, 2009: pp.2-39;), and also the benefits of human capital in postgraduate education (Jaeger and Page, 1996; Song et al., 2008; Fatima, 2009; Walker and Zhu, 2011; Morikawa, 2012) and professional education (Van Loo and Rocco, 2004). However, why human capital can play this role is still under researched. The findings from this research help to close the gap to some extent. The data generated some peripheral concepts surrounding the knowledge that constitutes human capital. These peripheral concepts and their links can lead to establishing an integrated connection to illustrate why human capital can explain the relationship between higher education and the labour market. The findings of this study also developed Glazer-Raymo (2005, pp.99-108)'s view that labour market demand is one of the impetuses for professionalising master's programmes. The findings interpret why professional programmes can meet the labour market expectations better than academic ones.

To sum up, this research has made five contributions to knowledge. First, it enriched the theories about knowledge and course design in professional education from the viewpoint of engineering master's education. Secondly, it developed the definition and classifications of human capital. Thirdly, it interpreted the role of knowledge in the labour market from different perspectives. Fourthly, it explained why professional master's programmes are expected to match labour market demands better. Fifthly, it explored why human capital can explain the relationship between higher education and the labour market.

The Implications for Practice and Policy

Besides the contributions to theoretical knowledge, this research also has practical implications and policy implications.

First, the findings addressed a practical question: why are the professional master's programmes able to meet labour market demands better? This research has a practical implication for higher education. As pointed out in Chapter One: Introduction (p.1), in practice, some master's programmes have been professionalised because of the labour market demands (Glazer-Raymo, 2005, pp.99-108). However, the reasons why the professionalised master's programmes seem to meet labour market demands better remain unclear. This study interprets the issue in a qualitative way. The findings can support professional master's programme reforms, based on both human capital theory externally and knowledge transmission within higher education internally.

Secondly, this study examined the knowledge and the practicum in China's professional master's programmes, which have been seldom studied before. The findings could help the understanding of the policy and implementation of China's professional master's education, against the background of China's economic restructuring, towards an innovation-driven paradigm.

Thirdly, the findings have policy implications for higher education development. For China's educational policy makers, the findings imply that the reformed professional master's programmes can play an important role in delivering applied specialists, and the policy for developing the new professional master's programmes is effective. Internationally, there might be other countries with a similar agenda of higher education reform. The findings can support policy decisions or practice, in terms of the necessity for or rationalisation of professionalising master's programmes.

Research Limitations

Besides the contributions and the implications outlined above, there are also some issues that could not be investigated in this study. This section discusses the limitations of the research and the reasons.

First, this study focused on the role of knowledge to explore why human capital can explain the relationship between higher education and the labour market, but the fieldwork failed to interview any representative of employer, such as the heads of companies, HR officers or the directors of R&D departments. The expectations of the labour market were represented by the job requirements in job advertisements. Some reasons were explained in Chapter Three: The Methodology and Methods. Although the labour market demands can be identified from job requirements, the text data seem to be abstractive and not subjective. The findings would have been more attractive and easily understood if students' bosses could have been interviewed.

Secondly, this research examined the professional master's programmes only in engineering disciplines for three reasons (in Research Gaps and Research Questions, Chapter Two, p.80). First, the study of professional master's education in engineering is a research gap, as established in the literature review. Secondly, the background to the introduction of the new professional master's programmes is China' economic restructuring, and the Engineering Industry Upgrading is a key part of this restructuring. Therefore, the engineering was an appropriate angle to study the topic. Thirdly, this in-depth interpretative case study had to concentrate on a specific discipline, not master's programmes generally or randomly. However, it might be useful if more professions/disciplines could be considered in future to add to the knowledge base about professional education and the nature of human capital.

Thirdly, although this study takes a case study for sufficient reasons, it does not mean the case study has no defects. As established in Chapter Three: The Methodology and Methods (Why a Case Study? p.91), case study findings cannot be generalised to a wider population. However, this research aimed to address the question in an exploratory way rather than to generalise a certain mature theory. Therefore, at this preliminary stage, the case study is an appropriate and acceptable method for this purpose. In order to make more general conclusions, more cases could be examined qualitatively or even quantitatively, by using the conclusions and findings from this study as the foundations for research questions or methods. For example, the quantitative correlations between different practices and different kinds of knowledge, or the quantitative correlation between different practices and the students' job prospects could be examined in a more general way rather than as a case study.

Finally, the scope of the research framework is limited. As established in Chapter Four: Data Presentation (The Differences by Gender, School and Type of Practicum Employer, p.217), the data suggest more possibilities than the designed directions. However, limited by the existing theories and the established conceptual framework, those possible issues could not be pursued further within this study, which is a limitation of this thesis, but it points to possible future areas of research.

Recommendations for Future Research

Based on the contributions, implications, and limitations of this research, this section suggests some issues for further research.

First, as mentioned in the limitations above, this study only examined the professional master's programmes in some engineering disciplines. Therefore, analogous empirical findings in other disciplines or professions could be possible research directions.

Second, as mentioned in the limitations, this study examined the professional master's programmes only at one case study university. Based on these findings, the research focus and methods could be applied to other cases in future. Alternatively, future research could consider other or additional research methods rather than the case study alone, for instance, cross-section surveys.

Third, as mentioned in the limitations, this study did not interview individual employers, such as the heads of companies, HR officers or the directors of R&D departments. Future research could include interviewing them as part of the pool of respondents to generate direct and insightful data from the graduate-receiving industries.

Fourth, concerning the role of knowledge in the labour market, this research focused on job *prospects* rather than actual graduate jobs, as explained in

Chapter Two: Literature Review (Research Gaps and Research Questions, p.80). Nonetheless, although it is time-consuming, a tracking survey of students' employment might be a research direction for the future. Based on more findings or evidence, the tracking survey could be designed to eliminate the impact of non-attainment factors that are irrelevant to this research focus, such as personal priorities or social networks. It could only concentrate on the impact of knowledge on employment or the payoff. This possible study might establish an even more direct relationship between knowledge and the labour market and make a further profound contribution to human capital theory.

Fifth, as established in Chapter Four (The Differences by Gender, School and Type of Practicum Employer, p.217), there were differences between the five sample schools, in terms of professional practicum types, knowledge categories, and students' graduate job prospects; there were also differences between the different types of practice employers, in terms of professional practicum types, knowledge categories, and students' graduate job prospects. Limited by the theoretical framework and analytical framework of this thesis, these links cannot be investigated further. However, these issues could be interesting topics for future research.

Sixth, as reviewed in Chapter Two: Literature Review (Learning by Practising, p.55), Eraut (2003) and Eraut (2007) have findings about the factors that influence practical learning in the work context. The empirical evidence of this study did not directly reflect Eraut's theories, though they may have some implied connections. In this case, the work context factors that could influence people's knowledge accumulation was not the focus of this research, and the findings of this study could not make a contribution to this area. Nevertheless, the work context of students' practicums might be a future research direction.

Personal Reflections

This section discusses personal considerations and offers some reflections on this research experience.

First, I now understand qualitative research better through completing this study. I had experience of quantitative research but little experience of qualitative research before this PhD study. Through this study, I learned about qualitative ontology, epistemology and methodology, the case study method, and interview skills. I also experienced interesting data collection and analysis procedures. I now have strong interests in qualitative research that have flexible methods and can generate rich and in-depth data.

Secondly, despite what I gained, I also suffered downs as well as ups on the road to completing the thesis. For example, I was 'wobbling' when looking for the research focus, the theoretical underpinning, and the research methods for a comparatively long time. Moreover, although I tried my best in doing this research, this thesis inevitably still has some imperfections or disappointments, as established previously. However, I have learned my lessons from the experience. I now have a growing awareness about how to design and conduct smooth-running research and how to adapt when things do not work out as planned.

Thirdly, the research experience and the research findings provided me with some ideas for my future professional path in higher education research. The research findings encouraged me to explore further knowledge, higher education, and human capital, using various methods and from different standpoints.

Finally, this PhD journey *per se* is an invaluable experience. It offered me the opportunity to conduct research within the British academic culture. Based on this experience and my previous research experience in China, I identify some differences between Western and Chinese social science research, such as educational value orientation, paradigm, or focus. This provided me with a more international research horizon, and allowed me to view the research questions from a more objective distance than studying in China alone.

In summary, all the experiences above have developed my capacity for doing research independently and professionally.

Summary

This chapter concludes the thesis. It restated the research questions and findings, compared the findings with other research to identify the contributions to knowledge, and summarised the implications for practice and policy and the limitations of this study. Based on the contributions, implications, and limitations, this chapter also suggested some issues and areas for subsequent research. Finally, it considered my personal reflections on the research process, what I learned along the way and how it enriched my experience.

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Appendices

There are five appendices. Appendix A presents interview question guides used during the fieldwork (in Chinese) and also their English translations. In Appendix B, two tables show detailed information of interviews and documents gathered during the fieldwork. Appendix C tabulates interview data extracts (translated into English by the author) and data codes for each research issue. Appendix D shows document data extracts (translated into English by the author) and data codes for each research issue. Appendix E shows related documents about research ethics.

Appendix A: Interview Question Guides

Interview Guide for Students (in Chinese)

访谈提纲——全日制工程硕士研究生

1. 请描述你所经历的专业实习。例如，你如何找到这份实习工作，你所在的实习单位的规模与性质，你在实习单位的什么部门工作，你的实习累计工作时间多久，你在实习期间去单位工作的频率。

2. 在专业实习中，你主要开展什么工作？例如，请具体描述一个典型的工作日你都做了什么事情。

3. 通过上述工作，你学到了什么知识、技能或其他？

4. 你通过什么具体方式或者通过做什么事情学到这些知识和技能的？

5. 在实习期间，是否接触到你所在行业领域的专业人士？与他们的接触，你有什么收获，特别是在专业知识、能力方面？

6. 请谈谈实习的整体收获，除了刚才谈到的专业知识技能之外，是否还有一般通用的就业技能，如团队精神、沟通技巧等。

7. 你在实习结束时或实习结束之后，是否收到过实习单位雇主、领导对你的工作表现的评价、反馈？评价如何？

8. 通过专业实习，你认为自己毕业之后的就业前景如何？为什么？

Interview Guide for Students (English Translation)

1. Please describe your professional practicum, for example, how did you find the job? What is the company like? Your department? How long and how often did you go to work?

2. What did you do in the professional practicum? Please describe what you carried out or completed in a typical working day in the workplace.

3. Through practicum work, what professional knowledge and/or skills, or other abilities, did you learn?

4. In which ways or through doing what kinds of things did you learn them?

5. Did you have any opportunity to work with professionals? What are their impacts on your professional knowledge and skills?

6. In addition to professional knowledge and skills, what did you learn regarding the general employability, such as, team spirit, community skills, etc.?

7. Have you got any feedback from your practicum employer? What was that?

8. Through the professional practicum, what is your prospect on your graduate job? Positive or negative? Why?

Interview Guide for Academic Staff (in Chinese)

访谈提纲——导师

1.您认为工程（专业）硕士有什么功能和意义？特别是与工学（学术）硕士相比？

2．您怎么看待工程硕士培养中的专业实习（实践）？您认为专业实习有什么意义？对学生获得知识、技能有什么帮助？对学生将来就业有什么帮助？

3. 您的学生都参加过哪些形式的专业实习（实践）？

4. 通过专业实习（实践），你的学生实际收获如何？他们毕业之后，就业市场的反馈如何？是否达到了培养预期？

Interview Guide for Academic Staff (English Translation)

1. What do you think are the function and significance of the professional master's programme? Particularly compared with the academic one.

2. What are your perceptions on the professional practicum? What is its implication? What is its role in students' learning knowledge and skills and seeking their graduate jobs?

3. What kinds of professional practicums did your students do?

4. Through the professional practicum, what kinds of knowledge and skills did they learn? How about feedbacks from the labour market? Whether the students achieved the goal of course programmes?

