Enhancing Australian Universities’ Research Commercialisation Performance

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

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June 2008
DECLARATION BY CANDIDATE

In respect of this, my thesis, I declare as follows:

(a) except where due acknowledgement has been made, this work is mine alone;
(b) this work has not been submitted previously, in whole or in part, to qualify for any other academic award;
(c) the content of this thesis is the result of work which has been carried out since the official commencement date of my approved research program;
(d) editorial work, paid or unpaid, carried out by a third party is acknowledged; and
(e) ethics procedures and guidelines approved by the university for my project have been followed.

........................................ Date:  
Alan James Collier
ACKNOWLEDGEMENTS

This work would not have been possible without the encouragement, forbearance and assistance I have received from many people. First and foremost I must acknowledge the love and encouragement of my wonderful wife, Berna, and the forbearance of my children, Hilary, Nicholas and Alexander. Dr Fang Zhao, my supervisor has known what to say on what occasion to prompt and encourage me, and her guidance has been invaluable. Early assistance and wise counsel from my second supervisor, Professor John Dalrymple, was greatly appreciated. RMIT has been especially good to my wife and me, and it will always have a special place in our affection.

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This work has been principally based on the use of case study method. Without the kindness shown by all the people who participated in interviews for my work it would never have been possible. These kind individuals have come from universities and industry in Australia, the US, Canada, New Zealand and the UK. A number of friends have resulted from this work.

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SUMMARY

The Australian Government provides research funding to universities exceeding $3.4 billion per annum. Over 95% of the knowledge produced by universities goes freely into the intellectual commons to be used by anyone. The relatively small balance of knowledge produced by universities is sold, or commercialised, mainly in the forms of consulting, conducting sponsored research, licensing know-how to industry, and through companies spun-out of universities. Knowledge commercialisation occurs most frequently in the fields of life sciences, information and communications technology, and physical sciences.

The practice of selling some of the knowledge produced by universities is a phenomenon now adopted in most advanced economies. World leaders in technology transfer and commercialisation (TT&C) are generally found among North American universities. But even there, it is only a relatively small group of universities – possibly no more than fifty – that is doing it well, and a mere handful of stand-out performers. Most universities in North America and elsewhere that participate in TT&C do not make a profit on the activity. Even the best performing universities typically do not generate more than 3% of a university’s annual research budget.

The Australian Government expects universities to engage in TT&C and almost all universities have established a technology transfer office (TTO) for this purpose. University TTOs go by many names and employ anywhere between one-half and more than seventy staff. Australian university TTOs have existed since the 1950s, but it is only since the mid-1990s that they have started to develop in most universities.

Generally, technology transfer is done by universities without any ambition to be profitable, rather to meet part of their obligation to disseminate knowledge widely for the benefit of the community. Commercialisation, on the other hand, has financial overtones and brings with it an expectation that it is done for profit. These mixed objectives are one of the ambiguities that permeate the field of TT&C.

A survey of the literature in this field disclosed that while there had been a great deal of valuable research completed on universities and their interaction with industry, there remained value in attempting to develop an understanding of the whole environment, in particular, why only some universities apparently exhibit superior TT&C performance, and what characteristics those universities possess.
The primary aim of this research was to identify what would enhance the overall performance of Australian universities in research commercialisation and industry uptake of the university research commercialisation outcomes. Four research questions were enunciated:

1. What are the systemic barriers to research commercialisation within Australian universities?
2. How could Australian universities overcome the systemic barriers to the commercialisation of university research?
3. How, in particular, could Australian smaller and regional universities enhance their research commercialisation capacity and performance?
4. How could the uptake by industry of Australian university research outcomes be improved?

Question 1 was answered using a qualitative content analysis on the substantial body of publications available. It identified thirteen issues that result in systemic barriers to TT&C among Australian universities. The most important of these involved linkages and relationships between researchers, industry and financiers, while the balance of twelve issues included some that are within the control of individual universities (such as policies and procedures), some that are within the purview of government (such as intellectual property and fiscal regimes), some pertinent to industry (industry depth and ability to absorb university research), through to some that may be described as cultural (the propensity of academic faculty to undertake TT&C).

Questions 2 and 3 were answered using multiple-case analysis involving eight Australian university case studies and comparing Australian university practice with five benchmark universities – two from the US, two from Canada, and one from New Zealand. By using multiple-case analysis and comparison with the benchmark universities two major conclusions were drawn.

The first major conclusion was that there are three essential criteria upon which university TT&C success is built: institutional and senior executive support for TT&C; superior TTO management; and sufficient world-class research being conducted. First, the university government and senior executives must demonstrate genuine support for TT&C over a period of years, supply the resources needed for success, and permit TTO management to develop and undertake long-term plans. Second, leadership of the TTO provides the vital

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1 The term TT&C is used in this thesis as the generic term for activities undertaken in technology transfer and commercialisation at universities, although the term ‘commercialisation’ is understood in many jurisdictions as the collective term. While technology transfer and commercialisation have slightly different meanings, ‘commercialisation’ is used occasionally in this thesis as the collective term (including in the thesis title) where no confusion should arise through its common meaning.
element in a successful enterprise. The TTO Director has to possess a unique combination of attributes that permits him or her to work in this most unusual enterprise: the ability to meld a team of highly intelligent individuals; the ability to work within the arcane structure of a university; the ability to work with a range of technologies that usually have vastly different profiles; and the inspiration to identify real commercial deals and the tenacity to see them through to completion. They also have to train researchers in commercialisation, and manage and grow a complex business in an environment that is immature and changing with amazing rapidity. The third criterion for TT&C success is the existence of world-class research at a university – the quantum of research does not appear to be important.

The second major conclusion was that the same key criteria for success in TT&C apply across the board, whether a university is smaller, regional, technical, new or old, research-intensive or otherwise. There may be more challenges facing smaller and regional universities but, if the essential criteria for TT&C success are in place, these challenges can be overcome. It was also found that regional universities, in particular, are more likely to engage in commercialisation through consulting and contract research than intellectual property licensing and technology company start-ups.

Question 4 (dealing with the uptake of university research by industry) was answered using case studies developed on five SME companies in the electronics industry in one Australian State and comparing these results with the outcome of a narrative review conducted on the literature. This allowed the primary data to be compared and thus triangulated against a second body of information. The relatively small number and type of companies involved in the case studies commends caution in relation to the generalisability of the conclusions drawn from the analysis. The most important conclusion from the data was that personal relationships are the most important element in TT&C as it concerns SMEs. This means that opportunities for personal interaction between researchers and industry should be encouraged regularly and deeply. While TTOs generally concentrate on four modes of interaction with industry: consulting, contract research, intellectual property licensing and spin-off companies (and many only the latter two), there is a much richer engagement with industry going on. This means that the TTO is not and never should be the sole interface with industry.

Regional and smaller universities are as likely to be involved in the rich interaction with high-technology industry as metropolitan universities. The data suggested that industry seeks from universities the best professors wherever they are located. This means that the task for both regional and smaller universities is to attract the best researchers in fields where these universities wish to excel. The challenge for regional universities may be in attracting the
best researchers to regional areas, and for smaller universities with lower research budgets to attract leading researchers.

The principal role of government, after constructing a workable common infrastructure\(^2\), is to encourage the participation of private capital in early-stage funding. An expanding role for intermediaries to link universities with industry was also identified.

In some important respects the results of this research are at variance with aspects of the literature, in particular the relative unimportance of many factors often believed to be important in university TT&C: academic faculty rewards; clustering; technology parks and incubators; and co-operative research centres. At the same time, it has found that factors such as university-industry linkages (often cited as the most important issue) are, indeed, important, along with culture and the need for translational development capital\(^3\). The research also highlights the need to understand and accept that different approaches to TT&C will be needed among different universities which reflect their respective different cultures, research profiles and experience. It also may be this fact of situational evolution that explains why this research has found Australian universities have their own set of challenges that, in some respects, are at variance with the literature.

The research has identified some areas for future research including the role that intermediaries linking universities and industry could play, the real effect, if any, that TT&C plays in academic promotion, the use made by Australian faculty members of time allocated in their staff agreements for TT&C-related work, the potential role that State governments (in particular) could play in linking universities and industry through their respective state development agencies, and undertaking a study of the particular skills and personal characteristics possessed and needed by Directors of successful TTOs. Research into university TT&C is a field replete with the need for investigators to work, as far as possible, across many disciplines including management, economics, government policy, education, law, and technology, and constitutes an excellent example of cross-disciplinary academic research.

\(^2\) Common infrastructure includes such factors as: investment in basic research; tax policies affecting corporate R&D and investment spending; supply of risk capital; aggregate level of education in the population; pool of talent in science and technology; information and communication infrastructure; protection of intellectual property; openness to international trade and investment; and overall sophistication of demand.

\(^3\) The term ‘translational development’ appears to be entering the TT&C lexicon to supplement (or replace) terms that include ‘pre-seed capital’, ‘seed capital’ and similar expressions, which have proven inexact and confusing.
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<tr>
<td>AAU</td>
<td>American Association of Universities</td>
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<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
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<td>AASCU</td>
<td>American Association of State Colleges and Universities</td>
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<td>ACST</td>
<td>(Canadian) Advisory Council on Science and Technology</td>
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<td>AIC</td>
<td>Australian Institute for Commercialisation</td>
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<td>AIM</td>
<td>(UK) Alternative Investment Market</td>
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<td>AIMS</td>
<td>Australian Institute of Marine Science</td>
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<td>ANSTO</td>
<td>Australian Nuclear Science and Technology Organisation</td>
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<td>ANU</td>
<td>Australian National University</td>
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<td>ARC</td>
<td>Australian Research Council</td>
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<td>ASRC</td>
<td>Australian Standard Research Classification</td>
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<td>ATN</td>
<td>Australian Technology Network</td>
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<td>ATNF</td>
<td>Australia Telescope National Facility</td>
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<td>AUCC</td>
<td>Association of Universities and Colleges of Canada</td>
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<tr>
<td>AUTM</td>
<td>The Association of University Technology Managers (US)</td>
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<td>AVCAL</td>
<td>Australian Private Equity and Venture Capital Association</td>
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<td>AVCC</td>
<td>Australian Vice-Chancellors’ Committee. Since 2007: Universities Australia</td>
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<td>BIHECC</td>
<td>Business, Industry and Higher Education Collaboration Council</td>
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<td>BMI</td>
<td>Battelle Memorial Institute</td>
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<td>CFI</td>
<td>Canada Foundation for Innovation</td>
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<td>Chief Technical Officer</td>
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<td>Commercialisation Training Scheme</td>
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<td>(Australian) Department of Communications, Information Technology and the Arts</td>
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<td>(Australian) Department of Education, Science and Training</td>
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<td>DETYA</td>
<td>(Australian) Department of Education, Training and Youth Affairs</td>
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<td>DISR</td>
<td>(Australian) Department of Industry, Science and Resources</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>DoE</td>
<td>(US) Department of Energy</td>
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<tr>
<td>DITR</td>
<td>(Australian) Department of Industry, Tourism and Resources</td>
</tr>
<tr>
<td>DSTO</td>
<td>Defence Science and Technology Organisation</td>
</tr>
<tr>
<td>DVC</td>
<td>Deputy Vice-Chancellor</td>
</tr>
<tr>
<td>EFTSU</td>
<td>Equivalent Full-Time Student Units</td>
</tr>
<tr>
<td>EMBA</td>
<td>Executive Master of Business Administration</td>
</tr>
<tr>
<td>ERISA</td>
<td>Employee Retirement Income Security Act 1974 (US)</td>
</tr>
<tr>
<td>ESE</td>
<td>Early Stage Enterprise</td>
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<tr>
<td>ESOP</td>
<td>Executive Share Option Plan</td>
</tr>
<tr>
<td>FLC</td>
<td>(US) Federal Laboratories Consortium</td>
</tr>
<tr>
<td>FOBO</td>
<td>Front Office/Back Office</td>
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<tr>
<td>FTE</td>
<td>Full Time Equivalent</td>
</tr>
<tr>
<td>Go8</td>
<td>Group of 8 Australian research-intensive universities</td>
</tr>
<tr>
<td>HASS</td>
<td>Humanities, Arts and Social Sciences</td>
</tr>
<tr>
<td>HEFCE</td>
<td>Higher Education Funding Council for England</td>
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<tr>
<td>HEI</td>
<td>Higher Education Institution</td>
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<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
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<tr>
<td>IP</td>
<td>Intellectual Property</td>
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<td>IPO</td>
<td>Initial Public Offering</td>
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<tr>
<td>IPRIA</td>
<td>Intellectual Property Research Institute of Australia</td>
</tr>
<tr>
<td>IRU</td>
<td>Innovative Research Universities – a group of Australian universities comprising: Flinders University, Griffith University, LaTrobe University, Macquarie University, Murdoch University and the University of Newcastle.</td>
</tr>
<tr>
<td>ISIG</td>
<td>Innovation Summit Implementation Group</td>
</tr>
<tr>
<td>IUCRC</td>
<td>(US) Industry/University Co-operative Research Centres</td>
</tr>
<tr>
<td>KCA</td>
<td>Knowledge Commercialisation Association (formerly the Australian Tertiary Institutions Commercial Companies Association, ATICCA)</td>
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<tr>
<td>LOA</td>
<td>Licences, Options and Agreements</td>
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<tr>
<td>MIC</td>
<td>Management &amp; Investment Companies</td>
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<tr>
<td>MIT</td>
<td>Massachusetts Institute of Technology</td>
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<tr>
<td>NASULGC</td>
<td>(US) National Association of State Universities and Land Grant Colleges</td>
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<tr>
<td>NCE</td>
<td>(Canadian) Networks of Centres of Excellence</td>
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<tr>
<td>NHMRC</td>
<td>(Australian) National Health and Medical Research Council</td>
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<tr>
<td>NIH</td>
<td>(US) National Institutes for Health</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>NIS</td>
<td>National Innovation System</td>
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<td>NSF</td>
<td>(US) National Science Foundation</td>
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<td>NTTC</td>
<td>(US) National Technology Transfer Center</td>
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<tr>
<td>OED</td>
<td>Oxford English Dictionary</td>
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<tr>
<td>OTL</td>
<td>Office of Technology Licensing</td>
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<tr>
<td>OST</td>
<td>(UK) Office of Science and Technology</td>
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<td>OTD</td>
<td>Office of Technology Development</td>
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<td>OTT</td>
<td>Office of Technology Transfer</td>
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<td>PDF</td>
<td>Pooled Development Fund</td>
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<td>PDP</td>
<td>Prototype Development Program</td>
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<tr>
<td>PFRO</td>
<td>Publicly Funded Research Organisation</td>
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<tr>
<td>QIDS</td>
<td>Queensland Industry Development Scheme</td>
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<td>RQF</td>
<td>Research Quality Framework</td>
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<td>RRDC</td>
<td>Rural Research and Development Corporation</td>
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<td>SBA</td>
<td>(US) Small Business Administration</td>
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<td>SBC</td>
<td>Small Business Concerns</td>
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<td>SBIR</td>
<td>(US) Small Business Innovation Research Program</td>
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<tr>
<td>SBRI</td>
<td>(UK) Small Business Research Initiative</td>
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<tr>
<td>SME</td>
<td>Small and Medium Enterprises</td>
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<td>SPRU</td>
<td>(UK) Science and Technology Policy Research Unit</td>
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<tr>
<td>TLO</td>
<td>Technology Licensing Office</td>
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<tr>
<td>TT&amp;C</td>
<td>Technology Transfer and Commercialisation</td>
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<tr>
<td>TTO</td>
<td>Technology Transfer Office</td>
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<tr>
<td>UBC</td>
<td>University of British Columbia</td>
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<tr>
<td>UILO</td>
<td>University-Industry Liaison Office</td>
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<tr>
<td>Unico</td>
<td>(UK) University Companies Association</td>
</tr>
<tr>
<td>USPTO</td>
<td>United States Patent and Trade Mark Office</td>
</tr>
<tr>
<td>VC</td>
<td>Venture Capitalist</td>
</tr>
<tr>
<td>VP(R)</td>
<td>Vice-President (Research)</td>
</tr>
<tr>
<td>WARF</td>
<td>Wisconsin Alumni Research Foundation</td>
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All currencies referred to in this thesis are expressed in the local currency. For example, when there is a reference to the US, the currency referred to is USD; when referring to Australia it is AUD; Canada CAD and so on.
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<td>Research-intensive university</td>
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<td>Newer innovative university</td>
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PART I - INTRODUCTION

1 Introduction

1.1 Background

Part I of this thesis introduces and provides some background to the topic, describes the need for and purpose of the research, describes research commercialisation, and gives an outline of the thesis structure.

There appears to be an implicit assumption within most of the literature and scholarship on the topic of university technology transfer and commercialisation (which have different meanings, despite their often being used interchangeably) that it is both a necessary and good thing. Underlying the need for a specific discipline involving technology transfer and commercialisation (hereafter TT&C\(^4\)) must be the desire to meet some need or satisfy some condition, or to avoid some adverse or undesirable consequence.

As long as they have existed, universities have been a source of ideas that have effected the transformation of society\(^5\). They have done this through a number of mechanisms, the most obvious being the training of minds. The invention of printing gave an ability to reach a greater audience and exert greater influence than previously, allowing ideas to flow faster and more widely than ever before. This technique of dissemination of ideas, an early manifestation of TT&C, has reached its present apogee in the broad spectrum of journals and similar written material published in paper and electronic form. Journals and the like are still arguably the most potent means of disseminating ideas and are used by academics and industry as a major medium for maintaining currency in ideas and technology. Publications by academics also form a key metric when it comes to assessing their academic standing, eminence and suitability for promotion.

During the twentieth century, in particular, a nascent movement emerged, largely from the United States, that introduced a new medium by which ideas could be disseminated from universities (and other laboratories, although these are not considered here in depth), the

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\(^4\) The term Technology Transfer & Commercialisation (TT&C) is used for the first time noticed by the author in Cripps, et al. (1999). This term conveys the two components of university commercialisation recognisable in all jurisdictions and is used here because it best conveys the extent of the topic. The term ‘research commercialisation’, nonetheless, remains in common usage and is retained in the project title and elsewhere in this thesis for this reason.

\(^5\) Mansfield (1986) found that as many as 10% of new products and processes commercialised in the US in the period 1975-1985 in advanced technology could not have been developed without substantial delay but for academic research. In some important areas, such as pharmaceuticals, the percentage was much higher.
technology transfer office (TTO), although this specific name was adopted at a later time. Probably the earliest identifiable TTO was established by some inspired individuals in Wisconsin who established the Wisconsin Alumni Research Foundation (WARF), now the envy of many American universities, as a result of pioneering work by Professor Harry Steenbock in using ultra-violet light to fortify food and other organic materials with Vitamin D. This idea of a university having some entity dedicated to the dissemination of ideas arising from research did not become commonplace rapidly, rather the prospect of improving the propagation of ideas from universities to the community for the common good through a separate entity established for this purpose grew slowly.

In the United States some prescient individuals could see that providing universities with support in their task of disseminating ideas was necessary if maximum effect was to be achieved. One of the most notable in the United States was a Professor at the Harvard Business School, Georges Doriot (Gupta 2004) who was responsible for bringing many inventions from universities to industry and thence the community, and for training several generations of technology entrepreneurs. But still the number of university TTOs grew slowly until, in the United States, there was a seminal event, the passage by Congress of the Bayh-Dole Act6. From having no more than twenty-one university TTOs in the United States before the passage of the Bayh-Dole Act in 1980, it had grown to over 150 by 2005 (AUTM 2007b). The idea of university TTOs has been replicated in every advanced economy, and it is likely that a majority of universities in advanced economies now have a TTO or some equivalent.

The purpose and effect of a TTO may be a matter of perspective. The current tasks being undertaken by university TTOs have been described as embracing three principal elements: economic development7; innovation; and ‘grand challenges’ (US Strategist Interview 2007). Most university research funding comes from government, and government can see the economic potential that could be derived from TT&C, such as economic growth and jobs – and if these jobs are in regional areas, all the better. Second, there is a national expectation and demand for innovation and competitiveness in which universities have a pivotal role. Third, “[the] grand challenges that our country face are everything from homeland security, energy, health, water. These are big, grand, challenges. And therefore, what we are looking for is ‘best minds’, in partnership” (US Strategist Interview 2007).

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7 The role of the university as an engine of economic development has, of course, been commented upon earlier by scholars such as Etzkowitz (1998).
Three of the most prominent and effective TTOs in the United States see their role in undertaking TT&C as:

- “Moving inventions arising from the university’s laboratories to the marketplace for the benefit of the university, the inventors and society; and carefully managing an endowment that WARF has grown since its inception” (WARF)\(^8\)

- “The mission of Stanford University's Office of Technology Licensing (OTL) is to promote the transfer of Stanford technology for society’s use and benefit while generating unrestricted income to support research and education” (Stanford)\(^9\)

- “To foster commercial investment in the development of inventions and discoveries flowing from the research at the Massachusetts Institute of Technology, Lincoln Laboratory, the Broad Institute and the Whitehead Institute. We do this through licensing of the intellectual property resulting from our research” (MIT)\(^10\)

One of these universities is public (Wisconsin) and two private, but their common enunciated mission involves two essential components: to disseminate university technology to the community, and to make money in the process. The three elements identified above (economic development, innovation, grand challenges) will be met by being either an incident of the activity (economic development), by being granted sufficient research funding (creating the innovations), or by being granted sufficient government funding (the grand challenges).

This makes an interesting juxtaposition with views endorsed by the Association of University Technology Managers (AUTM), when it noted with approval comments by University of Michigan President Mary Sue Coleman when she said in 2005 (AUTM 2005, p.iii):

> “Many people are often confused about why we are interested in technology commercialization, in nurturing startup companies, and in facilitating more patents and license agreements. It is not about the promise of future revenues that might be generated from this activity...It is not about the money. ... Technology transfer must serve our core mission: sharing ideas and innovations in the service of society’s well-being”.

These apparently divergent views on the reasons for undertaking TT&C, on the one hand to benefit the community while, on the other, making money, and the several agendas to which it must respond: economic development, innovation and grand challenges, make this topic a particular challenge. In order to answer the principal research question one has, first, to define the topic under analysis: how do technology transfer and commercialisation differ? And what do they mean? Do they mean both making money and benefiting society, and

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*\(^8\)* WARF mission enunciated on its website: [http://www.warf.org/about/index.jsp?cid=6](http://www.warf.org/about/index.jsp?cid=6)


something else as well? In this case, how is it achieved? This is probably why Bozeman (2000, p.627) said:

“In the study of technology transfer, the neophyte and the veteran researcher are easily distinguished. The neophyte is the one who is not confused. Anyone studying technology transfer understands just how complicated it can be. First, putting a boundary on ‘the technology’ is not so easy. Second, outlining the technology transfer process is virtually impossible because there are so many concurrent processes. Third, measuring the impacts of transferred technology challenges scholars and evaluators, requiring them to reach deep down into their research technique kit bag”.

Commercialisation is an activity fraught with risk and uncertainty. As Reamer, et al. (2003, p.39) stated:

“Commercialization is the process of transforming technology into economically successful products. Several key points … about the technology commercialization process bear repeating:

- Commercialization is a costly, lengthy process with a highly uncertain outcome. On average, the costs of commercialization run from between 10 and 100 times the costs of research, development, and demonstration of the new technology.
- Success is rare - less than five percent of new ideas are successfully commercialized.11
- Even when successful, commercialization does not happen quickly. On average, the commercialization of university research takes over six years, and that of radically new technologies far longer.
- The direct economic benefits of commercialization are likely to be geographically dispersed. Manufacturing and distribution sites are often in different states, or countries, from the site of technology development. However, at the original site, successful commercialization can have a clustering effect, attracting additional technology development and commercialization activity”.

The same general view is put by Australian Government agency, the Department of Education, Science and Training (DEST 2007, p.25), when it said (bold text in original):

“… it is important to understand that research commercialisation is:
complex - usually non-linear, involving multiple phases, processes and participants;
broads - can be carried out through a number of different mechanisms, ranging from intellectual property patenting and licensing, through open publication and dissemination, to the movement of skilled and knowledgeable people;
multi-faceted - involving a range and often substantial complementary investments in product development, production, marketing and distribution;
riskys - a significant proportion of early investments may not bear direct economic returns; and
time consuming - there can be significant delays between the investment phase and the generation of economic returns”.

University TT&C gives the appearance of representing an archetype of the process of creative destruction first expounded by eminent economist Joseph Schumpeter (1942) in

11 Author’s note: for pharmaceuticals, the success rate is said to be far lower. Of every 5,000 medicines tested, according to the Pharmaceutical Research and Manufacturers of America, only five on average are tested in clinical trials. Based on research by the Tufts Center for the Study of Drug Development, only one of these five is eventually approved for patient use. For an outline of the steps in drug development, see Tufts Center press release, November 30, 2001: www.tufts.edu/med/csdd/images/StepsInDrugDevelopment.pdf.
which the old ways of doing things are endogenously destroyed and replaced by the new. He was also, arguably, the first thinker to articulate the idea of entrepreneurialism, which is so important in the field of university TT&C.

Not all university faculty members and researchers are convinced of the efficacy of TT&C. Many argue that TT&C has the potential to erode the traditional university view encouraging the free dissemination of ideas and the intellectual commons (Argyres and Liebeskind 1998; Campbell and Slaughter 1999). One of the potential adverse effects includes prejudicing the intellectual commons by making much of it, effectively, private, with implications for collegiality (Nelson 2001).

Harman (2002) provided evidence that up to 30% of Australian university researchers delay publication for periods longer than six months. He expressed the view that these data suggest that the protection of researcher self interest is as important and, perhaps, more important, than protection of a sponsor's intellectual property, with publication delaying behaviour most common among engineering and physical science researchers and least common among medicine and mathematical/computer science researchers.

In terms of US life science researchers that have been sponsored by industry, it has been found (Louis, et al. 2001, p.242) that “non-clinical researchers are significantly more likely than clinical researchers to experience data withholding”.

Other research suggests that increasing examples of university licensing in the US are due less to any shift in research undertaken by faculty members than to an increased willingness on the part of faculty members and administrators to license and increased business reliance on external research and development (Thursby and Thursby 2002).

Two terms will appear to the reader in this field from time to time: the triple helix; and third-stream. They are best explained early. The term triple helix refers to the three entities that comprise the principal elements of university TT&C: university, industry and government and the relationship between them (Etzkowitz and Leydesdorff 2001). Third stream is an ill-defined term that refers generally to activities involving a university in extra-mural dealings (the first two streams being teaching and research), most commonly commercial dealings with industry. It is also sometimes called knowledge transfer, knowledge diffusion or engagement, and is probably best defined as being “concerned with the generation, use, application and exploitation of knowledge and other university capabilities outside academic environments" (SPRU 2002, pp.iii-iv). Howard (2005b), an Australian author, has also analysed issues surrounding this term in considerable depth.
It was argued by the Business Council of Australia (BCA 2006a) that innovation is the key to Australian productivity, and improvements in productivity are the most important element of this rather than the more obvious great leaps forward in particular high-technology fields that often make the headlines. In somewhat similar terms, Hirsch-Kriensen, et al. (2006) argued that innovation is just as important in low-technology industries within high-technology economies like the European Union. This is not to eschew the importance of the high technology ideas emanating from universities, but to place them into perspective. For there is no real doubt that ideas emanating from universities constitute a potent force for economic advancement that was recognised by scholars such as the eminent Professor Georges Doriot of Harvard Business School (Gupta 2004) at least as early as the 1930s\textsuperscript{12}.

\subsection*{1.2 The Need for and Purpose of this Research}

Research commercialisation is generally the process of developing research outcomes into commercial products, processes or services and putting them into the marketplace. It embraces a range of university activities broadly defined as knowledge products (Howard 2005b) that have useful economic or social outcomes.

The intended aim of this research is (Zhao 2004a)\textsuperscript{13}:

To identify leading research commercialisation practices and to make recommendations on how these can be implemented in the Australian university context for the purpose of enhancing Australian university performance in research commercialisation.

There are two subsidiary, but related, objectives of this research:

(a) To explore the needs of smaller and regional Australian universities to develop effective strategies that will enhance their research commercialisation capacity and performance through the promotion of industry uptake of their research outcomes; and

(b) To explore the needs of industry to promote the uptake of university research outcomes from these universities.

To achieve the aim, this research involves, among other things:

(a) Developing a detailed understanding of the systemic barriers to research commercialisation within Australian universities; and

(b) Identifying model solutions that have overcome those barriers in successful commercialising universities in Australia and overseas.

\textsuperscript{12} Nonetheless, there is some research that demonstrates that university technology transfer appears to have little economic impact, like that by researchers at the University of Minnesota such as Harmon, et al. (1997).

\textsuperscript{13} Paraphrased and re-cast from the proposal for ARC funding for this research prepared by RMIT University.
Based on the enunciated aim and objectives of the research, four research questions were posed:

1. What are the systemic barriers to research commercialisation within Australian universities?
2. How could Australian universities overcome the systemic barriers to the commercialisation of university research?
3. How, in particular, could Australian smaller and regional universities enhance their research commercialisation capacity and performance?
4. How could the uptake by industry of Australian university research outcomes be improved?

While many of the factors motivating Australian universities to engage in commercialisation have been identified (ARC 2000; Allen 2003c), there are some evident difficulties in universities being comprehensively involved in commercialisation: some factors are within the control of the universities themselves; some within the reasonable control of government; and some exogenous factors affected more by broader social and economic circumstances. These challenges are examined in the first research question: what are the systemic barriers to research commercialisation within Australian universities?

There are some Australian universities that have made an apparent success of commercialisation. Governments at several levels have also shown interest in encouraging commercialisation by establishing structures and systems intended to support and assist universities (as well as other research entities) in this regard. Governments in almost every developed nation now promote research commercialisation as an important element in national economic success and have, to varying degrees, implemented systems that attempt to promote research commercialisation. The second research question – how could Australian universities overcome the systemic barriers to the commercialisation of university research? – is intended to examine how this has been done in Australia and elsewhere.