Appendix B: Data Information

The Detail Information of Interviews

Data number	Format	Date	Location	Participants		Duration of questions and answers	Chinese words of transcription
				School	Status/position		
I-1-F	Face to face	25th June 2014	The main campus of B University	School of Mechanical Engineering and Automation	final-year student	12’23”	2,072
I-2-F	Face to face	25th June 2014	The main campus of B University	School of Mechanical Engineering and Automation	final-year student	20’22”	3,890
I-3-F	Face to face	25th June 2014	The main campus of B University	School of Mechanical Engineering and Automation	final-year student	13’18”	2,491
I-4-F	Face to face	25th June 2014	The main campus of B University	School of Aeronautical Science and Engineering	final-year student	10’53”	2,125
I-5-F	Face to face	25th June 2014	The main campus of B University	School of Aeronautical Science and Engineering	final-year student	14’50”	3,486
I-6-F	Face to face	25th June 2014	The main campus of B University	School of Aeronautical Science and Engineering	final-year student	17’15”	4,996
I-7-F	Face to face	26th June 2014	The main campus of B University	The Materials Science and Engineering School	final-year student	18’17”	4,218
I-8-F	Face to face	26th June 2014	The main campus of B University	The Materials Science and Engineering School	final-year student	33’34”	9,417
I-9-F	Face to face	26th June 2014	The main campus of B University	The Materials Science and Engineering School	final-year student	15’39”	4,131
I-10-F	Face to face	26th June 2014	The main campus of B University	The Materials Science and Engineering School	final-year student	16’10”	3,863
I-11-F	Face to face	26th June 2014	The main campus of B University	School of Automation Science and Electrical Engineering	final-year student	17’00”	4,969

I-12-F	Face to face	26th June 2014	The main campus of B University	School of Automation Science and Electrical Engineering	final-year student	17’57”	3,217
I-13-F	Face to face	26th June 2014	The main campus of B University	School of Automation Science and Electrical Engineering	final-year student	11’56”	3,025
I-14-F	Face to face	26th June 2014	The main campus of B University	School of Automation Science and Electrical Engineering	final-year student	12’18”	3,066
I-15-F	Face to face	26th June 2014	The main campus of B University	School of Automation Science and Electrical Engineering	final-year student	11’36”	3,483
I-16-F	Face to face	6th July 2014	The main campus of B University	School of Mechanical Engineering and Automation	final-year student having a graduate job	20’07”	4,860
I-17-F	Face to face	6th July 2014	The main campus of B University	School of Transportation Science and Engineering	final-year student	19’49”	4,244
I-18-F	Face to face	8th July 2014	The main campus of B University	School of Transportation Science and Engineering	Supervisor	39’48”	10,381
I-19-F	Face to face	9th July 2014	The main campus of B University	School of Transportation Science and Engineering	Course designer and supervisor	48’15’’	13,741
I-20-F	Face to face	2nd September 2014	The main campus of B University	School of Transportation Science and Engineering	final-year student	31’27”	8,638
I-21-F	Face to face	6th September 2014	The main campus of B University	School of Transportation Science and Engineering	final-year student	41’36”	11,607
I-22-E	Email	12th September 2014	——	The Materials Science and Engineering School	Course tutor and supervisor	——	1,477
I-23-E	Email	22nd September 2014	——	School of Transportation Science and Engineering	Graduated and employed student	——	1,965
I-24-E	Email	25th November 2014	——	School of Automation Science and Electrical Engineering	Supervisor	——	1,018
I-25-E	Email	26th November 2014	——	School of Aeronautical Science and Engineering	Supervisor	——	1,735
I-26-E	Email	27th November 2014	——	School of Mechanical Engineering and Automation	Supervisor	——	729

The Detail Information of Documentation

Data number	Title in Chinese	English translation of title
D-1	教育部关于做好全日制硕士专业学位研究生培养工作的若干意见	The Ministry of Education Guidance Suggestions about Full-time Professional Master's Programme Education
D-2	材料科学与工程学院 […][49] 全日制工程硕士研究生培养方案	The Materials Science and Engineering School […] Full-Time Engineering (Professional) Master's Course Programme
D-3	材料科学与工程学院[…]学术学位硕士研究生培养方案	The Materials Science and Engineering School […] Academic Master's Course Programme
D-4	自动化科学与电气工程学院 […] 全日制工程硕士研究生培养方案	School of Automation Science and Electrical Engineering […] Full-Time Engineering (Professional) Master's Course Programme
D-5	自动化科学与电气工程学院[…]学术型硕士研究生培养方案	School of Automation Science and Electrical Engineering […] Academic Master's Course Programme
D-6	航空科学与工程学院[…]全日制专业学位硕士研究生培养方案	School of Aeronautical Science and Engineering […] Full-Time Engineering (Professional) Master's Course Programme
D-7	航空科学与工程学院[…] 学术学位硕士研究生培养方案	School of Aeronautical Science and Engineering […] Academic Master's Course Programme
D-8	机械工程及自动化学院[…] 全日制工程硕士研究生培养方案	School of Mechanical Engineering and Automation […] Full-Time Engineering (Professional) Master's Course Programme
D-9	机械工程及自动化学院[…]学术型硕士研究生培养方案	School of Mechanical Engineering and Automation […] Academic Master's Course Programme
D-10	交通科学与工程学院 […] 全日制专业学位硕士研究生培养方案	School of Transportation Science and Engineering […] Full-Time Engineering (Professional) Master's Course Programme

49 The square brackets and the ellipsis, added by the author for anonymity, represent specific course names or company names, same as below.

D-11	交通科学与工程学院 [...] 学术学位硕士研究生培养方案	School of Transportation Science and Engineering [...] Academic Master's Course Programme
D-12	中国 [...] 有限责任公司 2015 年校园招聘公告	China [...]Limited Liability Company 2015 Graduate Recruitments
D-13	[...] 2015 届高校毕业生招聘需求信息	[...] 2015 Graduate Recruitments
D-14	全国大学生就业一站式服务系统-招聘职位	One-stop Service System of National University Graduate Recruitments

Appendix C: Interview Data Examples

Data Extracts and Codes for Professional Practicum Types

Type I Professional Practicum

Interview number	Related translated excerpts from the interview transcriptions
I-2-F	• *A：[…] After my supervisor had the project meeting with them, we stayed there (the company) and kept doing (the research project).* • *A：[…] It is **supervisor's research project**. We went back (to the university) when **we have done the project**.* • *A：I reckon I stayed there for **one month.** I went there many times. (Q: accumulated, one month?) Yes. Chengdu, also stayed for **one month** […]* • *Q：When you were there, did you go to the office **every day**? **From 9 am to 5 pm**?* *A：Yes* *Q：Working **with their staff**?* *A：Yes* • *Q：Did you have the work bench and desktop?* *A：Yes, I had.*
I-6-F	• *A: […] (I was doing) **supervisor's research project** that had a contract with a company. When **we were doing the project**, […] we communicated with them (the industrial partner), carried out the research, and finally submitted a report […].* • *A: I have been doing this project for about one and half year.* • *A: […] I went there (the company) **every week.*** • *A: **From Monday to Friday**.* • *A: From 9 am to 5 pm, not quite strictly, but I had to go to the company.*

I-10-F	• *A: Last year, I did a practicum in a company recommended by my supervisor, for about* ***one month.*** • *A: I went there* ***every day*** *during that time.* • *Q: Like a* ***formal work****? From* ***9 am to 5 pm****?* *A: Yes.* • *Q: You went there doing the research project for your supervisor?* *A: Yes…it could be regard as* ***the research project of the supervisor*** *[…].*
I-12-F	• *Q：Were you doing it at the university or did you go to the collaborative company?* *A：I went to* **Henan** *(province)***.** • *A：(I stayed there for) accumulated…if just count the time for staying there… except for the Spring Festival, 9 months,* ***8-9 months****.* • *Q：Your went to office* ***every day*** *when staying there?* *A：Yes.* • *Q：From* ***9 am to 5 pm every day****?* *A：Yes.* • *Q：Doing* ***the collaborative research project for your supervisor****?* *A：Yes.*
I-16-F	• *A: I worked in a same company almost* ***for three years*** *[…].* • *Q: You went to the company* ***every day****?* *A: Exactly.* • *Q: From* ***9 am to 5 pm****?* *A: Correct.* • *A: […] because he (the employer) had* ***a (business) collaboration with my supervisor****.*

Type II Professional Practicum

Interview number	Related translated excerpts from the interview transcriptions	
	About the professional practicum type	**About the work**
I-4-F	• *Q: How long have you been doing this practicum?* *A:* ***Three months.*** • *Q: The practicum is recommended by your supervisor or the school?* *A: My school contacted (the company). And* ***I applied (the job) by myself.*** *…* *A: The school contacted them (employers). Then we applied the placement when there was a vacancy. They (the employers) came here (the university) for interviews. Then we went to work there after interviews.* • *A: Go to work* ***every day****, just* ***like their formal staff.*** *Q: From* ***9 am to 5 pm every day****?* *A: Yes, like that.* • *Q: As* ***an internship****?* *A: Yes.*	• *Q: What were you doing at the company? […]* *A: […] I worked with their team, doing some* ***supportive tasks****.* • *Q: Is your* ***work relevant to your academic subject****?* *A: Yes, relevant.*
I-17-F	• *Q: Did you find it（the placement）by yourself？* *A: The senior* ***student XSJ recommended.*** • *Q: You worked there* ***from 9 am to 5 pm every day****? Same as their* ***formal staff****?* *A: Yes, yes.* • *A: Very busy,* ***5 days a week, same as the formal staff.***	• *Q: Was it (the practicum work)* ***relevant to your course****?* *A:* ***No.*** • *Q: Your specific task is summarizing (the customer complaints)?* *A: Yes.* • *Q: Did it (the task) involve your specialised knowledge?* *A: No, not too much, only … the very basic (knowledge about automotive) is fine.*

I-20-F	• *Q: Did you find the practicum in BBAC by yourself or Professor X recommended?* *A:* ***I found****. A senior student XSJ of Professor X worked there, so he recommended the opportunity to me.* • *Q: How long have you been doing the practicum? Accumulated.* *A:* ***Three months****, from May to August.* *Q: Did you go to there* ***every working day****?* *A: Yes.* *Q: Full-time work?* *A: Basically* ***full-time****. May be asked for leave for one or two days occasionally.* *Q: As* ***the identity of internship****?* *A: Yes, yes. They (the employer) have the placement.*	• *Q: What is your speciality in your course?* *A: Turbocharger.* • *Q: What was your responsibility for your practicum work?* *A: My task was* ***trivial and not systematic*** *[…]* • *Q: You do some supportive tasks in your department?* *A: Yes, if there were some* ***assistant tasks****, the official staff asked our internships to do it, like making the poster, and so on.* • *Q: As far as the request of automotive knowledge, do you reckon what degree is fine to the work?* *A: It…it does not have a rigid requirement. It just happens to I was doing the automotive course and doing the work, […]* ***it is fine that you do this job even without any automotive knowledge****. […]*
I-21-F[50]	• *Q: It (the internship) is actually recommended by your supervisor? Your supervisor has the acquaintance there?* *A: Yes* • *A: I actually* ***did not do the project there****. I have been the* ***assistant*** *for them to do the (project) management, following the progress.* • *A: I have been there since 1st April,* ***almost five months*** *(so far).* • *Q:* ***Full-time work every working day****?* *A: Yes.* • *Q: Work as what identity?* *A:* ***The internship.***	• *Q: What was your responsibility? What did you do every day?* • *A: […] found all the (previous patents), read through them, and submitted a summary to them. And sometimes did the information searching online. Or when they planned to buy something, (I) found all the candidate sellers on internet, made a list and then called them for an enquiry one by one, like the price, specific parameters, and then submitted a summary.* • *Q: So it (the task)* ***does not need particularly an automotive background****?* *A:* ***No.***
I-23-E	• *Q: How did you find this internship?*	• *Q: What was your speciality in your master's course?*

50 The participant did two different types of professional practicums, so this case appears in both type II and type III.