Government has identified the needs of smaller and regional universities as requiring specific consideration. Since the Unified National System of Australian universities was adopted in 1987, which had the effect of changing entities such as Colleges of Advanced Education and Institutes of Technology, which constituted a large proportion of regional institutions, into universities, there has been an expectation that research will become a more significant activity in these newer universities. Regional support is also viewed by the Australian Government as a priority issue (Australian Government 1999), and there are a number of bodies funding rural R&D, much of which is undertaken in regional universities. However, of the 71 CRCs funded in 2004, only 12, or 17%, cited a non-metropolitan address as their
principal location (DEST 2004a). Consideration of matters affecting regional universities is addressed in the third research question: *How, in particular, could Australia’s smaller and regional universities enhance their research commercialisation capacity and performance?*

Universities are only able to engage in commercialisation if business and industry exist that is capable of taking the ideas generated by, and the abilities available in, universities and, from these, creating innovations sought by the market. For the betterment of Australian industry and society it is desirable that Australian (rather than foreign) industry is involved in working with universities in this regard. Achieving this would be facilitated by an environment supportive of such involvement. The need to examine this issue provides the rationale for the fourth research question: *How could the uptake by industry of Australian university research outcomes be improved?*

In this thesis TT&C means, unless the context requires otherwise, those areas of knowledge production that embrace patenting (and other registered intellectual property) and licensing; income streams from registered intellectual property; contract R&D; academic consulting to the extent that it is managed or co-ordinated through the university"; and spin-off company formation.

The Australian Government spent approximately $3.4 billion per year in research through Australian universities in 2002-2003, the latest figures available (ABS 2005a, Table 25.1). Australia is placed in the middle rank of nations in terms of total R&D expenditure and at the higher end of government R&D expenditure (ABS 2005a, Table 25.3).

This has led to Australia becoming a sophisticated producer of knowledge, as the Australian Government (1999, sect. 1.5) stated: “This investment has resulted in Australia producing 2.5 per cent of the world’s knowledge, well above our population base and share of world trade”. Similarly, according to the Wills Report (Australian Government 1998, p.5), “[w]ith 0.3% of the world’s population, Australia produces about 2.5% of the world’s health and medical research output”.

At the same time, Australia is in the middle rank of countries that commercialise the research they produce (Gans and Stern 2003). Of Australian commercialisation experience, it has been said (AIC 2002, pars.27-28): “we are good at turning dollars into ideas. Australia is not so good at turning ideas into dollars”. Changing this result is important if Australia is to obtain the best results from its investment in research and to remain a globally competitive

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14 Consulting by academic faculty members is included as a function managed by many Australian TTOs although it appears to be unknown in the US where such arrangements are strictly private matters.
economy. It is the purpose of this research to identify how Australia can enhance the outcomes from its investment in university research.

Some potential for complication in industry-university relations has arisen because the Government has raised issues about whether a single model for universities in Australia should be retained, or whether universities should be streamed as teaching or research (Guthrie, et al. 2004). Until this is resolved some universities may be reluctant to invest (or may over-invest) in TT&C, and industry may find that some established relationships are disrupted.

1.3 Classifying Research Commercialisation

1.3.1 Introduction

Many, possibly most, commentator and researchers on commercialisation tend not to discriminate between the various fields of research and the modes used in diffusing research results. For example, on the desirability of patenting, economics researchers often examine patents in aggregate and usually assume that the results of their analysis may be applied generally. However, an understanding of the commercialisation of university research requires that it be segmented in two principal ways: by broad field of research; and by mode of diffusion. The need to segment university research in this way arises because, first, commercialising each of the outputs from the three broad fields of research has distinctly different characteristics, and what applies to one may not (and often doesn't) apply to the others; while, second, the mode of dissemination used in relation to the outputs of the research will almost always have an impact on the costs, complexity and speed of getting the research results into the public domain.

1.3.2 Field of Research

Australian university research may be categorised into three broad fields:

- Medical and health sciences and biological sciences\(^{15}\) (called here life sciences);
- Science disciplines\(^{16}\) (called here other sciences); and
- All other disciplines\(^{17}\) (including humanities, arts and social sciences, or HASS).

This trifurcated nature of Australian university research is evident in the funding allocated to each: of the $3.43 billion expended in university research in 2002-2003\(^{18}\), $1.27 billion was

\(^{15}\) In accordance with Australian Standard Research Classification (ASRC) ABS 1297.0, 1998.
\(^{16}\) Sciences, per ASRC ABS 1297.0, 1998: mathematical; physical; chemical; earth; information, computing and communication; agricultural, veterinary and environmental; and engineering and technology.
\(^{17}\) For example: commerce, politics, accounting, history and law.
spent in medical research, $1.22 billion in science disciplines, and $0.94 billion in all other research including HASS.

In general terms, life sciences account for about half the TT&C results published. For example, of the “100 innovations from academic research to real-world application” published by AUTM (2007a), 48 involve medicine, pharmacology, health and biotechnology (rising to 52 if veterinary science is included), 16 involve electronics and IT (rising to 31 if all engineering disciplines are included), 8 deal with food and agriculture, while there are only 5 in humanities, arts and social sciences. Recent Australian data published in the Big Book of Ideas 2006 by Knowledge Commercialisation Australia (KCA 2006) discloses 199 discoveries arising from Australian research in three categories: life sciences (108 discoveries or 54%), information and communications technology (31 discoveries or 16%), and advanced engineering (60 discoveries or 30%, of which 14 relate to medical advances). Again, life sciences and medical advances constitute by far the greatest number of discoveries thought capable of commercialisation. Similar proportions are found by analysing university commercialisations in other jurisdictions.

One of the reasons for the preponderance of life sciences in commercialisation is the historically strong link between universities (and other institutes of medical research) and industry. This is evidenced by the strong clusters of medical research in Melbourne, Sydney and Brisbane20, much of which is supported by industry. While other research fields at particular universities often have good industry links21, these are generally less well institutionalised than those involving the life sciences, and the strength of the links are often dependent on particular individual researchers.

As a result of the extent of university-industry involvement in life sciences, this category of research generally tends to produce a return to universities greater than that in other

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18 ABS 8112.0 expenditure by research field, for 2002-2003, the latest year available
19 26 of these discoveries were not attributed to universities, but other research entities including the CSIRO, ANSTO, CRCs associated with universities, and commercial ventures associated with universities. This leaves 82 discoveries associated solely with Australian universities.
20 For example: the Melbourne cluster comprising: the University of Melbourne, Melbourne Health, the Walter and Eliza Hall Institute of Medical Research, the Howard Florey Institute, Ludwig Institute for Cancer Research, National Vision Research Institute, St Vincent's Institute of Medical Research, Victorian Breast Cancer Research Consortium, plus others in Melbourne including Peter MacCallum Cancer Institute, Macfarlane Burnet Institute, Baker Heart Research Institute, Brain Research Institute, The Mental Health Research Institute of Victoria, and National Stroke Research Institute; the Sydney cluster, comprising: Sydney University, the Garvan Institute, the Victor Chang Cardiac Research Institute, the George Institute for International Health, the Institute for Neuromuscular Research, Centenary Institute for Cancer Medicine, Institute for Dental Research, and The Heart Research Institute; the Brisbane cluster, comprising: the University of Queensland, the Royal Brisbane and Women's Hospital, the Queensland Institute of Medical Research, plus others in Brisbane such as the Mater Medical Research Institute. There are similar, although smaller, clusters in other Australian States
21 Some universities were established with close links to industry, particularly those that are members of the university grouping known as the Australian Technology Network, although there are some others, such as Swinburne University of Technology that were founded based on close industry links.
research fields. While universities may not participate in life sciences research based on the revenue that it can generate, this difference is a factor that often distinguishes life sciences commercialisation from other fields.

The next basis for this division of research outcomes can be seen in the market cycle. Life sciences discoveries generally take many years between discovery and market presence – ten to fifteen years is not unusual, largely as a result of strict regulatory requirements. For example, in 2006 Gardasil\textsuperscript{22} reached the markets of the first world after having been patented in 1991. Innovations in the field of communications and information technology, on the other hand, are becoming measured in months rather than years. For this reason, in many cases the issue of a patent for developments in communications and IT is not crucial in taking a discovery to market. The reason for this is that, by the time a patent is granted, the commercial life of the discovery may well have expired. In this case, any infringing conduct by an unlicensed user during the life of a product may be better settled by court-ordered damages rather than a prohibition against any continuing infringing conduct. In the case of humanities, arts and social sciences, patents and registered intellectual property rights are of limited or no use at all. Ideas originating from the HASS fields are unlikely to be protected to any significant extent by registering an interest – indeed, most ideas are simply not amenable to registration\textsuperscript{23}.

Finally, life sciences, in particular, is generally subject to a rigorous approvals and regulatory regime which other disciplines are not. For example, getting new medical technologies (such as pharmaceuticals) through regulatory approvals and into the market can cost in the order of one billion dollars (Goozner 2004) and take in the order of fifteen years. This rigorous regime distinguishes life sciences from all other fields of research, making life sciences \textit{sui generis} among research fields.

While humanities, arts and social sciences are sometimes neglected when considering TT&C they are, nonetheless, producing an increasing volume of research with commercialisation potential, as recognised by the Australian Government (DEST 2005c) and found in other research (Harman 2005a).

\textsuperscript{22} Gardasil is the trade name of a drug developed from research conducted at the University of Queensland that inhibits the development of certain types of human papillomavirus (HPV) known to lead to cervical cancer. It was patented in 1991 but only commercially available in 2006. Source: Commercialisation Success Stories published by UniQuest 2007.

\textsuperscript{23} While not an exception to the rule that ideas, as such, are almost never registrable, the form of expression of an idea may be protected by copyright in most cases, but this will rarely give any right to protection of the underlying idea (as distinct from its form of expression). Copyright is an automatic protection that does not require registration under Australian law.
While a few universities in Australia have profited from TT&C, the financial results achieved are generally lower than expected, while TT&C at universities has relied on government funding, which is diminishing, and will come to rely more heavily in the future on using earnings retained from earlier TT&C activities (Harman and Harman 2004).

Analysis of patent data from MIT suggests that the optimum means of commercialising from a robust patent is by licensing. University inventor commercialisation is generally done as a result of some limitation in the patent (or, maybe, where a patent is not the ideal protection) and is a second-best option which achieves lower financial results. As Shane (2002, p.135) concluded from his data analysis:

“The results provide evidence that university inventors become entrepreneurs because of failures in the market for knowledge, suggesting that inventor entrepreneurship is a second-best solution to the commercialization of new technology. This view stands in contrast to the perspective of most of the entrepreneurship literature (and the popular press), which argues that independent entrepreneurship is a better mechanism for university technology commercialization than commercialization by established firms. This difference is important because theories in which independent entrepreneurship is considered the best approach to technology commercialization yield different implications from theories in which independent entrepreneurship is considered a second best approach”.

Yet this view of Shane most probably reflects the US reality rather than that of Australia where the use of spin-out companies can be an optimum route (Yencken and Gillin 2002; Yencken, et al. 2002) and is the preferred route for some smaller universities (Aust Small Uni Interview 2006).

1.3.3 Mode of Dissemination

Howard (2005b) listed four categories of research commercialisation process, namely, knowledge diffusion, knowledge production, knowledge relationships, and knowledge engagement. Within these four categories he lists numerous ‘output indicators’, of which only three involve TT&C dissemination: patenting and licensing (and income streams from them); spin-off company formation; and contract research and consulting. Other commercial activities mentioned by Howard (2005b), such as university-industry joint ventures, and by Bok (2003), such as sporting teams and identity licensing, do not involve a TTO, and are excluded from the meaning of research commercialisation for the purpose of this research. Also excluded are the broader non-commercial activities included in the so-called “third stream” activities of universities discussed by authors such as Hatakenaka (2005).

Thus, for the purposes of this research, there are four components to the university repertoire of research commercialisation: consulting, contract research, licensing, and spin-off companies. These four components are consistent with the activities observed by the author in case studies of successful Australian universities, with UniQuest (at the University
of Queensland, arguably the most successful Australian university commercialisation entity) being the archetypal case embracing all four modes of TT&C dissemination.

In order to undertake a cogent analysis of university commercialisation activities it is necessary to understand the practical activities in which universities engage. The activities which constitute commercialisation, as it is practised by Australian universities, may be described under four headings, as shown in the left-hand column of Table 1.1. Table 1.1 shows not only a list of commercialisation activities, but also a summary of the main characteristics of each activity.

<table>
<thead>
<tr>
<th>Research Commercialisation Activities</th>
<th>Risk</th>
<th>Effort Required to Commercialise</th>
<th>Need for TTO/Commercialisation Office</th>
<th>Need for Early-stage Capital</th>
<th>Need for Venture Capital</th>
<th>Period Before Returns</th>
<th>Potential Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultancy</td>
<td>Minimal</td>
<td>Small to medium</td>
<td>None – legal assistance for contract</td>
<td>No</td>
<td>No</td>
<td>Short (months)</td>
<td>Based on time and skill</td>
</tr>
<tr>
<td>Contract Research</td>
<td>Some, but low</td>
<td>Small to medium</td>
<td>None – legal assistance for contract</td>
<td>No</td>
<td>No</td>
<td>Short (usually months)</td>
<td>Based on time and skill and special resources</td>
</tr>
<tr>
<td>Licensing</td>
<td>Generally low</td>
<td>Generally medium to high</td>
<td>Desirable: IP, contract, management</td>
<td>Often needed for proof-of-concept and a little beyond</td>
<td>No</td>
<td>Short-medium (months to years)</td>
<td>Variable. A great majority yield low results with some major exceptions</td>
</tr>
<tr>
<td>Spin-off Company</td>
<td>Increasing</td>
<td>Generally high – long-term commitment needed</td>
<td>Highly desirable</td>
<td>Almost always needed</td>
<td>May be needed</td>
<td>Usually long (years)</td>
<td>Variable. Many will fail, but some can be huge</td>
</tr>
</tbody>
</table>

Table 1.1 – Characteristics of Commercialisation Activities  Source: Author

Academic faculty members have been undertaking consultancy and contract research for many years, often before a TTO was contemplated. Consultancy and contract research generally offer little commercial risk to the staff or university, can be done usually without prejudice to other academic duties and provide reasonable and immediate cash returns. Generally speaking, neither consulting nor contract research have any special capital needs outside those normally required for research. Universities in all advanced economies contemplate participation in consulting and the pursuit of private commercial activities by academic faculty by granting time-off within working hours to pursue such activities. Consulting and contract research would continue to flourish in most universities whether or not a TTO existed. In the United States and most of Canada universities assume no role in private faculty consulting and commercial arrangements while, in Australia, TTOs often play no role in contract research (it being handled by an Office of Research or some similar
entity). In many universities, therefore, TT&C handled by a TTO embraces only the last two activities of this list: licensing intellectual property, and spin-off companies. This means that it is necessary in many cases, particularly in Australia, to identify those activities in which TTOs engage in order to permit analysis of like-for-like situations.

Research in industry has changed its character in recent decades. Most large company-owned research laboratories are all but gone, replaced by an emphasis on co-operation amongst companies and between companies and research entities like universities\(^\text{24}\). This is evident in every advanced economy and many industries. One manifestation of this in Australia is the creation of Co-operative Research Centres which, typically, involve several universities and several companies with some financing from government. Industry, or at least some parts of it, obtains benefits from this more open approach to research, in particular reduced costs and improved access to research generated by the best investigators in the field.

It must be kept in perspective that only a small proportion of the output of research conducted by Australian universities goes through a TTO. In the US, figures suggest that the proportion of university research transferred by way of patent does not exceed 7% at MIT, a premier commercialising university (Agrawal and Henderson 2002, p. 45), and this is very likely an overestimate.