	*A: **I found it by myself**, online recruitment, and interviewed, and so on.* • *A: The time range was **half a year**. I worked in the office **full-time every working day.***	*A: The match analysis on the turbo charging system of piston aero-engine.* • *Q: What were your specific responsibilities of internship?* *A: Orientation for the target process for field part analysis and supplier recovery. Analysis of existing IT-systems (QEC-Tool). Functional expansion of current IT program (QEC-Tool) to the functions of reporting and handling of supplier recovery. Evaluation of different solutions and profitability analysis. Bug fixing of QEC-Tool during daily operations.* • *Q: What knowledge and skills were required for these tasks?* *A: Good English reading and writing skills, basic automotive knowledge and be aware of Excel and Access (Office software).*

Type III Professional Practicum

Interview number	**Related translated excerpts from the interview transcriptions**	
	About the professional practicum type	**About the work**
I-1-F	• *Q: What kind of research project did you do? […]* *A: […] engineering realisation […]* *Q: **Basically stayed in the office in university**?* *A: Yes* *A：Did **some products, and did something in engineering.***	• *A：[…] I **went there** with the senior students or supervisor together. (I) was just making notes during the **evaluation (meeting) there** (the company). I just did some assistant tasks.*
I-9-F	• *A：(doing the practicum for) **two months** in last summer vacation. For this summer vacation, so far there is no task, probably will do one.* • *Q: Where did you complete the practicum?* *A：I **went to the company collaborated with my supervisor.** The company collaborated in a research project.* • *Q: Did you work there every day?* *A：**There was not too many constrains on you**. But you had to control your schedule of the research project by yourself.* *Q: As long as you was doing the research project, **no one supervised you from 9 am to 5 pm?*** *A: No.*	• *Q: What did you do there?* *A: […] basically **completed supervisor's project collaborated with them**, **using the equipment and instrument there**, to do that research project.* • *Q: Which part (of the research project) did you do there? Testing?* *A: Right, mainly did the **testing task.*** *Q: (Staying there) for using their (company's) …?* *A：**Using their equipment**.*
I-11-F	• *A：Our practicum is **the business trip for the supervisor**, doing something like **equipment testing/debugging.*** • *A：For example, (I did) business trips for many times, accumulatively, **2-3 months.***	• *A：(I travelled there for) **testing/debugging and the onsite acceptance check** at Neimenggu (a province). Same tasks at Xi'an (a city). The rotary table made for (the company at) Xi'an also was **tested and passed the onsite acceptance check**.* • *Q：You mean to show your product?* • *A: Right.*

I-14-F	• *A：[…] Because the work load of (the research project of) supervisor is quite a lot. Doing the supervisor's research project at the university has already taken lots of time.* • *Q：Have you ever done something out of the university, for example, a business trip for the project meeting with your supervisor?* *A：I did the* ***business trips.*** *Q：W**ent to the collaborative company**?* *A: Right, I did (this kind of business trips).* *Q：How long have you been?* *A：(I did) the business trip* ***one time, about one week.*** *Q：What did you do there?* *A：Also* ***did the supervisor's research project*** *[…].*	• *Q：What the specific work did you do there?* *A：**Testing an instrument.*** • *A：Yes, I went there myself. My supervisor did not go to there.*
I-15-F	• *A：**Doing the research project for my supervisor**, and **participating the research project** I mentioned just now.* • *Q：Have you been there (the collaborated company)?* *A：Yes, I **have been there many times.*** *Q：For meetings?* *A：Yes, for **meetings.***	• *Q：Did you need to go to the collaborative company to do something, like an experiment, or testing equipment?* • *A：[…] Yes, I did when I was doing the project. It was the **testing, like the experiment**, as you said.*
I-21-F	• *A: Hmm, actually I did many research projects in this aspect. Actually I **contacted with the company**…I have been to CC (the name an automotive company in the anonymity), CC, the vehicle (company). **I have been there 3-4 times**, (staying there) **one week every time.*** *Q：Your supervisor had the research project collaborated with them?* *A: Yes, my **supervisor had a research project, and I did the project there** […].*	*Q: Could you talk about what did you exactly do in CC?* *A: […] (explain the project) I basically did such a project. And the project actually has been done at the university, and then has been **tested/debugged there**.*

Type IV Professional Practicum

Interview number	Related translated excerpts from the interview transcriptions
I-3-F	• *Q: So you have been **doing the research at the university lab all the time**?* *A: Right, right.* • *Q: Haven't worked in any company?* *A: **Company? No.*** • *Q: Have your supervisor asked you to attend any industrial meeting or to contact any industrial partner in any way?* *A: Er, not yet.* • *Q: What kind of research project are you doing for your supervisor?* *A: What I am doing are not very systematic, recently **doing a project collaborated with a company**.*
I-5-F	• *Q: What is your professional practicum?* *A: Er, I **do the research project for my supervisor at the university** […].* • *Q: **No any specific company for a practice**?* *A: No, no.* • *Q: (The research project) **doesn't collaborate with any industrial company**?* *A: No, it doesn't.*
I-7-F	• *Q: You have been **doing the research project for your supervisor**?* • *A: Right, right.* • *Q: Have your supervisor taken you go out of university for a meeting or something?* *A: It depends on the project and the supervisor. It is different. **I haven't**.* • *Q: What kind of organisation does your research project collaborate with?* *A: It is probably a company. But the supervisor haven't discussed it specifically with me.*
I-8-F	*A: I don't have the professional practicum. I just **(do) the supervisor ('s research project).*** • *Q: So you just do the research for your supervisor at the university?* *A: Just **do his government-funded research project**.*
I-13-F	*Q：[…] You just work for your supervisor? Research project?* *A：Yes.*

	*Q：**Does the research collaborate with any industrial company**?* *A：**No**, it doesn't […].*

Data Extracts and Codes for Knowledge Learned by Students

Knowing How to Solve Practical Problems

Type	Interview number	Related translated excerpts from the interview transcriptions	Codes
Type I	I-6-F	*Take the aerofoil (R&D) as example, when we studied it, it has been taught […] (the principles about how to design the aerofoil). But, for the finished aerofoil, […] (the technological problems in the real design). So for the aerofoil, I needed to design it as a style which was economical as well as could match the required design specifications, in order to complete it (the project assignment). [Q: it (how to design) has been taught in the module?] Yes, but, the design theory is very fundamental. You need to **apply them into your engineering practice**. You have to **connect them (the theories) together**. The theories are very simple [laughing], I think so. **They are isolated 'pieces'. There have been no … [Q: an integration of the theories?] Right**, right. You can understand them fully only as you have done a stuff systematically (in practice). [Q: So you think you could integrate the 'isolated theories' together because you did this project?] Yes, yes [Q: but it has been never taught in the textbook?] No, no.*	Being different from theory to practice- how to apply design theories integrally into the actual project design
	I-6-F	*Er, compared with taught modules, what has been learned in taught modules is that the 'empty talk' (theories) have not been verified (in practice). Hypothetically, I could design a stuff to you, show you like this (on paper), but I don't know whether it could fulfil my design specifications specifically. But when I was doing this (industrial R&D) project, I did the pre-analysis by the software to make it could fulfil the [design specification], that is to say, I could modified my (theoretical) design by software and enable it to fulfil the design specifications. Additionally, I had to produce a sample (of the design) to test it and improve it. Comparing with … (the designing in university lab) that I just leave it there after I designed, that's all, no matter the design is good or bad. (But)*	Being different form theory to practice- Combination of theory and practice. The theoretical design can be verified and improved by practice.

		through this testing (in the industrial R&D project), I could modify my product and know where need to be improved. ***This is a very good combination of theories and engineering (practices)****.*	
	I-6-F	*[…] for example, a simple connector, it does not matter whether it is triangle or rectangle shape (theoretically). But in the actual project, how to say, I thought I could manufacture it, but the problem is that the stuffs I designed need to be assembled together. So in practice, I have to consider whether it could be assembled. For example, it is a rectangle, but the other (matching) one is triangle, so they cannot match each other. In our imagination, just considering the room. It (to be designed in such way) is OK. But in fact, it does not work. [Q: a lack of practical experience?] Right, right, […] [Q: it has not been taught in the university?] No, no, no.*	Engineering problem- The design which is feasible in theory but could be problematic in assembling.
Type III	I-9-F	*For example, in a step (of an experiment), a certain process, like a thermal insulation or whatever, is needed. If you knew (the right process before the experiment), your finding could be very good. But (in practice) no one told you, and you did it wrong (experiment failed). So you had to think the reasons, to check the literature or ask other (peers), and finally you know what should do in this step. [Q: so the 'procedure' you mentioned is just in practice but could not be taught in book or class?] Definitely no (in book or class).*	Engineering problem- Knowledge derived from failure practice
	I-14-F	*(through the practicum)* ***I could know that the theories taught in class can be applied only through the practice, and the applying process is totally different from the theoretical process you imagined****. That is to say, in practical process, there may be kinds of problems about the approaches which you designed previously and believed they are very good. […] at the beginning, we three (students) shared the task. One was charge of the software; the second one was charge of the algorithm; the other another one was charge of the hardware. (We thought) it was planned perfectly and just did it as the schedule. It turned out the schedule was disrupted. Because, the one who did the software had many tasks which could be done only as the hardware has been completed. And in the software part, what we imagined could be done very soon actually took the long time and lots of energy. … [Q: You have an imperfect operational plan?] Yes, because at the start, for example making an interface, I thought it is easy and may just need a couple of days, but actually this interface tasks took a very long time (to be done).*	Engineering problem- The experience of operational planning in engineering project. The student was lack of the experience of completing a whole project in practice. The parts in the whole system are connected, so they cannot be completed independently. And the student was lack of practical experience in actually finishing something and cannot estimate the time to complete a work accurately.
	I-14-F	*For example, our project specifically needs an implementation ability, i.e. (we) need to complete a simulation platform with the high implementation ability related the satellite. I was charge of the implementation specifically. But in the procedure of implementation, it may influence the late stages, i.e. some nodes may*	Engineering problem- The experience of operational planning in engineering project.

		influence the late stages. But I did not consider that at the beginning when I was doing. But they (the industrial professionals) can point out (this problem) and offer suggestions. And (I) could improve in this aspect.	The student was lack of the experience of completing a whole project in practice. Does not notice the nodes could impact on the following work.
	I-15-F	*For example in my previous project, it was collaborated by many institutes not only our team. We were only charge of the control panel and other parts are made by others. So you had no idea where would be a problem appears. […] because we didn't have their (other co-researcher) devices. We could just simulate it as possible, and done as what we thought. Then in there (where the design is actually used), the light didn't work. It turned out the transmission distance was longer (than we expected in the simulation). It is like, for example, we used the A signal system to transmission which is fit for the distance about ten metres. But actually the distance between the airport to control panel is more than a hundred metres. It needed the B signal. So it doesn't work. It is normal that the light doesn't work. Surely it needed to be checked (and solved). But we didn't know why. The client said no as they couldn't turn it on, you must find the reason, […]* ***I think the biggest gain is it the problem-solving ability****. As I said before, you may face kinds of challenges which you can't imagine, but need to solve it as soon as the problem appears. [Q: have you learnt them before from textbook?] No, not at all.*	Engineering problem- On-site problem- The experience of fully considering all the possible situation in an engineering project. The experience of problem-solving on the spot.
Type IV	I-3-F	*[…] I participated in the process and knew the procedure (in the practicum). So I feel it enables you to notice what you neglected (before) in (theoretical) design. […] with respect to mechanical design, it is no problem that you could design it theoretically, but when you manufacture it and assemble it, many problems may appear. I feel this experience might be helpful to your future design. […] In our design, for we were making a test rotary table with only one axle. Lots of parts were assembled there (on the rotary table). When you designed, you surely didn't consider the assembling. When I was designing, I thought a compact (structure) design should be good. But later the problem is that the assembling is troublesome, and disassembly is troublesome if some parts are broken, […]* ***some designs are feasible theoretically, but could be troublesome when operated practically****. [Q: So you didn't realise some problems when you learnt them, but you found the problems when you actually did it, right?] Yes, yes, yes.*	Engineering problem- The design in paper is feasible but troublesome in operation, which has not been realised before.