1.4 Structure of this Thesis

This thesis is divided into six Parts to reflect the need to undertake a comprehensive review in order to gain a sound understanding of the commercialisation environment and the role that universities play within it before moving on to the detailed analysis of data that seeks to answer the research questions.

Part II is a Literature Review which covers the history of TT&C, an overview of national innovation systems, explains the Australian university commercialisation environment, identifies the systemic barriers to commercialisation facing Australian universities, and develops a number of propositions that are used to inform the structure of the project.

Part III describes the methodologies used in this project, discusses their strengths and weaknesses, and concludes with comments on the reliability and validity of the results obtained using the methodologies selected. This project uses qualitative methodologies for

\(^{24}\) But not just universities. In Australia there are many government-sponsored research entities that also undertake important research, including the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Nuclear Science and Technology Organisation (ANSTO), the Defence Science and Technology Organisation (DSTO), the Australian Institute of Marine Sciences (AIMS), the Australian Geophysical Science Organisation (AGSO) and numerous Rural Research and Development Corporations (RRDC).
reasons explained in this Part using principally primary data, with recourse to secondary data for the purpose of testing conclusions about industry involvement.

Part IV is principally concerned with analysing the performance of Australian universities in commercialisation, comparing them with benchmark results, and identifying the key factors that distinguish the universities that exhibit superior commercialisation performance. It is the largest and probably most important Part, and relies on primary data compiled from interviews and other first-hand sources, often supplemented by reliable secondary data to test, illuminate and explain particular issues.

Part V moves on to examining how a segment of Australian industry – in this case a sample of SMEs in the electronics industry – interact with universities and university TTOs. It identifies the types of interactions that this industry segment seeks and how this is being served by universities generally and TTOs in particular. This Part complements the analysis of university commercialisation performance by providing a view from a group of users of university technology.

Part VI draws together the threads of the analysis with conclusions and recommendations for further research.
PART II – LITERATURE REVIEW

Technology Transfer & Commercialisation is not conducted in a vacuum. In each jurisdiction it is part of a national system of innovation and is conducted within a set of national parameters, or what Gans and Stern (2003, p.13) call common infrastructure. It seems that all economies grow on the back of innovations – innovations that come from a number of sources of which universities are only one, albeit an important one.

Chapter 2 describes some of the history of TT&C, some seminal events, and how TT&C has evolved.

Chapter 3 discusses the general importance of national innovation systems and the role universities play as a key component of the system.

Chapter 4 identifies and describes the key features of the Australian commercialisation environment with an emphasis on the issues faced by universities. It does this within the framework of three headings covering its major elements: mechanisms and facilitators of partnerships and economic development; institutional enablers, which largely pertain to organisational culture and rewards; and boundary-spanning structures and systems such as industry bodies. The chapter ends with a summary of the gaps on the topic found in the literature.

Chapter 5 builds on the information in this Part to answer Research Question 1: What are the systemic barriers to research commercialisation in Australian universities?

Finally Chapter 6 uses the results of the literature review to construct thirteen propositions which emerge from the analysis and which are used later in the thesis to inform and shape the analysis in order to answer the remaining research questions. The propositions are especially important because they provide the structural framework on which the remainder of the analysis is conducted.

2 History and Development

Prior to the 1980 Bayh-Dole Act in the United States there was quite limited scholarship relevant to university research commercialisation, and most of what did exist dealt with the economics of innovation from eminent scholars that included Schumpeter (1942) and Griliches (Diamond 2004).
After 1980, scholarship in this field began to accelerate across a limited number of fields, principally economics and management, with the former preferring numerical analysis while the latter used both numerical and qualitative analysis. Most scholarship has come from the United States with significant contributions from the United Kingdom, Canada and parts of Europe including the OECD. In addition to scholarship, governments plus business and industry have become concerned to analyse and understand the university research commercialisation environment in some depth. Much of this scholarship and analysis has relevance to Australia but, for reasons that include tangible differences in areas such as the legal, financial and political environment, and intangible differences such as culture, conclusions from the research and analysis into university commercialisation in other jurisdictions require some interpretation for Australian circumstances.

Since about the mid-1990s the Australian Government, in particular, has undertaken or been concerned in the commissioning of many studies and reports relevant to university commercialisation. For the assistance of other scholars a list of relevant studies and reports that have been identified are consolidated into Appendix 3. Australian business and industry, and their representative associations, have become involved in studying the issue because of its relevance to national innovation and economic advancement, and reports by these entities make a useful contribution to the study here and are also listed in Appendix 3. This panoply of government, government-inspired, and business and industry associations is listed at length by Collier (2007). Australian academic researchers have also made a contribution to an understanding of the university research commercialisation environment although, up to now, in a fairly restricted number of areas such as dealing with spin-off companies (Yencken and Gillin 2002; Yencken, et al. 2002), university research commercialisation performance (Harman 2002; Harman and Olliff 2004; Harman and Harman 2004), fiscal issues (Rider, et al. 2006) and co-operative research centres (Turpin 1997), or in specific fields of commercialisation such as the creative arts (Hearn, et al. 2004).


Various Australian governments and agencies and others have examined and reported on threshold issues of innovation (Australian Government 1999, 2001, 2005; BCA 2006a; DEST
2003a; DIST 1997; DITR 2002b), publicly-funded science (Allen 2003a; DISR 2000; Productivity Commission 2007) and the economic value arising from research (Allen 2003a, 2003c). As well, government and industry have examined and reported on a number of specific issues including co-operative research centres (BioAccent and Capital Hill 2002; Howard 2003; Allen 2005; Insight Economics 2006), small and medium businesses (DITR 2002a), health and medical research commercialisation barriers (Johnston, et al. 1999), industry linkages (DETYA 1999; DEST 2003c), commercialisation incentives (DEST 2005b), and commercialisation metrics (DEST 2005a). This list represents a sample of the issues covered by government-funded analysis.

Government and industry associations in other advanced economies have also examined issues relating to university TT&C in some detail over some time. Close parallels can be seen between the Australian situation and that identified by the Canadian Government and industry in analyses of their environment (Reimers 1999; Gu and Whewell 1999; AUCC 2001; Canada Foundation for Innovation 2002; Industry Canada 2005), and much of this literature is useful in understanding the Australian environment. Having a similar history, population and government structure, Canadian scholarly, government and industry analysis has particular relevance to Australia.

Similarly there has been government and industry analysis relevant to TT&C in the US (BHEF 2001; Tornatzky, et al. 2002; Reamer, et al. 2003; PCAST 2003; NAE 2003) and the UK (DTI 2000; SPRU 2002; Lambert 2003; Miles and Daniels 2007).

There is little official analysis of the situation in New Zealand: Engelbrecht and Darroch (1999).

The broader literature has examined university TT&C from many perspectives, with economic analysis being probably the most significant viewpoint\textsuperscript{25}, but with significant contributions from journals dealing with public policy\textsuperscript{26}, business and management\textsuperscript{27}, education\textsuperscript{28}, science and technology\textsuperscript{29}, and some specialist TT&C journals\textsuperscript{30}, among others.


\textsuperscript{26} European Planning Studies, Journal of Comparative Policy Analysis, and Policy Studies Journal


A major influence upon thinking in this area has been the development of the so-called triple helix, embracing the three principal actors in the university TT&C environment: universities-industry-government (Etzkowitz and Leydesdorff 2001), first espoused in the mid-1990s. This approach identifies the importance of each of the three main actors and supersedes rather simpler models based on approaches such as “technology push” and “demand pull”. The influence of their thinking is evident in much of the subsequent learned literature and government reviews dealing with university research commercialisation.

The participation of university researchers in entrepreneurial activity such as TT&C is sometimes called the virtuous cycle, at least by its proponents. For example, Johnston, et al. (1999) entitled their paper for the Australian Government encouraging entrepreneurship amongst university life sciences researchers “Enabling the Virtuous Cycle”.

Gibson (1988) in a relatively early paper examining the topic from an economic viewpoint identified four issues important in understanding the environment: innovation and patents; commercialisation and technology transfer; entrepreneurship; and incubators and technology parks. More recently, business and management schools have investigated some specific issues of apparent importance to the topic, for example Carlsson and Fridh (2002) examined technology transfer statistics from US universities; Shane (2002) developed some conclusions about commercialisation from an examination of patent activity at MIT; and Goldfarb and Henrekson (2003) compared the results derived from policies supporting top-down (government intervention) with bottom-up (commercially-driven universities).

Some research has been done specifically on models of best commercialisation practice: (Smilor and Matthews 2004); and in Australia: Cripps, et al. (1999); ARC (2000); DEST (2002).

Research in the UK by Lowe (1993) demonstrated that the mode, or route, of commercialisation depends on the nature of the technology involved, the IP protection available and the need for assistance in its exploitation.

The Cambridge biotechnology cluster provides one possible commercialisation model, largely relevant to a particular type of research – life sciences (Casper and Karamanos 2003; Pacec 2003). There has been substantial analysis of the reasons for success of the well-

One particular issue that appears not to have been considered in depth up to this time is the interaction of multiple organisations in innovation and TT&C (Anderson 2001). After considering the views on academy-industry relations put forward by several distinguished authors, she concluded that:

“As useful as these theories prove in the literature, there is a need to develop and employ models that can handle more fully the complexity of interorganization interaction. All of the models listed above focus on a single organization, or on a focal organization in relation to a set of actors in its environment, or on dyads of organizations. None of them takes a set of interacting organizations as the level of analysis or the connections among them as the object of analysis”.

This need is addressed, to some extent, through the prism of multiple case studies as conducted here.

Another aspect of the organisation theme is the effect that the structure of the university itself and its TTO have on TT&C. Until about 2000, analysis on this topic tended to concentrate on quantitative measures such as the number and type of invention disclosures and patents but, subsequently, greater interest is evident in the effect that organisational structure has on the effect of TT&C (Bercovitz, et al. 2001), with the relevance of patents as an indicator of TT&C performance coming under increasing criticism.

Another model that is well-known and much-studied is the effect on university research of the US\ Bayh-Dole Act which, since enacted in 1980, has permitted universities to exploit the results of federally-funded research. There are differences between the Australian and US environment, but legislative intervention is a potential model that could be considered for Australia. There is ample academic analysis of the Bayh-Dole Act as it affects US institutions, such as: Lee and Gaertner (1994) and, more recently, Bremer (2001) and Mowery, et al. (2001). The Australian Institute for Commercialisation has suggested (AIC 2002) that consideration should be given to enforcing through law a positive obligation on the part of universities to assess all research for intellectual property capable of patent protection, and then act upon that assessment.

Institutional entrepreneurship is a common theme among many academic modellers, such as Liu and Dubinsky (2000), where the authors suggested that institutional entrepreneurship supports strategic marketing and management that can generate revenue from research. This is also reported upon by Zhao (2004b, 2004c) in an Australian context.
Experience from Taiwan suggests that the mode of university-industry commercialisation that works there is based on short-term objectives rather than long-term relationship building, which is somewhat counter-intuitive in the Asian context: (Chang, et al. 2005).

There is some international literature that examines particular issues, such as: Franklin, et al. (2001) who analysed the options of using internal and external entrepreneurs as vectors to take technology to market; how to package university knowledge so that it can be taken to market (Rappert and Webster 1997); entrepreneurship and spin-out companies (Franklin, et al. 2001); and the role of university equity holdings in spin-out companies (Feldman, et al. 2002).

Some government and industry reports have analysed the overall Australian higher education commercialisation environment, for example those by Johnston, et al. (1999) as it concerned health and medical research, and generally by DITR (2002b) and Allen (2004).

What appears from the literature is that most of it is recent – since about 1990 – and that most analyses have addressed a limited range of issues on research commercialisation, with few demonstrating an understanding of the system as a whole. Indeed, it may be such a complex, amorphous and fast-moving system that the best that can be achieved is a partial understanding. Taking account of the desirability of critically examining overseas scholarship and analysis for applicability to Australia, of the limited local scholarship, and the gaps remaining in the studies and reports prepared by government and others in Australia, there is benefit in a comprehensive review of the Australian environment capable of addressing the large number of issues relevant to the question of enhancing Australian universities’ research commercialisation performance as undertaken here.

3 The Importance of Innovation

3.1 Introduction

It may be useful to distinguish between three issues that often become inter-twined and are sometimes difficult to separate. These are, first, the role and importance of innovation in an economy; second, public support for research (and, sometimes, development) at universities, in publicly-funded research organisations, and by private entities; and, third, the implications of commercialising university research. The relative importance of university research commercialisation as a driver of the national economy is often assumed, but there exist few hard data, and some significant scepticism as to the accuracy of the assumption.

Nations view technological innovation as an important component of the national economy – the United States’ American Competitiveness Initiative (Domestic Policy Council 2006) being
a prominent example of such a program which aims to maintain America’s “competitive edge in the world economy ... [with] focused policies that lay the groundwork for continued leadership in innovation, exploration, and ingenuity” (p.1); likewise in Britain through its White Paper, *Excellence and Opportunity – A Science and Innovation Policy for the 21st Century* (DTI 2000); and Canada in its policy, *Achieving Excellence: Investing in People, Knowledge and Opportunity* (Prime Minister of Canada 2001). Similarly in Australia, the Australian Government has examined the importance of innovation (ISIG 2000), as has the business peak body, the Business Council of Australia (BCA 2006a, 2006b). Innovation, whatever its source, is the driver of continuing economic development and growth.

Notwithstanding the emphasis on high-technology research and development, arguably some of the most important developments in innovation occur in the low-medium technology area where most of industry is located (Smith 2006; BCA 2006a). As Smith (2006, p.iii) said: “Research and development is certainly not the main, nor the most important, ingredient in the production of economically useful knowledge or innovative capabilities in business enterprises”.

Continuing public funding of research at universities and publicly-funded research agencies remains the policy pursued in advanced economies: the United States (Domestic Policy Council 2006); the United Kingdom (UK Treasury 2004); Canada (Industry Canada 2005) and New Zealand (FRST 2005); as well as Australia (Productivity Commission 2007).

3.2 Technology Innovation

Every advanced industrial economy has developed a national innovation system (NIS) in order to promote continued economic growth. Standing still is not an option - every economy needs to advance in order to continue to produce more and better outcomes for its citizens.

Entirely new and sophisticated industries are created from sources such as the ideas generated by university research. And the importance of universities in the generation of these new ideas can be seen clearly in the attitudes and beliefs of Georges Doriot (1899-1987) of the Harvard Business School who identified and nurtured numerous new companies founded on ideas created in universities (Gupta 2004). In regard to the need to nurture the new ideas that will become the new and sophisticated industries, Professor Doriot said that cultures and economies “cannot live off the enterprise and vision of preceding generations only” (Gupta 2004, p.xix). This view is common among learned economic authors, for example Porter (1990, p.6) said: “Sustained productivity growth requires that an economy continually *upgrade* itself” (italics in original). He explained what he meant by upgrade when he said (pp.6-7), “…an upgrading economy is one which has the capability of competing successfully in entirely new and sophisticated industries".
Even in the world’s largest economy in 2006, American opinion leaders believed that the United States was not maintaining its intellectual lead and was failing to upgrade its economy (NAS, et al. 2006). This failing was seen to be such a threat to the national welfare that the President of the United States, in his 2006 State of the Union address, announced the American Competitiveness Initiative in an attempt to redress this position. In response to the President’s announcement, the US Domestic Policy Council published American Competitiveness Initiative – Leading the World in Innovation (Domestic Policy Council 2006).