Knowing How to Do in An Industrial R&D Project

Type	Interview number	Related translated excerpts from the interview transcriptions	Codes
Type I	I-16-F	*Q: So do you think your previous practicum task is helpful to the current job (an R&D job)?* *A: definitely helpful. […] when I worked there (practicum company), I learned this kind of knowledge (R&D knowledge).*	• R&D knowledge
Type III	I-11-F	*Q: What do you think is the difference between 'do it following others' and 'do it by yourself'?* *A: It is different. For example, at the beginning of doing the project, […] (was requested to do the parts of the engineering project supportively) but I had no idea about rotary table. I just knew its framework, i.e. what it is for, but didn't know its mechanism or structures, etc. rationales as well. But later I did that robot (project), […] I did it by hands, still felt unacquainted at the beginning when I just took the charge. At the start still was unacquainted, but felt better gradually.* *Q: What do you think are unacquainted?* *A: Every aspect, like the construct of hardware, software, the system, all need your responsibility. When I took the charge of the whole system, felt still comparatively unacquainted. […] like in the past, I have done and passed it to the senior students. They integrated them including software and hardware, […], if do another in the future, it may be easier.* *Q: Why easier? Because you are proficient?* *A: it is actually a process of proficiency.* *Q: So now in your profession, if ask you to set up a software and hardware platform, you could complete proficiently?* *A: At least (I can) in my robot; I can learn by analogy for others. […]*	• The student did not know the whole system when doing a project following others because the integrating work has been done by others. He only knew the parts rather than the entire. Only as he was charge of the whole project, he became proficient to the entire.
Type III	I-14-F	*First is the experience, which means when we have something to do, I can confirm in a short time that how long I need to complete it, need what steps, and whether need others help in the procedure which means which parts are unfamiliar and needs others help. At least if there is something (R&D tasks) need me to do, now I can make a framework. But in the past, when I saw it (an R&D project), may feel totally have no idea how to, even from where to start. Probably this is a great development.*	The experience accumulated is knowledge about how to start and complete a project.

Knowing How to Operate Equipment or Software in Practice

Type	Interview number	Related translated excerpts from the interview transcriptions	Codes
Type I	I-2-F	*Q: How do you feel about the software you use?* *A: **Proficient.*** *Q: Being proficient **because the practicum task**?* *A: Yes.*	
	I-6-F	*Q: Through the practicum, how do you think the (using of) software or hardware development platform in your profession? Have you possessed them proficiently?* *A: Yes, **proficiently**, must be proficient.*	
	I-16-F	*A: […] something like, for example, I did the image processing card. I needed to use the DSP. **But no one in university use such advanced stuff**. They use just 51, or even ARM which is easier ARM. The DSP I use is more complicated and using it to do the integrated development is complicated.* *[…] As I said before, we made the circuit board, and wrote the programme codes for lower computer, or drive (programme). **All of these can't be accessed in the university lab**.*	• could access some advanced devices in practicum
Type II	I-4-F	*Q: Through the practicum, have you known about the software or hardware platform?* *A: Definitely yes, you have to use, it is impossible to say (I can't use them)* *Q: Are you proficient?* *A: I am Ok.*	
Type III	I-1-F	*Q: Whether it is helpful to your professional skills, like using the software or development platform?* *A: That is enhanced most greatly. Because learning the software from books in the past, you*	• To solve the practice problem 'push' the student to be familiar with the software.

	couldn't practice to do anything after learning. When you have the practical problems in engineering, then you use the software again, that is (you could be) very proficient. Like in the laboratory exercises, just holding the book, do what they instruct you to do. When you meet the practical problems, you will find [laugh] many things in the book are useless. It still need the practice. […] for example, the software SolidWorks and ANSYS, when learning it, without the underpinning of practice, first, you may feel you don't have enough motivation (to learn). When meet the difficulties, you don't want to face the difficulties. But when you have practical issues, you have to solve the problems. ***So became more and more familiar with the software. The practical problems are very helpful to learn the software.***	
I-9-F	*Q: Do you enhance the ability or skills of testing?* *A: Surely, it is totally operated by yourself. You at least have to know how to use these equipment and instruments.* *Q: What have you learnt through your operation?* *A: The operation (itself), such as the scanning electron microscope, how to observe, and how to get the result you wanted, like these.*	
I-11-F	*A: At the least, there is no pressure using the programme at university. But on-site, they (the clients) were watching you. (When they find) what is unfulfilled or what else, you have to (fix it instantly).* ***So first there is a time limit. It requires your speed ability. And secondly it requires your comparatively accuracy, good accuracy****. Only as meet all their demands, you could (complete the mission), (in a) comparatively pressured ambient.* *Q: So you don't have the opportunity to develop the 'speed ability' and 'accuracy' at the university?* *A: University? […] feel it anyway, I have more freedom to arrange my time. By at there, first, considering the expenditure of business trip; secondly, their requirements. And we also hope … after all in the business trip, no one wish to go there many times. So I feel it needs to … [Q: To consider it thoroughly at one time?] Yes. So everyone were nervous and focused at there.*	• The operation on the spot developed the student's 'speed ability' and 'accuracy' of operation sills
I-11-F	*A: Benefits are, mainly are, our engineering Masters […], have many opportunities (to practice) by ourselves.* ***In fact it is different between you did and you didn't, and it is also different between that did it following others, did it yourself and you took charge of a project.***	• It is different between you practiced and you did not practice. The practicum offers

		Q: What do you think is the difference between you did and not? *A: If you didn't do, when you go to a company, particularly the research department where they request you to have a strong technology ability and hands-on ability, (if you don't take the practicum) I feel* ***it may take a longer time to 'ready-to-handle'****.* ***But the professional Masters, at the least, have a transition (of accumulating the skills). At the least this kind of ability could be enhanced a lot.***	a transition for the student to accumulate the hands-on ability.
	I-14-F	*Q: Then with respect to the use of some software or hardware platforms, do you feel you have an enhancement about it?* *A: Surely yes.* ***In terms of the specific operation (skills), surely they have been enhanced. Because it is actually a 'proficiency' for many things in engineering****. In fact writing the codes (of the programme) is the process of proficiency. […]* ***the proficiency of your codes writing actually, i.e. the practical ability of writing codes, is closely connected with the volume of the codes you have done. […] So it must be better practising more****.* *Q: Do you feel you have enough practices (in the practicum)?* *A: Not that much, but I have done in a certain volume.*	• The proficiency has a positive correlation with the volume of practice.
Type IV	I-3-F	*Q: Do you need to use some software to simulate or analysis?* *A: Yes.* *Q: Then how about your mastering degree through the project?* *A: Yes, definitely more proficient than before.*	
	I-7-F	*For example, we have an electron scanning device with a not very high sensitivity. When observing something really micro, like amplifying the sample thousands or ten thousand times, if you operate it properly, the picture is still clear when amplifying in ten thousand times or twenty thousand times. But if you operate it improperly, it could be very vague even in amplifying in thousand times. There have been something like the astigmatism to be observed by experience, and then adjust. […] Yes, it needs operation by hands. It needs to set up the parameters and to turn the device left or right (by hands).*	

	I-13-F	*A: I feel my gain is, for example, a (computer) language, e.g. C or C++, I knew it; I knew how it operate; and I knew how to write the programme codes. And when I am requested to complete a task, I at least know how to do it step by step based on my consideration.* *Q: A (computer) language could be learned in the lesson. What do you think is the difference from the practice?* *A: Surely there are differences. Because in the past it was learnt, but it has not been connected specifically with some applications. Only taught. (For example) this is an IF ELSE sentence; what is the function. You only knew the function of the sentence. But now you need to apply the sentence to realise a mission you expected. So firstly you have the mission, could set up the framework, set up by yourself. And then you fill up it. With respect to the language, you learned it (by taught), you only know its usage. But now you make a thing, you need to, er, how to say, the thing you needed, designed at first, and then consider how to use (the language), and realise it (expected function) step by step.*	The student has been taught the abstract usage of computer language only in the past. But in the practicum, she knew how to use it to realise a goal.

Knowing How to Be A Professional Engineer

Type	Interview number	Related translated excerpts from the interview transcriptions	Codes
Type I	I-10-F	*Their (the industrial professionals) abilities of doing a project I think is strong. I feel their thoughts are 'in-depth excavation'. […] for example, when we got a picture of diffractive something, if we do, we just analyse something like dark spots. That is fine. But they consider more. Comparing with them, we didn't consider as much as they do. […] That is something of experience. They know in which ways to analyse it as soon as they see it. […] for example the performance of something need a test, we maybe just think up a few of types of performances, while they could think of more performances.*	Professionals experience- By comparing with the professionals, the student realised the lack of experience in engineering analysing.
	I-12-F	*[…] in engineering, there is … a '**professional competency**'. It is different from when did not do (any project) previously. […] for example, specifically, when using a (circuit) board, you should test whether it has any short*	'Professional competency', i.e. the habit which means the

		*circuit before plugging in. The detailed issues like this. I think that those are '**professional competency'. It is a habit but not just that you knew the principle of the (circuit) board or some kinds of knowledge**. […] [Q: Did you accumulate the habit through the practicum?] Yes. […] I think **the difference between the one with engineering experience and the one graduated freshly is the habit, i.e. the 'professional quality'**. I think there is not many differences in other aspects such as the knowledge, just the habit. […] that cannot be taught. **The habit is accumulated (in practice)**.*	engineering operation in a good paradigm. And it is accumulated in practice.
	I-12-F	*[…] something professional, or say something like their experience. For example, identifying what is the problem with the signal when see the signal at once. [Q: which means they (the industrial professionals) could recognise the problem of a signal, but you can't?] Right, yes. […] [Q: Do you think you have learned (that experience)?] Surely learned some.*	Professionals experience- The experience of recognise/identify the problem of signal, which have been learnt in the practicum
Type III	I-1-F	*The most direct (gain) is the sense of engineering problems. They (industrial professionals) can identify lots of problems accurately. […] for example, in our review (meeting), when we were answering how could realise the performance specifications, for several indexes they requested, we said we use this sensor with an accuracy of 0.1% which could completely meet your demand of tension control of 1%. Then we concluded that the sensor we chose fit your requirement of performance. And then an expert sitting oppositely said 'do you think the accuracy of one sensor could represent the accuracy of whole system?' He explained the system accuracy cannot reach the single sensor accuracy. The accuracy of an assembled system cannot be guaranteed as same as one sensor (used in it). […] [Q: which means they could offer the engineering practical experience which you haven't?] Right.*	The student did not know the accuracy of whole system is lower than the accuracy of its one part, which is due to the lack of experience. While it enable the student learnt the lesson that the professionals encountered by the student practicum identified the problem.