The United Kingdom and Canada have also examined this issue. In the UK, for example, the 1999 Baker Report, Creating Knowledge, Creating Wealth, and the more recent 2005 Confederation of British Industry Report, Innovation Survey 2005, demonstrate a continuing concern to ensure that the British economy is focused on innovation. Canada has a Foundation for Innovation31, and the Federal Government in 2001 prepared an innovation strategy, Achieving Excellence – Investing in People, Knowledge and Opportunity, while Canada’s national industry association, the Conference Board of Canada, produces annual Innovation Reports.

The Australian Government has been active in examining innovation, principally under the auspices of the Department of Industry, Tourism and Resources (DITR). A major study was undertaken in 2000 under an ad-hoc group called the Innovation Summit Implementation Group (ISIG) which made twenty-four recommendations for improvement to the Australian NIS (ISIG 2000) covering matters such as awareness, venture capital, corporate structure and entrepreneur training. The results of this led to the establishment of Australia’s recent major innovation thrust announced by the Prime Minister in 2001, Backing Australia’s Ability (Australian Government 2001), a package intended to promote research, development and innovation. Both before and since the announcement of this package by the Australian Government, analysis of Australia’s innovative performance had been undertaken (DITR 2000, 2002a, 2003). The Australian Government also produces annual Innovation Reports through the DITR. Similarly the Business Council of Australia has examined at a practical level the challenges facing Australia’s innovation system (BCA 2006b) and has, similarly, made a series of recommendations intended to create a comprehensive national innovation framework.

One of the challenges facing all jurisdictions is that it is difficult, if not impossible, for a country to devise clever innovation strategies that are profoundly different from their national peers, thus allowing a particular economy to make exceptional progress. Most strategies are somewhat similar, if not substantially the same, for example, when talking about the progress

31 See: www.innovation.ca/index.cfm
made by Scotland in science policy since devolution, de la Mothe and Mowery (2006) said (pp.28-29):

“However, all the news is not good news. For example, the science strategy bears a remarkable and undifferentiated resemblance to the science strategies of a number of countries, including Canada, South Africa, Finland, Denmark, the Netherlands, and Australia. It lacks specificity to Scotland’s unique capabilities, opportunities and challenges”.

Notwithstanding the reports and good intentions of the Australian Government in its work to date, it does not appear to have created a significant relative advantage in Australia's competitive position compared to its peers. It seems that it is a matter more of changing to remain abreast, at least as far as Australia’s relative position on the economic results from research and development are concerned.

For all the effort that has been put into an Australian NIS, there is room for improvement. In the opinion of senior Australian business scholar John Milton-Smith (2001, p.143): “It is generally agreed that Australia has a relatively weak innovation system. Apart from the lack of funding, there is a high level of fragmentation and confusion”. Indeed, this may be a characteristic of smaller economies, with New Zealand having substantially the same, and probably more, of the NIS challenges that face Australia (Engelbrecht and Darroch 1999), although Barlow (2006, p.xvi) sees Australia as having “... a promising future, particularly with our capacity to compete technologically. Australia is not failing at innovation.”

An assessment of Australia’s innovation system was conducted in 2003 by Gans and Stern (2003) in which they concluded that “a nation’s relative performance in producing global innovation is linked to three factors: (1) the strength of a common innovation infrastructure; (2) the vitality and innovation orientation of regional clusters and (3) the quality of linkages between the innovation infrastructure and a nation’s clusters”. The common infrastructure was defined as (p.13):

- Investment in basic research
- Tax policies affecting corporate R&D and investment spending
- Supply of risk capital
- Aggregate level of education in the population
- Pool of talent in science and technology
- Information and communication infrastructure
- Protection of intellectual property
- Openness to international trade and investment
- Overall sophistication of demand
One element consistently identified by experienced operators in commercialisation but not mentioned by Gans and Stern is experienced start-up management.

Analysis of the social rate of return resulting from university innovation has been estimated as high as 28% by Mansfield (1991), where the social rate of return represents innovations that (p.11): “… could not have been developed (without substantial delay) in the absence of recent academic research”. In Australia, the only attempt to calculate a rate of return on investment in university research, by Allen (2003c), suggested that the social rate of return is 3%.

3.3 The Actors in National Innovation

There are three principal actors in Australian national innovation: industry, government, and universities. Industry is placed first in this list because most innovation is undertaken by industry, often incrementally, and it is industry that is responsible for the great majority of innovations in any economy (BCA 2006a). Industry associations have a major role to play in Australia, in particular as an important link between research entities and industry, as described by Howard (2005a).

Governments have a significant role in national innovation by setting the national agenda as reflected through policy, through the fiscal regime, and through laws (Collier 2007). In Australia, innovation policy is largely the domain of the federal Government32, although each State and Territory government maintains a department concerned with state development. The Australian fiscal regime is almost entirely the province of the Australian Government (because Australian State and Territory governments have quite limited taxing powers), and this regime has come in for some significant criticism as it affects innovation (Rider, et al. 2006). State and Territory governments do, however, offer a suite of financial incentives that apply to industry to encourage desired business behaviour such as innovation. Federal legislation affecting innovation, other than fiscal legislation, largely concerns intellectual property. In this regard, the Australian Parliament has legislative power in the areas of patents, copyright, trade marks, designs, plant varieties and circuit layouts. State and Territory law covers areas such as the creation of universities (except for the Australian National University), confidentiality and trade secrets. Like most common law jurisdictions,

32 In Australia this power is exercised largely through the federal Departments of Education, Science and Training, and Industry, Tourism and Resources, although there are many other federal and State entities as explained in Collier (2007) and shown in DITR (2003).
Australia does not have any law that mandates universities as the owners of intellectual property generated within them\textsuperscript{33}.

The role of government in the NIS is important. Gans & Stern (2003) of the Melbourne Business School made the point that: “Government funding is the mainstay of virtually every nation’s investment in truly frontier research”. While this observation deals with research – and basic (“frontier”) research at that – it is equally true that government support is provided through most of the commercialisation chain; certainly up to the point where the commercial potential of the idea has been proven, beyond which point private funding usually becomes easier to obtain. The Australian Government has in place an array of laws, programs and policies that constitute the substance of the Australian NIS, the most recent articulation of the system being in the Government’s statements on Backing Australia’s Ability (Australian Government 2001; 2005), but there are many others (DITR 2000; Allen 2003b; DEST 2003a).

3.4 The Role of Universities in National Innovation

Universities are seen as important generators of new ideas and promoters of innovation (Etzkowitz and Leydesdorff 2001; ISIG 2000; Batterham 2000; Gupta 2004). Australia has looked extensively at this issue (Turpin, et al. 1999; DEST 2004c, Howard 2005a; PhillipsKPA 2006).

Australian universities have historically performed a significant proportion of national research as shown in Figure 3.1.

\textsuperscript{33} Which is the same approach adopted in the United Kingdom, Canada and New Zealand, unlike the US, where the Bayh-Dole Act grants all right, title and interest in intellectual property generated from federally-funded research in the university that undertakes the research, subject to certain conditions.
Public research, in which universities represent the greatest proportion, particularly in Australia, is a vital and growing ingredient in innovations introduced by industry and has been for many years. As it concerns the US, Narin, et al. (1997, p.317) opined that “[a]mong both scientists and economists it is widely accepted that public science - scientific research that is performed in academic and governmental research institutions and supported by governmental and charitable agencies - is a driving force behind high technology and economic growth”. They concluded (p.340) that “… public science plays an essential role in supporting U.S. industry, across all the science-linked areas of industry, amongst companies large and small, and is a fundamental pillar of the advance of U.S. technology”.

There is strong evidence that universities in the US have been key to a number of innovative developments in seven major industries\textsuperscript{34} during the period 1986-1994. Indeed, Mansfield (1998, p.773) reported that: “Innovations that could not have been developed (without substantial delay) in the absence of recent academic research accounted for over 5% of the total sales of all major firms”. And, at p.775: “over 10% of the new products and processes introduced in these industries could not have been developed (without substantial delay) in the absence of recent academic research”. He also observed that university research has led to cost savings amongst the same major firms: “Innovations that could not have been developed (without substantial delay) in the absence of recent academic research resulted in cost savings of about 2%”. He further noted that, between his two surveys, in the later one,

\textsuperscript{34} The industries and the number of firms surveyed by Mansfield (1991,1998) in each are: drugs and medical products (16); information processing (14); chemical (13); electrical (10); instruments (10); machinery (10); and metals (4)
“... there was a decrease in the average time lag between academic research results and the first commercial introduction of new products and processes based on these results...” from 7 years to 6 years. Results consistent with those of Mansfield are reported by Cohen, et al. (2002), particularly noting the importance of university research to the pharmaceutical industry. But they also made the observation that universities are important not only in ground-breaking discoveries, but in research that aids industrial innovation in many industries and for all sizes of companies. They reported that almost one-third of industrial research and development projects from their sample made use of research findings from publicly-funded research and that knowledge originating from public research is often conveyed through consulting and other informal channels, although the results are tempered by the finding that other sources of knowledge, typically customers and competitors, are, in many cases, more important than the public research component.

The Australian Productivity Commission (2007, finding 7.1) recently made the finding that:

“... [the] policy framework for universities should be focused on maximising the social return from public investment in R&D through the transfer, diffusion and utilisation of knowledge and technology. The pursuit of financial returns from the sale or licensing of intellectual property, and the creation of university spin-off companies, while important pathways in their own right, should not be to the detriment of this overarching objective”.

There can be little to argue with about this finding which generally reflects the views expressed by technology transfer practitioners.

The seminal work on the changed role of universities in the national economy is by Etzkowitz and Leydesdorff (2001) who described the triple helix of university-industry-government relations. There are a number of consequences arising from the perspective they propound, in particular the expanding importance of the “knowledge sector in relation to the political and economic structure of the larger society” (p.155), and the re-structuring of each participant in the triple helix, such as increasing numbers of research centres in universities and strategic alliances amongst companies (p.156). The resulting increasing interactions among the three participants has led universities, in the view of some authors (Gunasekara 2005, p.526), “... to initiate and drive agglomeration through knowledge capitalisation projects, often with government and industry support”. The most obvious point of intersection between the three interests (university, government and industry) is in Australia’s co-operative research centres, which are discussed later in the analysis of the case studies.

One of the many ways that universities stimulate economic activity is through spin-off companies. But there are real gaps in understanding the extent to which spin-off companies benefit the economy, as described by O’Shea, et al. (2004, p.26), when commenting on the literature on this topic they said:
“... much of the literature has focused on a single university or on a very small number of institutions making it hard to draw any generalisations...As a result, the conclusions of much of the current research concerning university spinout performance may not be generalisable to other settings”.

The work of scholars at Australia’s Swinburne University of Technology, Yencken and Gillin (2002) and Yencken, et al. (2002) are also relevant to this issue.

Heavy investment in university research in Europe apparently has not led to a commensurate increase in commercialisation (Audretsch and Lehmann 2005). These authors use Germany as an example, and concluded that (p.343): “Investments in German universities have ranked among the highest in Europe. Still, the ensuing commercialization has been disappointing”. The correlation between investment and result is not always clear.

Japan, which has a strong industrial base, has only relatively recently begun to promote the university-industry link through formal structures such as the TTO, and the evidence suggests that it will take many years before this link will be functionally effective (Collins and Wakoh 2000).

4 Australia’s University Research Commercialisation Environment

4.1 Explaining the Environment

The Australian Government has provided significant support for the commercialisation of research conducted in universities and publicly-funded research agencies in an attempt to improve outcomes in this area, certainly since it announced its Backing Australia’s Ability package in 2001 (Australian Government 2001). There is evidence that it has been successful in raising commercialisation results (DEST 2004b, 2007), an outcome that is important because “This Government believes that innovation—developing skills, generating new ideas through research, and turning them into commercial success—is key to Australia’s future prosperity” (Australian Government 2001, p.7).

It is clear that the Australian Government expects universities to take economic advantage of the perceived benefits of research commercialisation (Australian Government 1999, 2001). However, there has been no research published that identifies the financial returns obtained by Australian universities from research commercialisation activities. The nearest is research commissioned by the Australian Research Council (Allen 2003c) which noted, inter alia, a social rate of return to the community of 3% with a 10-year time lag arising “…from the generation of commercialisable intellectual property” (p.70); which represents a rather modest return. However, this research has, itself, been the subject of adverse comment as over-stating the benefits obtained (Davidson 2006). With Australian universities unlikely to
obtain any significant financial advantage from research commercialisation, the four non-financial reasons noted by DEST (2002, p.47) must represent the most cogent reasons why university research commercialisation is important to the national economy and encouraged by the Australian Government. These four non-financial reasons are:

- to facilitate the commercialisation of research for the public good;
- to promote economic growth;
- to forge closer ties to industry; and
- to reward, retain and recruit faculty and students

Tornatzky, et al. (2002, pp.16-20), in their analysis of the role of universities in the knowledge economy\textsuperscript{36} categorised university-industry relations into three principal domains which are also used here, namely:

- **mechanisms and facilitators** of partnerships and economic development;
- **institutional enablers**, which primarily pertain to organizational culture and rewards; and
- **boundary-spanning** structures and systems.

Adopting these headings permits a coherent structure to be applied to the analysis of university-government-industry relationships, and it is these relationships that determine the effectiveness of universities as sources of innovation and contributors to the national economy. Because it provides a coherent theoretical approach, the three principal domains developed by Tornatzky, et al. (2002), expanded somewhat to embrace not only the university but also the broader environment in which universities operate, are used below to describe the Australian university research commercialisation system.

### 4.2 Mechanisms and Facilitators

Governments in Australia at national and State/Territory level have taken steps to encourage and promote university commercialisation (Harman 2005b). At the national level, the Australian Government has three principal areas of activity that influence university commercialisation practices:

- Legislation – enacted through the Australian Parliament on matters such as intellectual property\textsuperscript{36},

\textsuperscript{36} These authors, on behalf of economic development agencies in the Southern US, undertook an identification and analysis of the characteristics of the twelve best-performing US universities in terms of high-quality business-higher education partnerships. Another useful way to analyse the environment is developed by Bozeman (2000) with his Contingent Effectiveness Model.
• Fiscal – such as influencing the venture capital industry through fiscal incentives to undertake certain activities such as research, commercialisation and linkages\textsuperscript{37}, through the general taxation regime which affects incentives to invest in commercialisation (Rider, \textit{et al.} 2006), and by providing incentives to researchers to undertake commercialisation through schemes such as linkage grants\textsuperscript{38}, and

• Policies – which are reviewed, developed and implemented through two principal agencies: the Department of Education, Science and Training (DEST) and the Department of Industry, Tourism and Resources (DITR) and their respective predecessor agencies. In addition, the Australian Government has established entities which analyse and inform the Government on particular issues relevant to commercialisation, such as: the Office of the Chief Scientist\textsuperscript{39}, the Prime Minister’s Science, Engineering and Innovation Council\textsuperscript{40}; the Australian Biotechnology Advisory Council\textsuperscript{41}; the Industry Research and Development Board\textsuperscript{42}; the Co-ordinating Committee on Science and Technology\textsuperscript{43}, the Rural Industries Research and Development Corporation\textsuperscript{44}, and the Business-Industry-Higher Education Collaboration Council\textsuperscript{45}.