Knowledge of the Industry or Profession

Type	Interview number	Related translated excerpts from the interview transcriptions	Codes
Type I	I-10-F	*A: In fact the focus of thought is different between the university and the industry. They (the companies) consider things **practically**. […] for example, make the performance of this material to reach a certain degree or (fulfil) what requirements. They will ask, the superior (of company) will ask, to make something (the material) to a certain degree (a practical effect). But at the university, I just try (experiment), or make it in many ways, and just keep the findings as (the experiment) derived, without any in-depth consideration, such as what it is used for, or excavating deeply whether it could be used on something, or whether it could be used, something like these.* *Q: **The industry focuses more on the practicability**?* *A: **yes**, yes, yes. In the university, there are lots of findings by research for reserving, just keep it. And you may publish them. And other people may see it and reckon it is useful, and keep developing it. But in the industry, when they need whatever a thing, a performance or something, they do it intentionally, like this.*	• Industrial demands • Enterprise focuses on the practical function and usage of a material, while the university only does experiment for theory breakthrough without thinking about the practicability.
	I-12-F	*A: A **perceptual knowledge** of this industry, unlike the feeling of reading books.* *Q: What do you mean by 'perceptual knowledge'?* *A: For example, a missile, seeing it in the book and or seeing a real one there, it is different.*	• Industrial perceptual knowledge • Learning it from book accumulates the conceptual knowledge, while seeing it actually forms the perceptual knowledge. And the practicum offers him the opportunity to see the actual one.
Type II	I-17-F	*What you learned in university stresses the theories or optimisation. It is different from the commercial products. I feel **a commercial product is***	• Industrial demands

	***mainly orientated to the customer's demands, like durability or reliability, which is a quite different focus in the university**. […] (in the university) your focus is the power performance or economy. You could test the power, torque or fuel consumption rate of it (the engine). But, yes, for customers specifically, they not only regards them as important, they also think the durability or reliability is important, which means do be broken.*	• For the same automotive engine, the industrial concern is the customer's demands which are durability or reliability, but the university focuses only on the data of performance.
	*A: […] You could know something, like the **operation of a company,** after the practicum experience*	•
	[…] I reckon (the most important gain) is a kind of experience. For same the engine or the automotive industry, it is a different experience (from in the university). *Q: Have an awareness about the industry?* *A: Yes.*	• know the industry
I-20-F	*A: […] I feel one thing is **what have been learned at the university are over-advanced than the practical application**. […] The current (university) research … particularly the pure theory research is of break-through considerably. But **actually in their process of producing cars, there are some technologies which have been used for decades**. […] Because what you have been taught are very advanced, […] may not very focused on those (old technologies). Then went there (the industry) you found they are using those technologies which you haven't focused on, haven't learned. So you still had no idea about (the old technologies). […] If you knew the decades-old technologies (have been used in the industry) at the beginning, you may learn them with more intentions (in the taught modules), learn it seriously, rather than just concentrating on the new ones only.*	• Industrial demands • The university teaching or research is overly concerned with break-through technologies, which misleads this student to focus on them only but neglect the 'old' or say matured technologies. He realised the matured technologies still have been used in the industry when he worked in the enterprise.
I-20-F	*A: (I) know their … something like the price of automotive parts, or something in their process of producing. How to say, (something) unknown to the outsiders. You will know them, as long as you are inside (in the industry). But*	• Know what the enterprise is doing in their industry • Being an insider, knew that some so called big companies do not manufacture vehicles and they just buy the parts and

	you can't know them, if you are the outsider. Like they buy all the parts. […] They usually don't manufacture anything, basically buy, and then assemble them there. *Q: Something inside 'secrets' in the industry?* *A: Yes, yes. And also (know) the parts, mostly the producers of parts. In the past, (I) only focused on the finished vehicle. You may never focus the parts. But after went to the company, you found that so called the 'big company' is actually just an assembling plant. The producers of parts make the actual things.* *A:* ***I feel (I understand) the automotive industry, or maybe also know the other companies in this industry. Unlike in the university (previously), I had no idea about the industry****. During the three-months-practicum, because … maybe hearing from the colleagues, or communicating with other colleagues, I know the other companies in this industry. (I know) how about them. […] (I know) parts producers, others … like Hyundai, BMW, and Audi, all of them involved. I reckon I know more about the requirements in this industry.* *A: For they who produce the cars, most people think the cars are made in the company. They produce the cars by themselves. But after I been there, I found they (the company) have no manufacturing plants. All they have is an assembling plant. I found all their parts … it collaborates with other companies. I develop the mould; you process and produce it. Like that. And then, if say, what I know more than them (other students) is that the particular supply chain, particular car producers or parts producers … I know more.* *Q: You know more about the situation of the automotive industry?* *A: Right, right, right. For this industry, for this company, I know more thoroughly. Generally speaking, if no practicum, just speaking of the Mercedes, what do you think it do? The outsiders may think it produces cars and sells cars. But how do they produce cars? Are all the cars produced by itself? Then*	assemble them. The student did not know this situation in the industry before. After that he found a 'new' industry, parts.

		they have no idea.	
	I-23-E	*I learned more knowledge about the brands and automotive manufacturing process, learned the basic knowledge of imported cars and the operation of joint venture enterprises. I have experience in the after-sales quality analysis of parts and supplier claims.*	• Know what the enterprise is doing in their industry
Type III	I-11-F	*At least I know some inner things in the institute [laugh] [Q: what do you mean by the 'inner things'] For example, if you work there, how do you develop yourself? Like the difference between the Masters and the PhD. How do you improve? Which direction you should to improve. […]*	• Professional development in the industry
		Like the project we made, they (the industrial partners) often found many deficiencies and asked us to improve many times. […] the deficiencies, from the aspects of hardware and software respectively. For the hardware, whether process them finely, whether they could reach something like technological standards, which are very demanding. The other one is about the software. How about the reliability, whether it could reach their (requirements) like the long-time stability, the after testing something. […] They (clients) hope buy a better stuff or a longer service with fewer money. [Q: They are critical to your things?] Yes, very critical.	• a contract-based project • Know the real demands in engineering project • The industrial professionals are critical to the products in terms of the practical quality.
	I-14-F	*They are the client and we are the undertaker, which means they propose the requirements of project and we should fulfil, a status like this. They often rise different demands. Aiming at their demands, we have to realise them, like this way.*	• a contract-based project
	I-15-F	*A: It's quite different. For example, if you let me work in […] (the name of companies), I don't think there will be a problem. But if you let me work there in the first year (of my Masters course), I totally had no idea what should do.* *Q: So you know what you do there?* *A: Yes. It is different between I did and I haven't.*	• What they will do in the enterprise in their industry • Before the practicum, the student had no idea what do they do; while after the practicum, the student knows.

I-15-F	***Doing the actual project is totally different from the lessons and reading literature or writing the programme codes in the university lab****. You do the project for them (the clients), and they don't care this or that (the excuses). They just say it has to fulfil what requirements. [Q: You have to reach their requirement?] Yes, it cannot happen that you can't reach their requirements. It can't. There is the contract with a clear statement.*	• Doing a contract-based project is different from research in university • Doing product for industrial clients is unlike do project in university. There has been the real contract with no negotiation.
I-21-F	*The on-site work lets me know the ambient and salary of F company (a state-owned enterprise) is bad. I won't go to work there [laugh]. […] But I went to C company, it is totally different. I found the work efficiency in C is much higher than F. This is maybe the gap between the state-owned company and the private company. I think F company is a good place for waiting to retire. […] The graduate wouldn't like to work there for the very low salary.*	• Professional development • Identifying the advantages and disadvantages of different types companies • A state-owned company is inefficient and underpaid, while a private company is efficient, know the difference
I-21-F	*I communicated with the colleagues after work, talking about such as my job finding. I asked them such as which direction I could do in the future so I would have a better prospect, or where is better for my development. […] They told me you could work in blah and then go to blah [laugh], which could help your wage promotion. Or they told me to do what kinds of task could have a broad future. [...] So the biggest enhancement is they let me know my future direction of career. […] So I have a clearer direction or the range of the future career.*	• Professional development • The path of career development

Knowledge of the Workplace

Type	Interview number	Related translated excerpts from the interview transcriptions	Codes
Type I	I-6-F	*[…] The biggest impact is the difference between the enterprise you stayed and the university. Your university office/laboratory is smaller after all, just a few of people in total, knowing each other in one room. But when you go to a company, it has many departments. For example, where we went to do the experiment, it has a special department for receiving you, a department for the experiment equipment, and other their supportive departments. In the process of your experiment, **you have to coordinate with all the departments**. If one department didn't cooperate, then you can't proceed. For example I arrived there, but I can't find the one who receipt me (to register), then your experiment findings can't be accepted. Or you need to contact with someone, but you can't find the one who is charge for the equipment, then you can't start the device. [Q: so it needs you to coordinate and communicate?] Right, right, right, **everything needs to coordinate and communicate**.*	• Coordination and communication • University laboratory is simple and smaller, and is familiar to the students • Enterprise has complex structures. The student feels everything need to coordinate and communicate
		*At the beginning, I was just graduated (from the undergraduate) for not a long time (in the first year of postgraduate). And I was introverted, not good at interacting with people. But the people in the workplace are very active. After I contacted with them, I felt the **introversion doesn't not match the workplace**. You have to be lively. And for many things if you don't (ask/request) in person, it won't … (happen).*	• Proactivity
	I-16-F	*I feel in the **interpersonal aspect**, it is quite a different style that the university lab/office and the enterprise. At the university lab, you don't need to think about many things. But in the enterprise, you have to consider more. What you said may have an impact on the different people. Because they have an inner estrangement … that is. But in the laboratory, you don't need to think, because all the people are peer students, without the deep grudge, without the interest relationship. [Q: what kind of impact do you think?] Because I did the R&D. Doing the R&D actually needs a team. Particularly I did the embedded development which involves many*	• Interpersonal issues • Interpersonal relationship in workplace involves benefit or interests, it is different from university. If handle improperly, it may affect work.

		people. I need to (communicate with the others who did) the mechanical design, upper computer, lower computer, and so on, all involved. Otherwise, they won't cooperate with you. […] I was just an internship, so the economic benefit is not important. But I think the most important thing is the efficiency of development for the team.	
Type II	I-4-F	*For example, **you have to be proactive in many things**. Like at the beginning when I stayed there, (the employer planed to) buy a computer for me. And the human resource department asked me to wait, and then they … if you were not proactive, then keep waiting, maybe you wait for a long time. So you have to urge, again and again. Then after several times, they bought me the computer. […] to contact with the colleagues, you also need to be proactive. […] you can't stay alone, just do your thing.*	• Proactivity
		Q: Then besides the professional knowledge, how about the general skills (you gained), such as the communication or the team skills? *A: More improvement in these aspects.* *Q: Could you give an example?* *A: **Get along with people**, learned it gradually. Like at the beginning, there were twenty something colleagues. You have to know them at first and then have been familiar with them.*	• Interpersonal skills
	I-17-F	*(I) gained actually an (understand of) ambient. The enterprise ambient is different from the university. And (there was) a high requirement of English. In that kind of team … our team is a small team, and […] we have the divisions of duties and cooperation. If staying at the university, I feel (I can't gain) the perceptual knowledge of the enterprise and staff.*	• Enterprise ambient • Experience in work with colleagues
	I-20-F	*[…] felt the ambient of the enterprise … I just heard **the workplace and university are different, so (the practicum is an opportunity) to feel in person what the difference is**.*	•
		*I think anyway at the workplace, you **should be extroverted** first. And secondly for many things, you have to **struggle proactively**. Unlike at the university, there have been administrative staff remind you. […] One time when our manager was leaving, there was a farewell. The secretary sent the invitation. But because I was the internship, and he/she missed me. They didn't send the invitation to me. […] Later on I found that person (secretary), asking*	• Proactivity

	why I haven't (the invitation) reminding him/her. He/she said sorry and then I was included. Another example, they have the employee referral. […] I heard from another internship student that his department has a vacancy. I went to their manager directly and asked do you have a vacancy. […] I think if I didn't find him, there was absolutely [Q: no such an opportunity] Right.	
	*Besides an experience, maybe more (gain) is the **interpersonal ability**. […] The feel in the workplace is different from the university. Staying there, I feel first of all even you are very busy, meanwhile other people are at a loose end, they however won't say let me help you to do something. It (the help) is impossible. Even if you have a busy day and you have to do something outside, leaving some office tasks haven't completed, no one would help you. Because it is your work, your thing. That is their view, isn't it? You do the job and earn the money by yourself. I have no obligation to help you. […] I fell it is **very realistic**. […] The feel is different from the university. At university office, there may be someone help you. At there, very realistic. Some people sit around every day, but some people … you are very busy every day. But no one help you. At there, I feel it seems the relationship between colleagues are not very close. I feel something, such as the money, have been deemed as very important. […] Those who looks have a good relationship (at working time) have no relationship at all after work.*	• Dark side • Interpersonal issues • The interpersonal relationship is calculating, not as kind as in university
I-21-F	***The most intuitive impression is a rough idea about the scene of the future work**.*	• intuitive impression
	*And how do you **get along with the colleagues**. I feel this kind of **relationship is totally different from the relationship with peer students**. Because in the university, you get along with peers. You don't need set up any defence. But at there, you really have to think carefully when talking.*	• Dark side • The tricky communication
	*In fact I feel I can't learn too much about the professionals, but **learned some experience in the workplace**. […] And they have a very clear responsibility division. Sometimes, even it is your problem, you have to offer lots of evidences to prove it happens inevitably in this situation rather than your fault. They are good at how to get rid of the duty. Anyway keeping away from the other's business/fault as possible. […] [Q: you reckon the ambient is different from the university?] Different.*	• Dark side • shirk responsibility