Australia’s eight State and Territory governments have been working to influence Australia’s science and technology systems in a number of ways (Allen 2003b), with commercialisation being influenced through two principal mechanisms:

\textsuperscript{36} In particular the following Commonwealth Acts: \textit{Patents Act} 1990; \textit{Copyright Act} 1968; \textit{Trade Marks Act} 1995; \textit{Designs Act} 2003; \textit{Plant Breeder’s Rights Act} 1994; \textit{Circuit Layouts Act} 1989. Under sect. 51(xviii) of the Australian Constitution the Australian Parliament has power to make laws with respect to “copyrights, patents of inventions and designs, and trade marks”, which leaves State and Territory Parliaments to cover related intellectual property issues of confidentiality, trade secrets and such matters. As to general regulatory matters, see also: Phillips Fox (2001).

\textsuperscript{37} The number of Commonwealth and State fiscal programs includes: 39 in commercialisation; 26 offering financing; 36 supporting linkages; 6 providing loans; 13 supporting regional development; 49 in R&D; 23 supporting start-up companies; and 23 promoting technology transfer/diffusion/uptake. Source: Department of Industry, Tourism and Resources, \textit{Commonwealth and State Government Programs Supporting Innovation in Firms: At January 2003, 2003, Index A.}

\textsuperscript{38} Linkage grants are part of the National Competitive Grants Program administered by the Australian Government and are specifically intended to encourage collaborative research with a particular emphasis on linkages with industry.

\textsuperscript{39} \url{www.dest.gov.au/chiefscientist/default.htm}

\textsuperscript{40} \url{www.dest.gov.au/sectors/science_innovation/science_agencies_committees/prime_ministers_science_engineering_innovation_council}

\textsuperscript{41} \url{www.biotechnology.gov.au/index.cfm?event=object.showContent&objectId=53799C64-BCD6-81AC-197045E7DFCC6514}

\textsuperscript{42} \url{www.ausindustry.gov.au/content/az/index.cfm?Keyword=industry%20research%20and%20development%20(r%206d)%20board}

\textsuperscript{43} \url{www.dest.gov.au/sectors/science_innovation/science_agencies_committees/coordination_committee_on_science_and_technology.htm}

\textsuperscript{44} \url{www.rirdc.gov.au/}

\textsuperscript{45} \url{www.dest.gov.au/sectors/higher_education/programmes_funding/programme_categories/key_priorities/business_industry_higher_education_collaboration_council.htm}
• Legislation – because, apart from universities in the Australian Capital Territory, it is State and Territory legislation that establishes and governs Australian universities; as well as which, States have legislative competence in important business areas such as partnerships, confidentiality and trade secrets; and

• Financial – which is generally exercised through State and Territory agencies\(^{46}\) responsible for industry development in such matters as financial incentive schemes (Allen 2003b, pp.45-46). To the extent that States and Territories have any policy impact it is usually manifest through financial means delivered through these agencies.

The Australian Government has implemented a number of programs and actions designed to promote commercialisation (Allen 2003a)\(^{47}\), including that of universities, such as:

• Establishing the environment to encourage financing schemes such as Management & Investment Companies\(^{48}\), Pooled Development Funds\(^{49}\), the Venture Capital Limited Partnerships Program\(^{50}\), schemes to modify Customs Duty and GST imposts\(^{51}\) and certain taxation benefits\(^{52}\);

• Providing financing, to certain levels, at particular stages of development\(^{53}\);

• Funding technology incubators\(^{54}\);

• Funding university centres of commercialisation and entrepreneurship;

• Encouraging the development of Co-operative Research Centres (Turpin 1997);

• Removing some taxation impediments to venture capital investment in Australia\(^{55}\) (Fletcher 2004);

• Developing the Commercialisation Training Scheme, intended to train researchers in commercialisation (DEST 2006); and

\(^{46}\) As at February 2006: NSW Department of State and Regional Development; Vic Department of Innovation, Industry and Regional Development; Oda Department of State Development, Trade and Innovation; SA Department of Industry, Trade and Regional Development; WA Department of Industry and Resources; Tas Department of Economic Development; ACT Department of Economic Development; NT Department of Business, Economic and Regional Development.

\(^{47}\) For the periods 1983-1997 (Chapter 3), and 1998-2003 (Chapter 4).

\(^{48}\) Under the Management and Investment Companies Act, 1983 (Cth).

\(^{49}\) Under the Pooled Development Funds Act 1992 (Cth).

\(^{50}\) Administered by AusIndustry, part of the federal Department of Industry, Tourism and Resources.

\(^{51}\) Such as the Tradex scheme, Space Concession, and Certain Inputs to Manufacture, all administered by AusIndustry.

\(^{52}\) Such as the R&D tax concession, allowing a tax deduction for eligible research expenditure of up to 175%.

\(^{53}\) Such as R&D Start, Pre-Seed Fund, Commercial Ready Program and Biotechnology Innovation Fund.

\(^{54}\) Such as the Building on Information Technology Strengths Incubator Program (Department of Communications, Information Technology and the Arts, Building on Information Technology Strengths (BITS) Incubator Program, Annual Report 2003-2004, Commonwealth of Australia, 2005) and its successor program: ICTIP (ICT Incubator Program).

\(^{55}\) By the enactment of the Venture Capital Act 2002 (Cth).
• The establishment in 1992 of the Australian Technology Group to provide early stage equity for ventures.

This is not to suggest that the Australian Government has developed and administers an ideal environment – academe and industry both suggest that there are fiscal matters that require some substantial review (Rider, *et al.* 2006; AVCAL 2005). At the same time, an Australian venture capitalist has expressed general satisfaction with the federal regime (Aust VC1 Interview 2006) and no interviewees expressed anything approaching comprehensive criticism.

The environment created by the Australian Government and described here largely aligns Australia with current international practice in the USA (BHEF 2001; Reamer, *et al.* 2003), the UK (Lambert 2003) and Canada (Voyer 2003), although, in some cases, several years after these other jurisdictions.

Consistent with the policy intention of the Australian Government under the *Venture Capital Act* 2002, as at 2006 most Australian States and Territories have enacted legislation to permit the formation of incorporated limited liability partnerships<sup>56</sup>. The special feature of an incorporated limited liability partnership is that there is no relation of agency between the general and limited partners (Fletcher 2004). Again, this desirable step represents less a radical innovation than bringing Australia more into line with international practice.

The Australian Government has funded, with industry, a number of university-industry co-operative research centres, CRCs, in the following fields (with the number of CRC in each category as at March 2006):

• Manufacturing technology (11)
• Information and Communications Technology (9)
• Mining and Energy (8)
• Agriculture and Rural Based Manufacturing (16)
• Environment (17)
• Medical Science and Technology (8)

Of the 71 CRCs funded in 2004, only 12, or 17%, cited a non-metropolitan address as their principal location (DEST 2004a), suggesting a noticeable bias towards metropolitan and the

more established and research-oriented universities. Some analysis of the role and results of Australian CRCs has been published in academic journals by McFarlane (1999) and by the Australian Government (Howard 2003).

In addition to the CRCs, as of 2004, Australia had a number of other university-affiliated research entities, comprising: 6 ARC Key Centres for Teaching and Research, 8 ARC Centres of Excellence, 8 ARC Centres, 16 ARC Special Research Centres, and 14 Rural Research and Development Corporations (Australian Government 2005).

The equivalent of CRCs can be found in other jurisdictions, for example Industry/University Co-operative Research Centres (IUCRC) and Co-operative Research and Development Agreements (CRADAs) in the US, Collaborative Research and Development in the UK, and Networks of Centres of Excellence (NCEs) in Canada.

Research on Australian commercialisation has tended to concentrate on a limited number of issues, such as the Australian Graduate School of Entrepreneurship at Swinburne University which has conducted in-depth analysis of the spin-off company as the mode by which ideas can be taken to market (Yencken and Gillin 2002); and the involvement of SMEs in commercialisation (Milton-Smith 2001; DITR 2002a). However, the following observation made by Burgio-Ficca (2001, p.263) remains substantially true in 2008: “...despite a growing body of literature on the benefits and/or spillovers of R&D, surprisingly little work has been undertaken on the actual contributions of the higher education sector to R&D”.

4.3 Institutional Enablers

Australian universities have not, until relatively recently, systematically sought to exploit the outcomes of science research through commercialisation. Where exploitation of ideas happened previously it relied, substantially, on individual academic staff having either a peculiar entrepreneurial bent or a personal relationship with an appropriate industrial partner.

57 Australia’s metropolitan population comprises a little over 60% of the total population: ABS 1301.0 Australian Year Book 2001.

56 The number and areas of research of CRCs and other entities varies over time as funding and research priorities change, however, the fact remains that there are a significant number of university-related commercial research entities.

58 There are many others in the UK, including: Partnerships for Research and Innovation, Knowledge Transfer Partnerships, and Knowledge Transfer Networks.

59 There are many others in Canada, some national and some provincial, including: Collaborative Research and Development Grants, Ontario Centres of Excellence, Research Partnership Agreements, and University-Industry Program.
A recent but important development by most universities in systematising commercialisation is the creation by most universities of a TTO (sometimes a commercialisation company)\(^{61}\). The role of TTOs varies between institutions but, in general terms, their role embraces some or all of the following activities (KCA 2003, p.11):

- Educating and creating awareness of intellectual property processes and requirements amongst researchers;
- Assisting researchers with their intellectual property and patent protection;
- Assessing market potential;
- Identifying potential industry partners and collaborators;
- Negotiating license agreements;
- Forming start-up companies; and
- Finding investors and industry partners.

Analysis of the effectiveness of commercialisation offices has been undertaken overseas on several occasions (Debackere and Veugelers 2005; Siegel, \textit{et al.} 2004), but little research appears to have been undertaken in Australia.

In Australia, the University of Queensland commercialisation company, UniQuest\(^{62}\) is one of the world’s more successful TTOs. Its charter is “…to identify, package and commercialise university technologies and expertise” (UniQuest 2004, p.4). UniQuest sees itself as having two major interfaces: with industry, business and government at one level; and with university researchers at the other. Amongst smaller Australian universities Swinburne University of Technology established its commercialisation abilities through \textit{Swinburne Knowledge}, which states its role as being “… broadly to facilitate, support, and monitor some of the University’s commercialisation activities”\(^{63}\). It says that, as a smaller university, it believes the best commercial returns are achieved through spinning-off companies. As at November 2007, UniQuest has a staff of over 70 plus a board of 9, while Swinburne Knowledge has two professional staff.

There may be more effective ways of structuring university TTOs than the present one-office-per-university model, such as consolidating offices either geographically (so that one office operates on behalf of more than one university) or by discipline (so that one office may

\(^{61}\) The earliest Australian university commercialisation office was formed in 1959 at the University of New South Wales, but the creation of offices in universities has been generally quite slow, with only ten established by 1992; source: Allen (2003a).

\(^{62}\) UniQuest is the commercialisation company of the University of Queensland: \url{http://www.uniquest.com.au}

\(^{63}\) Retrieved from the website of Swinburne University of Technology 15 Feb 2008: \url{http://www.swin.edu.au/corporate/knowledge/}
specialise in, for example, information and communications technology). A recommendation made by Lambert (2003, Recommendation 4.2) was to the effect that universities should establish and share common services within regions to support technology transfer. A recent development in Australia involved an agreement between UniQuest, located in the State of Queensland, and the University of Wollongong, in the State of New South Wales and located some 1,000km from Queensland, entered in November 2004, under which UniQuest assumed the lead role in commercialising research on behalf of Wollongong University. This development is philosophically similar to Lambert’s suggestion, but demonstrates that geographic proximity is not a pre-requisite to co-operation between universities; indeed, proximity, and the rivalry that arises from it, may be an impediment to sharing resources locally.

Protection of Australian university intellectual property is governed by the general law – there is no Australian legislation specifically affecting universities such as the US Bayh-Dole Act which reserves to universities ownership of intellectual property developed from federally-funded research. Australian universities have acted to identify, protect and exploit valuable intellectual property in two ways: through sets of agreed principles developed collectively by representative organisations; and through individual statutes, policies and procedures in each university.

There are two documents that have been developed by representative entities that have a major influence on intellectual property management in universities:

- the National Principles of Intellectual Property Management for Publicly Funded Research (the “National Principles”) (ARC, et al. 2001); and


The National Principles were drafted by parties that represent most major publicly-funded research interests in Australia, and are intended to apply to entities such as the Australian Government’s Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Defence Science and Technology Organisation (DSTO), as well as universities. The National Principles were developed “to assist researchers, research managers and their research institutions, in ensuring that they have access to best practices for the identification, protection and management of intellectual property, and therefore, to maximise the national benefits and returns from public investment in research” (ARC, et al. 2001, p.2). But they have no force in themselves and, to be effective in individual universities, have to be adopted by incorporation into the intellectual property policies and procedures of each university.
The Policy Guide was developed specifically for universities because the AVCC observed (Policy Guide, p.6) that: “…ownership of IP in universities (13 February 2001) shows a diversity of practices as to views on copyright ownership”. The Policy Guide was developed to provide “advice on how to deal with questions of ownership of intellectual property generated within the institution by staff, students, under agreements with outside bodies, and under grants or sponsorship” (Policy Guide, p.5). Like the National Principles, the Policy Guide has no force and effect in any university unless its recommendations are incorporated into individual university policies and procedures.

Just as the AVCC observed in 2001, it remains the case in 2008 that Australian universities have diverse policies and procedures affecting intellectual property. Each university has its own set of intellectual property policies and procedures, and no two appear to be the same. Few universities have adopted the National Principles in toto (explicitly or by necessary implication) and, notwithstanding the Policy Guide, there remains a diversity of approaches to intellectual property ownership. The uncertainty bred by this diversity of approach to intellectual property remains a matter of some concern to Australian industry (Howard 2006; AIG 2002) and has been increased by the 2008 case of University of Western Australia -v- Gray and others (No 20) [2008] FCA 498 involving research generated at a university, discussed later.

Almost certainly the most important component in successful commercialisation is the human component. The Australian Government has undertaken a survey of the university commercialisation environment in general (DEST 2004b), as well as the particular issue of incentives for involvement in research commercialisation (DEST 2005b). Without adequate incentives to engage in commercialisation, academic staff may not participate with enthusiasm. Incentives are of two principal types: those that provide a benefit to individual academics; and those that ameliorate some adverse consequence.

Benefits to academics come in several forms, the most usual being relief from teaching obligations, monetary reward, enhanced reputation, and promotion. One of the most common benefits academic researchers receive is relief in their teaching load while they participate in industry-related activities such as commercialisation. The monetary benefit to researchers is generally described in individual university intellectual property policies and procedures. Academic reputation increases, generally, from peer recognition, most usually from publication in reputable books and journals. There is often a potential conflict between the need to maintain some degree of secrecy in order to preserve intellectual property rights for TT&C purposes and the desire of academics to publish. Publications also have a significant influence on promotion prospects. The other factor influencing promotion is the weight (where it applies) given to commercialisation activities by universities when assessing
academic staff for promotion. Many Australian universities claim to value commercial activities when assessing staff for promotion, but whether this applies in reality needs further investigation.