		*And the work and the rest time of daily life. Actually at the university, […] (describing the daily life at the university). At there […] take use of the day time […]. When bell rings, you immediately run out to have the lunch. And you return to office exactly on time when the bell rings. And their **management is more reasonable and standard**. The management of our supervisor is very chaotic. They (the company) have a 'progress bar'. Every day's work have been arranged in details. Because they are experienced and they know how long every task will take. But in the university, students are still studying (how to complete a project). Even there is a personal schedule, but still it can't be implemented. Because you were told it could be done in two days, while actually you can't. And you don't know, because you haven't done that before. But at there, each department could coordinate, and (the schedule) could be very clear. […] This management is very important. It could enhance the work efficiency. And they have a meeting every week to discuss the project. All the people in the project (attended). […] which is a good (thing).*	• Enterprise management • Working time arrangement and management are reasonable, standard and efficient
	I-23-E	*The professionalism has been improved, from the personal cultivation to how to get along with people. […] I learned from them (colleagues) the serious and devoted work attitudes, handling the details, keeping a sense and eye on new problem emerging and not to miss any problem. [...] the multitasking ability, the importance of conscientiousness, paying attention to the details and professionalism.*	• A series of soft skills
Type III	I-9-F	*[Q: At the workplace, do you feel some difference from the university?] Absolutely different. They managed very strict, like the attendance or the completion of your work, very strict.*	• Enterprise management • Strict attendance
	I-14-F	***The interpersonal ability** has been improved in the practicum. It is useful for the future work.*	•
	I-21-F	*I think the biggest gain is you cannot be 'over honest'. As I said, you should speak scheming carefully. Because once they (clients) find any problem, they report to their supervisor and then to your supervisor. Finally my supervisor would call me to blame me [laugh]. So you'd better do not bring trouble to yourself. And even there is a problem, you should say it is not problematic and solve it instantly. To stabilise him for some less serious problems. You have to know how to cover up and get over it. [...] Sometimes it is our problem; sometimes it is their problem. But we are students and they are sophisticate. Even it is not our problem, they still*	• Dark side • Sophistication

		blame us directly. They don't even self-check whether it is their problem. So finally we learned how to prove it is not our fault to them.	

Data Extracts and Codes for Graduate Job Prospects

Type	Interview number	Related translated excerpts from the interview transcriptions	Notes
Type I	I-2-F	*Q: **Did they (the employer) expect you to work there in the future**?* *A: **Yes, right**. But it depends. I probably won't.* *Q: You have done the practicum, and you have a positive feedback from the enterprise. So has that increased your confidence in the future employment?* *A: **Yes, increased some.*** *Q: Do you feel **the skills and experience accumulated from the practicum can help you employment**?* *A: **Yes, surely it helps**.*	• Already have a possible opportunity to be employed • Positive • the skills and experience accumulated from practicum helps
	I-6-F	*Q: **Did they (the employer) expect you to work there in the future**?* *A: **Yes, they asked me.*** *Q: Are you going to?* *A: I, er, aerospace … the industry … yes, probably.* *Q: Since the enterprise want you, do you feel confident in your employment?* *A: Yes, I feel **I have some strengths than undergraduates**.* *Q: What do you think are your strengths?*	• Already have a possible opportunity to be employed • Positive • The possessed skills match the demands of enterprise. The employer could train them easily.

	A: I reckon, first, the degree, the most direct one. You are definitely higher than undergraduates. Moreover, ***the skills you possessed and the demands of enterprise, you better match their demands****. Actually the undergraduates are still a piece of 'blank paper'. They (employers) have to train you (undergraduates).* ***The postgraduates, after all, did the R&D project, so they basically possess the skills. They could (employer) train you comparatively easier****. It is surely due to what you learnt.*	
I-10-F	*Q: So with your gains, do you feel it is helpful to your future job?* *A:* ***I think it is helpful****. May be I will work in this industry.* *Q: What industry do you mean?* *A: Like the mechanical (engineering) (the interviewee's course is about material engineering). (I am going to) develop towards the mechanical direction. Maybe like moulding, material moulding, mechanical design, these directions.* *Q: So in this industry, do you have the confidence in future employment?* *A: I think so. […]* *Q: What do you think are your advantages?* *A****: I think I just learned these things*** *(doing the project) for such one year and I learned many things. So I feel if I am required to learn something new, I also can (master them efficiently), I think.* *Q: (You learned a learning ability) through your practicum?* *A: Right, right.*	• Positive • The practicum experience helped the student to adapt in a new direction in the industry. And the adaptability helps.
I-12-F	*Q: Since you possess the 'perceptual knowledge', 'professional quality', experience and skills, now do you have the confidence in your future employment?* *A:* ***No****.*	• Negative • Because the employment situation is not good • But still admit the engineering experience could help for certain profession.

		Q: why? *A: Because **the (macro) employment situation is not very good** recently.* *Q: Do you think you have any advantage (than others)?* *A: Hmmm, but everyone has the advantage. Because those who do not have engineering experience may have the theoretical advantages, the advantage in different aspects.* *Q: Nevertheless you have done the industrial practicum for a long time, do you think the company employers will appreciate your engineering experience?* *A: Hmmm, **if they need (the candidates to do) the R&D project, then engineering experience should be an advantage**.*	
	I-16-F	*Q: Do you think your previous practicum experience is helpful to your current job?* *A: **Surely helpful**. It has some helps. […] When I worked there, I learned the knowledge in this aspect.* *Q: In your previous practicum company?* *A: Right, right. And no matter doing the embedded development of dyeing machine, or doing the final project, all helped. They e**nable (me) to get start in the (real) work easily**.*	• Employed • Current work is similar to the practicum work.
Type II	I-4-F	*Q: Did they (the employer) give you something like feedback?* *A: Yes, they **asked would you like to work here future**, like this.* *Q: Through the practicum, have you increased the confidence in future employment?* *A: **Yes, I have**. And in the practicum **you must could gain lots of experience**. After all it is a real work. No matter it is successful or failed, **it is***	• Already have a possible opportunity to be employed • Positive • the practicum working experience helps

	an experience, which will be a great help to your future real job*. I think so.*	
I-17-F	*Q: Have you increased the confidence in your future employment through the practicum?* *A: Er,* ***it should be helpful to future employment****.* *Q: Why do you think it is helpful?* *A: Because* ***you get familiar with some parts of a job****. It is surely, for example, when you start to work in a post, you need something like trainings, […] but you have this practicum experience, you* ***know the operation of enterprise****.*	• Positive • The practicum working experience enables the student to be familiar to the enterprise and job
I-20-F	*Q: How do you feel (about future employment)?* *A: At least I feel* ***my job prospect has been broaden****. Previously, I only focused on the vehicle companies. However, after I went there (practicum company), I found to do the automotive parts is not bad. So I start to apply the jobs in the industry of automotive parts. […] And* ***I feel with this practicum experience, it is pretty good****. One big advantage is, compared with those without (the practicum experience), after all, I learned something there and staying the purchase department. It sounds sensitive (important department) I think [laughing].* *Q: So you think* ***your advantages come from first your practicum experience, and secondly the department you worked****.* *A:* ***Right****.* ***And the people I met there****. Maybe they have more communication with the other industrial colleagues, so I could heard more (job) information from them.*	• Positive • The practicum experience, particularly the working experience in the department which is also his aiming profession, and the social network accumulated in the practicum help • Practicum also helps the students broadened the orientation of employment
I-21-F	*Q: How do you feel? Do you have any confidence in an ideal graduate job?* *A:* ***No, not at all****.* *Q: Why?*	• Negative • Because the course itself is not very advantageous • But the student mentioned the practicum experience offered a knowledge of the possible workplace, which

		A: How to say, actually ***the X major (the student's course) is not very good****, without a high ranking nationwide. Anyway, I feel the employment … now* ***it is difficult to find a job*** *[…]* *Q: Do you think your practicum experience is helpful to your graduate job?* *A: In fact, this practicum …* ***the most direct gain is you know roughly what the scene of the future workplace looks like …*** *which is the future roughly like a … which is* ***a psychological preparation****. For an enterprise, when you apply a job, maybe* ***you could recognise whether an enterprise is good or bad. You may be more experienced, not be deluded easily****. And I can know now what is exactly I don't want. […] I want to work in a company, and I want to work in a place which is efficient even if I have to work harder, […] it (the practicum) functions in this aspect.*	could help to recognise the attribute of the enterprise. So from his view, the practicum helps to the process of employing although it is not very helpful to be employed.
	I-23-E	*A: Because it happens that there was a vacancy when (I was doing) the practicum, so* ***I stay to work here****.* ***The work responsibility is same as the practicum, which is kind of a 'seamless connection'****. […]* *Q: Generally speaking, do you think what kinds of help do your practicum have for your current job?* *A: First of all, it happens that I could stay in the practicum enterprise. It is kind of a help. […]*	• Employed • The current job is same as the practicum post.
Type III	I-1-F	*Q: Have you increased the confidence in your employment?* *A:* ***It is helpful to the employment. It surely increases the confidence****.* *Q: Through what, do you think?* *A:* ***The experience accumulated from the R&D project*** *is one point. And* ***when the employers see you have this experience, they probably think you are more reliable****.* *Q: Like you can operate those software?* *A: Yes,* ***they think you can get start (the task) directly****.*	• Positive • The experience of practicum helps the student to get start a real work sooner.

	I-9-F	*Q: […] Now do you think you have the confidence if had a job now?* *A: The job … after all, **the current situation is not very good**. These years, from the employment situation of the previous graduates, it becomes **worse and worse**. Plus my course is the material which is taught in the most universities all over the country. So **the competition is quite fierce**.*	• Negative • Because the whole situation of higher education employment is not good
	I-11-F	*Q: Based on your experience and proficient skills, do you have a confidence in your future employment?* *A: I feel employment … **it should be fine**. Comparatively speaking, **I have some confidence**.* *Q: Your confidence comes from?* *A: If say the employment, […] I think those academic Masters, they have massive modules. […] I reckon **I started to practice very early, which is better**, plus I have certain foundation. […] **I feel it is fine. Comparatively speaking, I have confidence**.*	• Positive • comparing with the research-orientated students, the students have practical experience
	I-15-F	*Q: So after you have done these, do you have a confidence in your employment?* *A: **My confidence comes from the R&D project I have done**.*	• Positive • Confidence comes from the project have done in the practicum
	I-21-F	*Q: How do you feel? Do you have any confidence in an ideal graduate job?* *A: **No, not at all**.* *Q: Why?* *A: How to say, actually **the X major (the student's course) is not very good**, without a high ranking nationwide. Anyway, I feel the employment … now **it is difficult to find a job** […]* *Q: Do you think your practicum experience is helpful to your graduate job?* *A: In fact, this practicum … **the most direct gain is you know roughly what the scene of future workplace is like ...** which is the future roughly*	• Negative • Because the course itself is not very advantageous • But the student mentioned the practicum experience offered a knowledge of the possible workplace, which could help to recognise the attribute of the enterprise. So from his view, the practicum helps to the process of employing although it is not very helpful to be employed.

		like a … which is ***a psychological preparation****. For an enterprise, when finding a job, maybe* ***you could recognise whether an enterprise is good or bad. You may be more experienced, not be deluded easily****. And I can know now what is exactly I don't want. […] I want to work in a company, and I want to work in a place which is efficient even if I have to work harder, […] it (the practicum) functions in this aspect.*	
Type IV	I-3-F	*Q: Do you have any confidence in the graduate job?* *A: Yes,* ***it should be fine****. I reckon. After all it is the Master of B university.* *Q:* ***do you know their (employer's) requirement for graduates****?* *A:* ***it's … not clear****.*	• Positive, but not very confirmed. • The student did not explain the reason why it is fine to find a job and he does not know the requirement of employer which reveals his optimism might be groundless.
	I-5-F	*Q: Have you increased the confidence in your future employment through doing the project (in the university)?* *A:* ***On the contrary****, I think my knowledge is lesser and lesser. I think if there is opportunity,* ***I am going to have a further education****.* *Q: You are not going to find a job after graduation?* *A: No […].*	• Negative • The student is aiming to have more education rather than employment after graduation.
	I-7-F	*Q: Then through the project you participated, do you have any confidence in your future employment?* *A: [He sighs].* ***It should be comparatively better to the future*** *that having the Master, and having the degree of B university. But because this year, the graduates should be the most massive than ever before.* ***The employment could not be so optimistic****. But* ***it should be fine to find a job****. It is just,* ***it is not quite sure that we can find an ideal job****. So, it is probably just we could find a job.*	• Positive, but not very confirmed. • Can find a job but not sure to find a 'good' job.
	I-8-F	*Q: Do you have any confidence on your future employment?*	• Negative, answered indirectly • Because the whole situation: more graduates than job supplied

		A: Yes, I think, in our profession, there is 'too many monks but too little porridge' (refers to the graduates are much more than the jobs supplied). It feels we should endure (to promotion). If stay in this profession, frankly speaking, what tasks you can do could be done by anyone.	
	I-13-F	*Q: Do you think what you are doing now will be helpful to your ideal jobs?* *A:* ***I think it is surely helpful. Because you do it is better than haven't done.***	• Positive and affirmative • The student did not explain the reason

Data Extracts and Codes for Interviews with Academic Staff

Interview number	Related translated excerpts from the interview transcriptions	Codes
I-18-F	*Engineering (Professional) Master's course stresses the **engineering application**, the **practical** training for students, and the training of **engineering ability and practical ability.***	Applied skills Practical skills

	*One is the **ability of engineering practice**, which is the **hands-on skills, engineering practical ability**. Because for a product, from the start which is the raw materials to an actual product, it needs not only the specialised and tough science breakthrough; it also depends on the engineering, such as the application of the (research) achievement in engineering, an integrative application. That is to say, a product involves some technologies which depends on the theoretical challenges during the R&D, but it does not mean it could be produced only as those (theoretical) challenges are resolved. There are also other technological problems in engineering need to be solved, such as the application of mechanical automation. So engineering application also includes how to actually manufacture the product in the context of our current capacity of industrialisation, but not only the (R&D). There have been actually two layers: technological layer and scientific (layer). Technological layer refers to how to realise it when theoretically you could realise. Scientific layer is that I do not consider whether it could be realised; I just find its theories and methods. But there has been still a long distance from 'finding a method' (to produce a new product) to the real product.*	• Explicitly define practical skill:
		  • hands-on skills
		• Explicitly define applied skill:
		  • apply the existing theories or methods to solve technological problems in engineering (rather than the research skills in theory or technology breakthrough)
		  • integrative application
		  • actually realise theoretical technologies, rationales, methods, and so forth, in manufactured or produced

	In automotive industry, taking the electronic vehicle or say the new energy automobile as example, actually the three key technologies of the new energy automobile, battery, electronic motor, and vehicles control have been solved already. But it does not mean we could produce the electronic vehicle. There still have been other problems, such as the lightweight structure, driving range (extend range), etc. A series of problems, like how to	An example in a certain industry to explaining the existing technologies and the problems of applying the existing technologies to achieve the engineering function

	develop them into a finished automobile, and how to design, manufacture and process a vehicle running on the real road, are still existing. All of these problems is associated to the ***practical application (of technologies)****. These problems (are existing) not because we do not possess the rationale of technologies. (The crus is) how we* ***apply the possessed technologies on the new product****, which is the abilities demanding for the Engineering (Professional) Master's students.*	or product. And defines the skills solving these problems are the objective of this course.
I-19-F	*(The Professional Master's courses in Engineering is)* ***industry-orientated or enterprise-orientated****. It more stresses the* ***ability of engineering practices*** *of students, the* ***ability of engineering problem-solving****. It is a style of postgraduate education taking the* ***ability of engineering problem-solving*** *of students as a main course aim. Well, of course, there are also research-orientated (Master's course), which is aiming at the research problem-solving.*	Industry/enterprise-orientated Engineering practices Engineering problem-solving
	Research ability actually focuses more on something like the fundamental research, such as theoretical or original (research skills). Such as in automotive, control theories and methods, […] which are pure theories. But for engineering, (required abilities refer to) for example, I ***apply some modern, comparatively mature theories, technologies and methods to solve the existing problems in engineering****. For example, from my view, in our research area of transmission, we are doing the automatic transmission. Then there are both theoretical problems and engineering problems in automatic transmission. The theoretical problems like […]. While for the* ***engineering problems****, for example, in my actual gear-shifting control, how to deal with the shock in gear shift, how to improve the dynamic response characteristic in my hydraulic system, problems like these. They are actually the engineering problems.*	Explain the engineering problem-solving skills: applying comparatively mature theories, technologies and methods to solve the existing problems in engineering.
I-22-E	*To deliver outstanding* ***engineers****. To* ***enhance the practical ability*** *of students.*	Engineers (rather than engineering researchers) Practical ability
I-24-E	*In China, the graduates delivering from some of the other higher education institutions or research institutions are 'blocked in the middle' after graduation, which means they are weak in theoretical foundation for doing research but* ***they are lack of hands-on skills for doing***	Lack of hands-on skills fulfil the authentic demands from enterprises currently in China

	engineering or technological work*. From this viewpoint,* ***the full-time engineering master's programme which stresses the engineering ability could fulfil the authentic demands from the enterprises currently in China****.*	
I-25-E	*The discipline per se requires the master's students to* ***be based on the engineering application, participate in engineering project, and complete the project meeting the demands of engineering application and taking the engineering case as verifying objective****. The delivered graduates are required to possess the theories,* ***professional knowledge and engineering consciousness****. The aim of introducing this kind of degree programme by the Ministry of Education maybe enable the graduates from universities to* ***be orientated to the engineering practice. It has a realistic context and is significant as far as it is concerned that china has been the 'manufacturing power'.***	engineering application, participate in engineering project professional knowledge and engineering consciousness engineering practice It has a realistic context and is significant as far as it is concerned that china has been the 'manufacturing power'
I-26-E	*(It aims) to deliver* ***high-level, applied and complex talents*** *in engineering or management.*	high-level, applied and complex talents

Appendix D: Document Data Examples

Data Extracts for Course Aims of the Professional and Academic Master's Courses in Five Schools

School	Full-time professional (Engineering) master's course	academic master's course
The Materials Science and Engineering School	*Possessing sound fundamental theoretical knowledge and systematic professional knowledge of materials science and engineering, being aware of the trend of development in this field, grasping advanced experimental facilities, testing methods and evaluation technology. Being orientated to the **professional demands** from economic and social industrial sections, putting emphasis on **engineering application**, possessing the research ability. Using a foreign language proficiently for academic communication in this field.*	*Possessing sound fundamental theoretical knowledge and systematic professional knowledge of materials science and engineering, being aware of the trend of development in this field, grasping advanced experimental facilities, testing methods and evaluation technology. Possessing the ability of conducting research and undertake independently the work with specialised technology. Having research output with academic significance or application value. Using a foreign language proficiently for academic communication in this field.*
School of Automation Science and Electrical Engineering	*Full-time Professional Master's Degree in Control Engineering Field is connected with the **employment qualification** in control engineering field. It delivers **applied**, inter-disciplinary and high-level graduates in engineering technology or engineering management possessing sound foundation, comprehensive qualities and strong **engineering practical ability**, and innovation ability for national economy and national defence construction. It claims to grasp the fundamental theories, advanced technique and methods, and modern technological means in control engineering field, possess the ability of conducting independently engineering design and operation, analysis and integration, research and development, and management and decision-making in this field, and **be capable of the analytical calculation, development and design, and usage and maintenance of actual control system, equipment or device**.*	*1. Meeting the demands of science and technology progress and social development; grasping sound fundamental theories and systematic specialised knowledge in the field; possessing comparatively broad knowledge and the strong ability of problem-analysing and problem-solution; possessing the ability of conducting research or undertake independently the work with specialised technology; knowing at least one foreign language.* *2. Having innovation spirit, creative ability, and entrepreneurial quality.*

School of Aeronautical Science and Engineering	*Full-time Professional Master's Degree in Aeronautical Engineering Field is connected with the* ***employment qualification*** *in aeronautical engineering field. It delivers* ***applied****, inter-disciplinary and high-level graduates in engineering and technology for national economy and national defence construction. About the aero-craft, it claims to grasp the concepts and theories of the General Design of Aero-craft, Flight Mechanics and Air Safety, Structural Strength and Structural Dynamics, Ergonomic and Environmental Engineering, Aerodynamics, Dynamics and Control; know the development frontier of this field; can* ***apply proficiently the related professional knowledge****; can undertake or conduct the project for technological breakthrough; and can solve the problem of the key technology in aero-craft development. Specification:* *1. Political allegiance, patriotism, compliance, professional ethics, rigorous and realistic, and pragmatic study attitude and work manner.* *2. Possessing sound fundamental knowledge and systemic specialised knowledge in aeronautical engineering field; being capable of doing independently the engineering design, engineering research or engineering development related to modern aero-craft design; being capable of applying advanced methods and modern technological approaches to solve engineering problems; knowing the trend of development in aeronautical field; and having the international horizon and competitiveness.* *3. Knowing a foreign language.*	*1. Political allegiance, patriotism, compliance, right morality and behaviour, honesty and trustworthiness, physical and psychological health, good research ethics and professional ethics.* *2. Meeting the demands of science and technology progress and social development; possessing sound fundamental theories and systemic specialised knowledge in aero-craft design field; having broad knowledge and strong self-study ability; possessing the knowledge about the General Design of Aero-craft, Physical Design, Aero-elasticity, Flight Mechanics and Air Safety; being capable of conducting research or undertake independently the work with specialised technology; knowing a foreign language; delivering research-orientated high-level and inter-disciplinary specialists in engineering and technology with international horizon and competiveness in aeronautical engineering field.* *3. Having innovation spirit, creative ability, and entrepreneurial quality.*
School of Mechanical Engineering and Automation	*Full-time Professional Master's Degree in Mechanical Engineering Field is aimed to deliver high-level,* ***applied*** *and inter-disciplinary specialists in engineering and management for national key designer or* ***manufactories*** *or other organisations. The Degree possessor should grasp necessary fundamental theories and specialised knowledge in mechanical engineering field, know comprehensively the advanced technology and development trend in this field, have strong research and development skills and problem-solving ability of key engineering and technology related to this field, have innovative spirit, entrepreneurial quality and leadership, and know a foreign language.*	*The course including multiple disciplines is aimed to deliver high-level specialists in research, development or management for higher education institutions, research institutes or national key manufactories. The Degree possessor should grasp sound fundamental theories and systemic specialised knowledge in the field of machine science and manufacturing engineering, know in depth the advanced technology and development trend in this field, be capable of doing research or undertake independently the work with specialised technologies, can solve the theoretical problems or engineering and technological problems related to*

		this field, have innovation spirit, creative ability, entrepreneurial quality, international horizon and leadership, and know a foreign language.
School of Transportation Science and Engineering	*Full-time Professional Master's Degree in Transportation Engineering Field and Vehicle Engineering Field is associated with transportation and vehicle engineering technology field. It delivers high-level, **applied** and inter-disciplinary specialists in engineering and management for enterprise and public institution in transportation or automotive **industry**. The education process of course **meets the demands from the transportation and automotive industry** which are developing rapidly in the country, and is orientated towards the **engineering practices**, and emphasis on the **practicability and applicability**. The graduates will be the high-ranking engineering specialists or engineering management specialists possessing the research and development skills or the ability of undertaking the work with specialised engineering and technologies.* *Specifications:* *1. Political allegiance, patriotism, compliance, right morality and behaviour, honesty and trustworthiness, physical and psychological health, good research ethics and professional ethics.* *2. Possessing the **professional ability and attainments requested in the industry**, knowing the history, state quo and trend of development of this field; being able to **apply existing theories, knowledge and technologies** in this field to do effectively engineering design, engineering implementation, engineering research, engineering development, and engineering management; **solving professional problems** properly; and having rigorous and pragmatic research attitude and manner.* *3. Possessing the ability of conducting independently the work about engineering and technology and research; having rigorous and pragmatic research attitude and manner; having the spirit and ability of originality; and making contribution with practical value or high academic standards in specialised engineering and technology field.* *4. Mastering proficiently a foreign language; and possessing the writing ability and international academic communication ability.*	*1. the academic leader or industrial leader with the political allegiance, patriotism, compliance, right morality and behaviour, honesty and trustworthiness, physical and psychological health, good research ethics and professional ethics, the spirit and ability of originality.* *2. Possessing sound fundamental theories and systemic specialised knowledge in this field; knowing the history, state quo and trend of development of this field; grasping advanced theories, technologies and experimental research methods in this field; and having rigorous and pragmatic research attitude and manner.* *3. Possessing the ability of conducting research or undertaking independently the work with specialised technologies; having rigorous and pragmatic research attitude and manner; having the spirit and ability of originality; and making contribution with practical value or high academic standards in research or specialised technological aspects.* *4. Mastering proficiently a foreign language; and possessing the writing ability and international academic communication ability.*

Samples of Job Advertisements

Two samples of job advertisements collected are translated by the author and showed below.