Academic faculty may be disinclined to engage in commercialisation unless potential adverse consequences are sufficiently minimised. Probably the largest of these is the cost of establishing intellectual property rights and the financial risk attending commercialisation failure. Both of these consequences are significantly reduced for individuals when the university itself undertakes to obtain intellectual property protection and becomes the entity that licenses intellectual property or establishes the commercial venture to exploit the intellectual property. The circumstances when individual universities will assume these costs and risks are prescribed in the intellectual property policies and procedures of individual universities.

### 4.4 Boundary-spanning Structures and Systems

Links between industry, financiers and universities are facilitated in Australia through entities such as:

- the Australian Institute for Commercialisation (AIC);
- Knowledge Commercialisation Australia (KCA);
- the Australasian Research Management Society (ARMS);
- the Licensing Executives Society of Australia and New Zealand (LESANZ);
- Organisations representative of science and technology practitioners, such as the Federation of Australian Scientific and Technological Societies (FASTS) and the Australian Academy of Technological Sciences and Engineering (ATSE);
- the Australian Industrial Research Group;
- On-line and other mechanisms to disseminate ideas from research and promote linkages between researchers and industry.

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64 In Australia, the Group of 8 research universities rank commercialisation as a criterion for promotion slightly higher (50% vs 42% for all universities); Technology universities place noticeably greater emphasis on commercialisation as a criterion for promotion than universities on average (80% vs 42% for all universities); Regional universities rank commercialisation as a criterion for promotion slightly lower (38% vs 42% for all universities). Figures here are derived from university published criteria for academic promotion to Level D (Associate Professor) compiled by the author.


66 [www.kca.asn.au](http://www.kca.asn.au)


68 [www.lesanz.org.au](http://www.lesanz.org.au)

69 [www.fast.org](http://www.fast.org)

70 [www.atse.org.au](http://www.atse.org.au)

71 [www.airg.org.au](http://www.airg.org.au)
• University TTOs;
• Co-operative Research Centres and similar entities (Howard 2003)\textsuperscript{73};
• the Australian Private Equity and Venture Capital Association Limited (AVCAL)\textsuperscript{74}
• Business-Higher Education Round Table\textsuperscript{75};
• Business Industry and Higher Education Collaboration Council\textsuperscript{76}; and
• Industry associations.

There are also a number of links being created between individual financiers such as superannuation funds (that are generally prepared to finance longer-term opportunities) and research groups. For example Western Australia’s largest superannuation fund, Westscheme, has offered funding for the development of university technologies through Uniseed (a joint venture originally between UQ Holdings/Uniquest and Melbourne University) up to $15 million, and with Murdoch University $12.5 million over 10 years\textsuperscript{77}.

Some Australian industry associations that have an interest in this area include:

• Australian Industry Group\textsuperscript{78};
• Australian Electrical and Electronics Manufacturers’ Association\textsuperscript{79};
• Australian Telecommunications Users’ Group\textsuperscript{80};
• Australian Information Industry Association\textsuperscript{81};
• Australian Computer Society\textsuperscript{82};
• Australian Interactive Media Industry Association\textsuperscript{83}, and
• Australian Chamber of Commerce and Industry\textsuperscript{84}.

Some other groups and associations that represent participants in research, development and innovation generally, include:

\begin{footnotesize}
\begin{itemize}
\item[72] For example: www.aussieopportunities.com
\item[73] www.crca.asn.au
\item[74] www.avcal.com.au
\item[75] www.bhert.com/default.htm
\item[76] http://www.dest.gov.au/sectors/higher_education/programmes_funding/programme_categories/key_priorities/business_industry_higher_education_collaboration_council.htm
\item[77] Reported in KCA News, June 2005, p.5. Uniseed now includes the commercialisation arm of the University of NSW, New South Innovations. See Uniseed at: http://www.uniseed.com/
\item[78] www.aigroup.asn.au
\item[79] www.aeema.asn.au
\item[80] www.atug.com.au
\item[81] www.aiia.com.au
\item[82] www.acs.org.au
\item[83] www.aimia.com.au
\item[84] www.accia.asn.au
\end{itemize}
\end{footnotesize}
• ANZA Technology Network\textsuperscript{85} - formed to connect Australian, New Zealand and US technology executives, showcase Australian and New Zealand technology companies and executives in the US, and to educate Australian and New Zealand technology executives on how to perform better in the US;

• Technology Parks and Incubators Association\textsuperscript{86} - established to promote technology transfer, innovation and entrepreneurial growth in Australia, specifically through science and technology research parks and incubators;

• Innovation Exchange Network\textsuperscript{87} - which provides a secure, managed environment for the connection of insights and opportunities between business, universities and governments through the deployment of skilled individuals; and

• Australian Universities Community Engagement Alliance Inc\textsuperscript{88} – which was established in order to promote the social, environmental and economic and cultural development of communities.

Australia has a number of technology parks and incubators, some of them associated with universities. Incubators in the ICT field have been established systematically by the Australian Government since 1999 and reports indicate their success (DCITA 2006; Allen 2003d). There is also some anecdotal evidence on the effectiveness of incubators generally in helping new high-technology businesses survive the first few years of corporate life (Sime 2004).

Boundary spanning systems and structures exist in all advanced economies; many of them, such as the Licensing Executives Society, exist in each of them. However, Australia suffers a significant deficiency in terms of entities that assist in providing the bridge between research and industry. It is not alone in this. Industry Canada has recently recommended the establishment of a national Commercialisation Partnership Board (Industry Canada 2005, pp.9-10) to supplement Provincial efforts; while, on the other hand, the United States has had private sector entities involved in this for decades – for example, Battelle Memorial Institute, a major participant, was established in 1929; while intermediaries are still relatively new to the UK, such as the Scottish Intermediary Technology Institutes which were established in 2003\textsuperscript{89}, Imperial Innovations\textsuperscript{90} and other private intermediaries, most of which

\textsuperscript{85} \url{www.anzatechnet.com/}
\textsuperscript{86} \url{www.tpla.org.au/}
\textsuperscript{87} \url{www.ixc.com.au}
\textsuperscript{88} \url{www.aucea.net.au/}
\textsuperscript{89} \url{www.itiscotland.com}
\textsuperscript{90} Imperial Innovations existed for many years as the TTO of Imperial College but, in its current incarnation as a company listed on the London Stock Exchange Alternative Investment Market as Imperial Innovations plc (mnemonic IVO), it has existed only since 2005.
date from the early 2000s. In his report to the Australian Government then Chief Scientist, Dr Robin Batterham (2000) recommended the creation of Innovation Centres, along the lines of those extant in the UK, for the purpose of connecting researchers with commercial ability to evaluate opportunities and suggest the most appropriate paths for commercialisation, to help address the less than critical mass seen in some of the numerous commercialising arms of the universities, and to bring in the PFROs and encourage collaboration and consolidation. However, while some States and individual universities have created entities called innovation centres, nothing along the lines proposed by Dr Batterham has been established.

4.5 Australia’s Universities

Australia presently has thirty-nine universities which are represented by one principal organisation, Universities Australia91, but also by a number of organisations representing the interests of particular groups of universities92.

Details about each of the universities can be found in Universities Australia’s handbook (AVCC 2006).

The general regulatory environment applying to Australian universities is described by law firm Phillips Fox (2001).

4.6 Australian Universities’ Research

The three major divisions of Australian university research were identified earlier as:

- Medical and health sciences and biological sciences93 (life sciences);
- Science disciplines; and
- All other disciplines (HASS).

The research and experimental development expenditure reported by Australian universities for 2004, set out in table 4.1 (DEST 2007, Table 30), provides some idea of the relative scale of research undertaken by each of Australia’s universities.

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91 [http://www.universitiesaustralia.edu.au](http://www.universitiesaustralia.edu.au), formerly the Australian Vice-Chancellors Committee (AVCC)
92 In particular: the Group of 8 research intensive universities; the Australian Technology Network; and the Innovative Research Universities.
93 In accordance with Australian Standard Research Classification (ASRC) ABS 1297.0, 1998.
<table>
<thead>
<tr>
<th>University</th>
<th>Research and Experimental Development Expenditure 2004 (AUD million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Melbourne</td>
<td>428.6</td>
</tr>
<tr>
<td>University of Sydney</td>
<td>331.2</td>
</tr>
<tr>
<td>Monash University</td>
<td>328.8</td>
</tr>
<tr>
<td>Australian National University</td>
<td>317.9</td>
</tr>
<tr>
<td>University of Queensland</td>
<td>304.5</td>
</tr>
<tr>
<td>University of New South Wales</td>
<td>216.1</td>
</tr>
<tr>
<td>University of Adelaide</td>
<td>128.6</td>
</tr>
<tr>
<td>LaTrobe University</td>
<td>125.3</td>
</tr>
<tr>
<td>University of Western Australia</td>
<td>122.1</td>
</tr>
<tr>
<td>Griffith University</td>
<td>105.2</td>
</tr>
<tr>
<td>Curtin University of Technology</td>
<td>86.5</td>
</tr>
<tr>
<td>Queensland University of Technology</td>
<td>85.3</td>
</tr>
<tr>
<td>University of Tasmania</td>
<td>77.2</td>
</tr>
<tr>
<td>University of Newcastle</td>
<td>67.8</td>
</tr>
<tr>
<td>Macquarie University</td>
<td>67.4</td>
</tr>
<tr>
<td>University of South Australia</td>
<td>64.2</td>
</tr>
<tr>
<td>Murdoch University</td>
<td>63.1</td>
</tr>
<tr>
<td>University of Wollongong</td>
<td>59.7</td>
</tr>
<tr>
<td>Deakin University</td>
<td>55.6</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>University</th>
<th>Research and Experimental Development Expenditure 2004 (AUD million)</th>
</tr>
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<tbody>
<tr>
<td>University of Western Sydney</td>
<td>48.7</td>
</tr>
<tr>
<td>Flinders University</td>
<td>47.1</td>
</tr>
<tr>
<td>University of Technology, Sydney</td>
<td>45.9</td>
</tr>
<tr>
<td>RMIT University</td>
<td>42.5</td>
</tr>
<tr>
<td>University of New England</td>
<td>40.8</td>
</tr>
<tr>
<td>James Cook University</td>
<td>32.0</td>
</tr>
<tr>
<td>Victoria University</td>
<td>29.8</td>
</tr>
<tr>
<td>Swinburne University of Technology</td>
<td>27.7</td>
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<tr>
<td>Edith Cowan University</td>
<td>25.8</td>
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<tr>
<td>Charles Darwin University</td>
<td>20.5</td>
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<tr>
<td>Southern Cross University</td>
<td>12.1</td>
</tr>
<tr>
<td>Central Queensland University</td>
<td>11.6</td>
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<tr>
<td>Australian Catholic University</td>
<td>10.4</td>
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<tr>
<td>Charles Sturt University</td>
<td>8.2</td>
</tr>
<tr>
<td>University of Ballarat</td>
<td>7.6</td>
</tr>
<tr>
<td>University of Canberra</td>
<td>3.7</td>
</tr>
<tr>
<td>University of the Sunshine Coast</td>
<td>1.9</td>
</tr>
<tr>
<td>Bond University</td>
<td>0.3</td>
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<tr>
<td>University of Notre Dame Australia</td>
<td>0</td>
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</tbody>
</table>

Table 4.1 – University Research and Experimental Development Expenditure 2004 Source: DEST (2007, Table 30)

The Australian Bureau of Statistics defines four levels of research\(^4\):

- Pure basic research
- Strategic basic research
- Applied research
- Experimental development

This distinction is relevant when considering which types of research may be commercialised by which route over what timeframe. Generally speaking, research at more basic levels requires more time and work before being ready for commercialisation by industry, with implications in terms of the need for early-stage funding.

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\(^4\) ABS 1297.0-1998 Australian Standard Research Classification
4.7 Australian Universities’ Research Commercialisation

4.7.1 Commercialisation Model

The Productivity Commission (2007, p.xxiii) stated that:

“Universities’ core role remains the provision of teaching and the generation of high quality, openly disseminated, basic research. Even where universities undertake research that has practical applications, it is the transfer, diffusion and utilisation of such knowledge and technology that matters in terms of community wellbeing. Commercialisation is just one way of achieving this. The policy framework for universities should encourage them to select the transfer pathway that maximises the overall community benefits, which will only sometimes favour commercialisation for financial gains”.

Philosophically at least, TT&C is not generally to be undertaken for profit.

In Australia the exploitation of research outcomes through TT&C is, on common measures, dominated by the Group of 8 research-intensive universities as shown, for example, in the 2001 data compiled by DEST (2003b, p.30), shown in Figure 4.2.

![Figure 4.2 - Commercialisation data by broad university grouping, as a percentage of national total](source: DEST (2003b, p.30))

Since the early 1990s, universities have applied greater system to the creation, identification, capture, protection, dissemination and exploitation of ideas generated within their institution. Each of these steps, namely: creation, identification, capture, protection, dissemination and
exploitation of ideas, has been the subject of some new approaches by universities, but not, it should be noted, by all universities.\footnote{For example, as of March 2006, only 25 of Australia’s universities are members of Knowledge Commercialisation Australia (KCA), the Australian association dedicated to knowledge transfer from public sector organisations such as university research arms (all Group of 8 universities are members, as are 4 of the 5 ATN universities). In addition, not all Australian universities have established a TTO.}

The environment and culture of universities have a profound influence on the likelihood that research will be commercialised. Such matters within the control of universities include: intellectual property policies, procedures and practices; the effect of involvement in commercialisation on the promotion prospects of academic staff; and the way in which issues of risk and conflicts of interest are handled by the university in the context of commercialisation.

Where there is insufficient incentive to encourage individual researchers to engage in commercialisation, or where the impediments are too great, universities will have limited success. Incentives include matters like the financial benefit to the researcher, while impediments include commercialisation not being a factor in promotion:

“…it appears that the propensity of faculty members to disclose inventions, and thus increase the “supply” of technologies available for commercialisation, will be related to promotion and tenure policies and the university’s royalty and equity distribution formula”. (Siegel, et al. 2003a, pp.44-45)

The classic model for TT&C expounded by the OECD sets out what is called the chain link model, shown in Figure 4.3 (OECD 1994; DEST 2003a), but there are numerous models (Mohannak 1999; UVAPF 2004).

![Figure 4.3 - OECD Chain Link Model of Commercialisation](image)

Pure and strategic basic research are most usually undertaken in universities without industry funding or participation so, in the event that they give rise to an invention or discovery, commercialisation will require the identification of a suitable industry partner or the
creation of a spin-off company. Applied research, which is undertaken primarily to acquire new knowledge with a specific application in view, may be done with or without an industry partner, depending largely on where it is conducted. For example, if it is done through a CRC, it will already have an industry partner; while if done in a university department, it well may not. Experimental development, given its applied nature, may well have an industry partner involved or be readily useable by industry.

Analysis of various aspects of the Australian model of university commercialisation discloses that there are ten principal activities (environment, commercialisation training, through to relationship and contract management), and at least ten entities involved in these activities as illustrated in Table 4.4. This is not to suggest that each entity always has a role in the functions marked, rather to show that there are particular circumstances in which they can and have been involved.