Sample One

Company name: Commercial Aircraft Corporation of China

Division: Research division of overall aerodynamic design

Post name: C919 model operational stability Designer

Job responsibilities:

1. *Involve in making the design requirements of the manoeuvrability and stability of C919 aircraft*
2. *participate in the confirmation and validation of operation stability design requirements*
3. *Participate in the decomposition and implementation of operating stability design requirements*
4. *responsible for the computational evaluation of operating stability design*
5. *responsible for the safety assessment of the system in normal and fault conditions*
6. *Responsible for the computational evaluation of operating stability design in freezing condition, and so forth.*
7. *Participate in establishing high precision aircraft simulation model*
8. *Participate in quality assessment test flight*
9. *Involve in making the C919 aircraft operating stability test requirements*
10. *Participate in the airworthiness verification work in the operation stability profession*

Requirements:

1. *Master's Degree or above, the professional background knowledge of flight mechanics and flight control, experience in project is desired*
2. *proficient in Matlab and Simulink, familiar with operating stability design and evaluation processes*

3. *good communication skills, strong ability of organisation and coordination, proficient English skills*
4. *Strictly abide by the work ethic, proactive to complete work, optimise the tasks, improve work efficiency, responsibility and accountability, team spirit*

Sample Two

Company name: Delphi Shanghai Dynamics and Propulsion Systems Co., Ltd.

Division: Powertrain

Post name: Powertrain Electronics System Engineer

Job responsibilities:

- *Work independently to plan and lead OEM customer interfacing in the product design project*
- *Collect and analyse customers' (OEMs) system requirement for the ECM requirement definition*
- *Create product (ECM) /system functional and performance specification document*
- *Verify product function and performance against the specification on the bench and in vehicle*
- *New EMS logic development and implementation*
- *Follow system engineering process and product release procedures*
- *Support customer return parts analysis and system problem-solving*
- *Maintain the relation with OEM customers*

Requirements:

- *Master's degree in Mechanical Engineering & Automation/Dynamic Machinery and Engineering/Automobile Engineering (Internal Combustion Engine)*
- *Thorough knowledge and understanding of single-chip system development, including software and hardware*
- *Good understanding and/or knowledge of automotive electronics or internal combustion engine control*
- *Proficient in English reading and writing. Good at speaking*
- *Systematic skills for problem-solving*
- *Good communication skills with customers and peer staff*
- *Willing to learn, teamwork, responsibility and accountability*

Excerpts from Government Documents

The following paragraphs are excerpted from《教育部关于做好全日制硕士专业学位研究生培养工作的若干意见》 (*jiao yu bu guan yu zuo hao quan ri zhi shuo shi zhuan ye xue wei yan jiu sheng pei yang gong zuo de ruo gan yi jian*) [The Ministry of Education Guidance Suggestions about Full-time Professional Master's Programme Education]. The texts are translated by the author.

> *(I) Introducing the full-time professional master's degree education because that the postgraduate education should actively adapt to the demands for high level applied specialists in economic and social development.*
>
> *At present, science and technology are making great advances. New knowledge, new theories, and new technology are on the fast increase. The area division of professions are becoming increasingly detailed. The technologies and the professionalisation involved a profession is on the increase. The specialists are demanded in large number, multiple qualifications, and high level. The higher education sectors all over the world take some initiatives to adapt to this change, by revising the objectives and study modes, in order to enhance the adaptability and competitiveness of the specialist delivery. In recent years, with the rapid development of the economy and society in our country, a large number of high-level specialists with innovative capacity, entrepreneurial skills, and practical abilities have become an urgent requirement. Therefore, postgraduate education must be enhanced to serve national and social development needs, speed up adjustment, deliver more applied specialists, and closely link the specialist delivery with the actual demands of economic and social development.*
>
> *(II) Introducing the full-time professional master's degree education aims to meet the demands of the reforms and development of postgraduate education.*
>
> *By thirty-year development in our country, the magnitude of postgraduate education has been expanded, the quality has been improved, and the overall strength has been enhanced. A degree authorisation system was established, with relatively complete disciplines and a proper structure. The postgraduate education system, with unique features and quality guarantee, has been formed. For a long time, postgraduate education in our country delivered mainly*

academic specialists able to research and teach independently. However, as postgraduate education is expanding and social demands are changing, more postgraduates have been employed in the practical industries rather than taking up teaching or research posts at universities. With respect to the postgraduate education development all over the world, master's education basically aims to practical application, while the teaching and research specialists are derived from doctoral students more. To improve our postgraduate education, we have to review and re-orientate our postgraduate education aims, and adjust and optimise the types and structures of programmes, to gradually switch from delivering academic specialists to delivering applied specialists, for the coordinated and sustainable development of postgraduate education in magnitude, quality, structure, and efficiency.

(III) Introducing the full-time professional master's degree education is to meet the demands of improving the professional education institution.

Our country started to carry out the professional education since 1991. The types of programmes have been constantly increased; the magnitude has been expanded; and its social influence has been enhanced. Professional education plays an important role in delivering high-level applied specialists. It has been an important component of postgraduate education. Professional education should admit not only the on-the-job students with employment experience, to fulfil their needs: professional development and on-the-job training, but also admit fresh graduates, to meet their needs: to adapt social development, to improve professional competency, and to enhance employment competition. For different students, the study mode can be full-time or part-time. In our current professional education, part-time on-the-job students dominate, while full-time students without work experience are fewer. The current professional education does not reflect the status and role of full-time postgraduate education fully. Introducing full-time professional master's degree education orientated to mainly fresh graduates is significant, for improving professional education system, enhancing the capacity to deliver postgraduates with professional degrees, and meeting the multiple demands of society.

Appendix E: Research Ethics Approval

Information Sheet to Participants

Information Sheet to Participants

- This research is conducted by Xunzhe Zhang, who is a PhD student in the School of Education, The University of Nottingham, and supervised by Professor W. John Morgan, who is affiliated to the same organisations. It aims to explore the relation between knowledge, higher education and human capital by examining a case of new professional master's programme in China. This fieldwork by which the qualitative data will be generated is a key part of the research. The findings and conclusion will be achieved based on the data.
- The participant is requested to have a face-to-face interview with the investigator (Xunzhe Zhang). During the interview, the investigator will ask some questions to the participant, and the participant could answer them by stating perception or narrating individual experience. The interview will be recorded by a digital voice recorder. The interview roughly needs one hour. The specific time and location will be negotiated between the investigator and participant.
- The participant will be asked to give a written consent to participating in the research, and, where consent is given, separate copies of this will be retained by both researcher and participant.
- This research abides by the principle of confidentiality and security strictly. This research does not involve any personal information (e.g. gender or age) about the participants. For addressing research questions, the information gathered may cover the individual's employing/research background (for the academic staff and the employers from industries, e.g. the job position, the research supervision area, the related co-operating research project), or the education background (for students, e.g. grade, research area). All the participants are anonymous, and they will not be identifiable in any published material. The research information and data will be used for the PhD research. The original data (in the audio file) and

its transcripts (in electronic copy) will be stored appropriately in researcher's computer. No-one other than the researcher, supervisors or examiners will have access to the data.

- The participation in the research is completely voluntary. The participants are at liberty to withdraw at any time without prejudice or negative consequences.
- There has been no risk and harm at all in participating this research. This research will enrich the theories of higher education and particularly will offer a theoretical underpinning to the similar educational practices. Therefore, all the participants make a significant contribution to this research as well as to the higher education theories and development.
- For the participant requiring further information, the contact details of the investigator: Miss Xunzhe Zhang e: ttxxz4@nottingham.ac.uk; and her supervisor: Professor W. John Morgan e: john.morgan@nottingham.ac.uk
- If the participants wish to make a complaint on ethical grounds, please contact the Research Ethics Coordinator of the School of Education of The University of Nottingham: Email enquiries: educationresearchethics@nottingham.ac.uk

Participant Consent Form

Participant Consent Form

Project title: Labour Market, Industry and Postgraduate Programme: A Case Study on China's Postgraduate Education Reform
Researcher: Xunzhe Zhang
Supervisor: Professor W. John Morgan

- I have read the Participant Information Sheet, and the nature and purpose of the research project have been explained to me. I understand and agree to take part.
- I understand the purpose of the research project and my involvement in it.
- I understand that I may withdraw from the research project at any stage and that this will not affect my status now or in the future.
- I understand that while information gained during the study may be published, I will not be identified, and my personal results will remain confidential.
- I understand that the interview will be recorded.
- I understand that the original data (audio file) and its transcripts (electronic copy) will be stored appropriately in researcher's computer, and only the researcher, supervisor and examiner could access the data.
- I understand that I may contact the researcher or supervisor if I require further information about the research and that I may contact the Research Ethics Coordinator of the School of Education, University of Nottingham, if I wish to make a complaint relating to my involvement in the research.

Signed……………… (research participant) **Print name**……………………

Date…………………… **Contact details:**

Researcher: Miss Xunzhe Zhang e: ttxxz4@nottingham.ac.uk
Supervisor: Professor W. John Morgan e: john.morgan@nottingham.ac.uk
School of Education Research Ethics Coordinator:
educationresearchethics@nottingham.ac.uk

Research Ethics Approval Form

2014/11/JG

The University of Nottingham

School of Education – Research Ethics Approval Form

Name Xunzhe Zhang
Main Supervisor W John Morgan
Course of Study PhD
Title of Research Project: Labour market, industry and the postgraduate programnme: a case study on China's Postgraduate Education Reform
Is this a resubmission? No **Date statement of research ethics received by PGR Office:** 22/04/14

Research Ethics Coordinator Comments:

I have seen all the documents accompanying this submission and I am satisfied they meet the requirements for ethics approval.

I consider this research to be above minimum risk ☐

Final responsibility for ethical conduct of your research rests with you and your supervisor. The Codes of Practice setting out these responsibilities have been published by the British Educational Research Association (BERA) and the University Research Ethics Committee. http://www/educationstudentintranet/researchethics/index.aspx http://www.bera.ac.uk/publications/Ethical%20Guidelines *If you have any concerns during the conduct of your research then you should consult those Codes of Practice and refer again to the School of Education's Research Ethics Committee.*

Independently of the Ethics Committee procedures, supervisors also have responsibilities for the risk assessment of projects as detailed in the safety pages of the University web site. Ethics Committee approval does not alter, replace, or remove those responsibilities, nor does it certify that they have been met.

Outcome:
Approved √ Revise and Resubmit ☐

Signed: Name: Dr J. Gimenez (Research Ethics Coordinator) Date: 07.05.2014