<table>
<thead>
<tr>
<th>Function</th>
<th>Australian Government</th>
<th>State Governments</th>
<th>Universities</th>
<th>Commercialisation Offices</th>
<th>Research Funding Agencies</th>
<th>Financiers</th>
<th>Intermediaries</th>
<th>University Associations (AVCC, Go8)</th>
<th>Consultants &amp; Lawyers, etc</th>
<th>Business/Industry</th>
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<td>Environment</td>
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<td>Commercialisation Training</td>
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<td>Funding Research</td>
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<td>Patenting and Protection</td>
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<td>Market analysis and linkages</td>
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<td>Marketing ideas and research</td>
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<td>Negotiating agreements</td>
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Table 4.4 – Matrix Describing the Australian University Commercialisation Model  Source: Author
4.7.2 Fields of Commercialisation

It was noted earlier that Howard (2005b) identified three “output indicators”, which require the involvement of a TTO: patenting and licensing (and income streams from them); spin-off company formation; and contract research and consulting.

If contract research and consulting are treated as separate activities, Howard’s list mirrors the activities undertaken by Australia’s leading university commercialisation entity, UniQuest, which identifies its principal four modes as: consulting, contract research, licensing, and spin-off companies. These four modes are identifiable across all universities, although some TTOs may not be engaged in all of them, nor may some individual universities even presently consider one or more component as research commercialisation. Each of these four modes has a different means by which it delivers its output to the community, achieves different results for the university and individual faculty members, and requires a different set of environmental and contextual factors to encourage its successful practise. There are modes of diffusion of knowledge in addition to these four (in particular joint ventures such as co-operative research centres), but these are not so much modes of commercialisation, as specialised vehicles through which certain types of research are conducted jointly by industry and university. The research outputs from these vehicles often are not owned by the university and, therefore, are not the university’s alone to deal with.

Because the bulk of university TT&C involves life sciences, IT and telecommunications, and electrical engineering, it could be postulated that the presence of a medical school and/or and engineering school in universities would be an essential element in successful TT&C. Evidence from the literature, however, finds no such correlation. According to Powers (2003, p.40):

“… having either a medical or engineering school was not a significant predictor of any of the measures of technology transfer performance. This result suggests that institutions with one of these units on their campus do not outperform their counterparts that do not have one”.

Maybe this can be explained, in part, because many universities conduct life sciences research without having a medical school (such as some ATN universities), so the predictor is not strong. As Powers observed, this could also be because some of the blockbuster results have come from chemistry departments and, maybe, not all medical schools are equal. Other factors that appeared irrelevant to TT&C performance (at least as far as patent output was concerned) included whether the university was private or public, and the presence of high levels of venture capital in the State (although Powers said this may be anomalous). He found that differences occurred between universities based on factors such as the quality and reputation of the academic staff (the dominant factor) and R&D funding levels, and that (p.43):
“... it appears that universities with stronger overall climates for entrepreneurship (and hence the greatest likelihood for licensing opportunities with smaller firms), enjoy a small performance advantage over institutions located in states with weaker external environments of this kind”.

4.7.3 Metrics

With at least three perspectives on research commercialisation: industry, government, and university, the metrics applying to one are unlikely to be relevant to all others. Further, it is not possible to apply the same metrics to each of the four fields of commercialisation identified. Some examples are needed to explain this almost intractable issue.

Industry is concerned to turn ideas from researchers into products, processes or services that can be sold in the commercial marketplace for a profit. This requires nothing more than a constant stream of good ideas, at the lowest cost, with the greatest degree of monopoly that can be lawfully obtained, acquired as close to a marketable product, process or service as possible, with all the assistance it needs to take the resulting innovation to market. Industry is less concerned with the numbers of patents a university seeks or agreements it enters in a year, but is concerned with them being commercially viable – something that can only be tested in the marketplace.

Government will measure a university’s research commercialisation performance by such factors as the additional economic activity and jobs it generates, preferably in high-technology. National governments may take a broader perspective than State or local governments, with the latter two more concerned with regional economic development (Renault, et al. 2007). The ability to measure marginal economic performance attributable to specific innovations is notoriously difficult to measure, and often arrives years, even decades, after a discovery has been made (Allen 2003a).

Universities, on the other hand, can (and usually do) keep records about what they do, and are accustomed to supplying these to government agencies. Each year universities collect information about research funds expended, the number of researchers engaged at what level in what area, the number of discoveries disclosed by researchers, the number of patents sought and obtained, licenses negotiated and concluded and the funds received from them, and the number, type and income from various consultancies and research contracts. Because universities usually have such information, it has become the de-facto standard by which research commercialisation performance is judged (DEST 2004b, 2007; ASTP 2006; AUTM 2007b, 2007c). The Australian Government agency charged with the responsibility of measuring research commercialisation performance, DEST, has undertaken a worthy review of the metrics (DEST 2005a). But for practical reasons it has had to continue using data collected by the university, which thus presents a reasonably narrow view of
commercialisation. There remains a great deal of criticism about using these readily collected data for defining research commercialisation performance. For example, MIT operates at international best practice in research commercialisation, and is probably the university of choice among venture capitalists looking for opportunities (US VC Interview 2007). But even at MIT, analysis of technology transfer shows that only 7% of the knowledge transferred from the highly-regarded Mechanical and Electrical Engineering Departments takes the form of patented inventions (Agrawal and Henderson 2002, p.45).

A further significant challenge in measuring research commercialisation performance arises in the case of creative industries and HASS. There are increasing expectations that HASS and the creative fields will engage in more commercialisation activity in the future: (Hearn, et al. 2004; DEST 2005c; Harman 2005a). Because so much of the product of these fields is capable of protection only by copyright (rather than the patents typical in life sciences), and given that there is no method of registration of copyright in Australia, there is presently no suitable metric capable of capturing the commercialisation impact of HASS and creative industries.

The number of patents has been used as a metric of university commercialisation performance for many years by organisations such as AUTM, KCA and government agencies such as DEST. Patent numbers are a popular metric among economists, largely because they are readily available, describe a tangible output, and results arising from their analysis are reproducible. But they are a very narrow metric with, arguably, limited potential to describe the commercial results being achieved by universities (Renault, et al. 2007). Evidence presented by Agrawal and Henderson (2002, p.45) appears to support this view when they said, speaking of the commercially-oriented Mechanical and Electrical Engineering Departments at MIT:

“Our results suggest that a focus on patenting as a measure of the impact of university research must be carefully qualified by the recognition that patenting may play a relatively small role in the transfer of knowledge out of the university. As one might expect, for the faculty in our target departments, publishing academic papers is a far more important activity than patenting. In fact, only a small fraction of the faculty patent at all. On average, only about 10-20% of the faculty patent in any given year, and nearly half of the faculty in our sample never filed a patent during the 15-year period under investigation. In contrast, an average of 60% of the faculty publish in any given year and less than 3% never publish over the same period”.

The use of patents as a proxy for commercialisation activity by universities is rather unsatisfying for two further reasons. First, it fails to capture the other major modes of TT&C activity such as spin-off companies and licensing where no patent is involved, nor of consultancy or contract research. Second, the literature on the efficacy of patents as proxy for commercialisation activity is not compelling. The review by Duguet and MacGarvie (2005, p.389) found:
“... qualified support for the premise that patent citations are associated with flows of new technology. Patent citation counts contain relevant information on technology flows for some, but not all, of the channels through which firms claim to obtain new technology. However, the validity of using citations to measure knowledge flows varies with the source or destination of the knowledge transmitted and the channel through which it is transmitted”.

Another common metric of university TT&C performance has been, and remains, the number of invention disclosures. This metric is used in the revised and current Australian survey (DEST 2007) as well as those by AUTM (2007b, 2007c). The real difficulty with the approach of using as metrics those things that can be readily measured is highlighted by the unreliability of factors such as invention disclosures. As Jensen, et al. (2003, p.1291) related from their extensive survey:

“The directors [of TTOs] we talked with believe that some of the best inventions may not be disclosed because the most productive faculty are less likely to want to take the time to disclose inventions, much less work on further development. They also believe that many of the inventions disclosed to them are of questionable value. This suggests that the nature of inventions disclosed in U.S. universities is related to faculty quality, but perhaps in unanticipated ways”.

If this view is correct, it highlights that numbers such as invention disclosures (and it is not limited to this metric alone) are not a cogent metric of anything in particular and could well be subject to manipulation.

The challenge of measuring the results of commercialisation and the inadequacy of patents as a principal source of information is reflected in the comments of many researchers in the field. For example, Trajtenberg, et al. (1997, p.19), commented that:

“... progress in many areas of economics is often limited by the lack of empirical counterparts to the theoretical constructs that we believe to be important. This problem is particularly severe in the economics of technical change, where it is difficult to find good indicators even for such fundamental notions as the rate of invention or the value of innovations. Many widely used measures, such as simple patent counts or counts of identified innovations, are severely limited in that they cannot account for the enormous heterogeneity of research projects and outcomes that characterizes the R&D process”.

The authors then proposed a more elaborate analysis of patent data which still suffers from the limitation of relying on a narrow data set.

Lee (2000) continued the theme of the difficulty in attempting to calculate the economic benefits of university-industry collaboration. He said (p.112) that a calculation of return on investment, for example:

“... requires that we delineate the costs incurred to collaboration and the benefits derived from it. In reality, precise delineation, especially in the university-industry collaboration, is generally not possible because the costs and benefits, for the most part, cannot be reduced to commonly agreed economic measures. What is more, the costs and benefits are not closely related in time and space”.

The essence of the issue was summarised elegantly by the Productivity Commission (2007, p.280) when it said that, ultimately, “... in terms of community wellbeing, it is the transfer,
diffusion and utilisation of knowledge and technology that matters”. It went on to identify four factors that characterise the social rate of return from public investment in R&D:

- whether the knowledge and technology are transferred out of universities (that is, whether they see the light of day);
- how fast and widely the knowledge diffuses among potential users;
- whether the knowledge and technology is developed into some form of practical application (that is, whether it is taken up in some form or other that is welfare enhancing); and
- how widely the resulting innovation is used.

The difficulties attending measuring TT&C is well captured by PhillipsKPA (2006, p.36) in its report covering knowledge transfer and Australian universities:

“There may, however, be a fundamental limit to how comprehensive any knowledge transfer measurement system can be. If institutions are genuinely responsive to the needs of non-academic users of knowledge and their respective communities, then knowledge transfer initiatives will be uniquely shaped according to those needs, the academic strengths of the institution and the nature of the participating academic disciplines”.

There are still significant problems attending the metrics that are used when analysing TT&C in Australia and elsewhere, a problem that could be the subject of yet further research. It illustrates that, based on the present state of knowledge, using numerical indicators to rate TT&C performance is fraught with unreliability, and it is for this reason that the use of qualitative methods, in this project case studies, should produce results that are valid and intellectually satisfying. Nonetheless, it is difficult not to feel some sympathy for the view expressed by Hanson, et al. (1999, p.195) when criticising an increasing tendency to measure science, a criticism equally applicable to the commercialisation of science:

“... the tendency towards ever more (pseudo) precise measurement of outputs must be reversed. This will take time because it is embedded in carefully constructed bureaucratic careers as well as a still dominant modernist mind-set. Although management and accountability are inevitable, the trend towards measurement over research needs to be reversed”.

In the absence of better metrics, this project has been obliged to use, where necessary, the data collected by official sources such as DEST (2004b, 2007) and AUTM (2007b, 2007c) with all their attendant limitations. At the most basic level, a TTO is successful if it is able to generate sufficient income to pay for its continued operation. In fact most presently fail to do even this. The next level of achievement after the basic level is to generate a surplus of income in order to invest in nascent discoveries at the point where private capital is not available. The funds to do this are often supplemented by money from government or not-for-profit foundations. At the superior level of performance TTOs achieve both of these outcomes as well as return cash in the form of dividends to the general purposes of the
university. There are few universities in the world at this level, and only UniQuest in Australia has been able to do this consistently for many years.

4.7.4 University-Industry Interaction

Universities have not historically been concerned with developing a suite of intellectual property across a series of disciplines to address a particular industrial need. It has been more in the manner of research leading to the serendipitous discovery of a product or process that may have some industrial application. This is the one-off model of licensing, described by Martin, et al. (2004, p.170) in the following terms:

“University inventions are disclosed as discrete, early-stage solutions to problems defined by government agencies or academic disciplines, which are licensed as single discrete units, usually during some early part of the patent life cycle. Universities tend to produce inventions in incremental pieces across diffuse domains without any market context, making the commercialization value of inventions all but unpredictable”.

While there may be a general perception that licensing and spin-off companies are the stand-out performers of the four modes of TT&C, income from these two categories can often rely upon results that occur infrequently and take a long time to mature to commercial outcomes, while the other two modes (consulting and contract research) represent a more stable and consistent source of income. For example Australia’s leading university commercialisation entity, UniQuest, reported that its income in each of the four categories for the period 2000-2005 was (UniQuest 2006):

- Consultancy contracts $24.2 million
- Contract research $40.5 million
- Royalty and licence payments: $23.1 million
- Value of shares in spin-off companies: $22.4 million

UniQuest performance demonstrates the importance to the university of consultancy and contract research in earning commercialisation revenue. Also, revenue from both of these sources can be earned across the range of academic disciplines and need not be skewed in favour of the life science and ICT-related disciplines which usually dominate royalties and licence payments and spin-off company results.

One of the difficulties in using existing scholarly analysis dealing in university research commercialisation is that there is little recognition given to these multiple sources of commercialisation income. Economists’ preference for hard numbers such as invention disclosures or patent numbers gives a very narrow view of university research output, and one that is largely relevant to spin-off companies and licence agreements, neglecting the substantial commercialisation results evident in consultancy and contract research which, on UniQuest performance, could dominate when included in TT&C metrics.
An interesting route to Australian university research commercialisation was proposed by the Deputy Vice-Chancellor (International) of Curtin University, namely the use of SMEs (Milton-Smith 2001). The issue of technology diffusion through SMEs (although it was not in that case looking at universities specifically as the technology source) has also been examined by the Australian Government (DITR 2002a).

In relation to Australian industry’s capability to absorb university research output the observation was made by the Director OTD (Office of Technology Development) at a US university:

“Certainly, one of my observations...was the limitation on technology transfer from Australian universities was not [with] the universities [because], I thought, by and large the offices of technology transfer seem to know how to do it, but it was on the receptor side that the availability of early-stage risk capital was limiting, and the availability of experienced management who knew how to do start-ups” (US Private University Interview 2007).

It is sometimes argued that Australia undertakes a relatively low quantum of research and development because of its relatively small industrial base. It was shown by Mitchell and Stonecash (1996) using case studies from automotive, mining and pharmaceuticals industries that where Australian firms are internationally competitive, economies of scale in production do not hamper R&D. They also postulated that even when Australian firms are at a comparative disadvantage in producing a product, Australia may still be competitive in basic research or the initial development of ideas.

Australia has industrial strengths in a number of areas such as agriculture, mining and life sciences but links between university and industry have not always been strong. CRCs, discussed later, address part of this concern, but more can be done to improve links, especially with SMEs.

Where there may be particular problems such as market and systemic failures and structural rigidities, specific government intervention may be warranted: (Salmenkaita and Salo 2002).

4.7.5 Intellectual Property

Australia operates an intellectual property regime similar to those of comparable advanced industrialised nations embracing, principally, patents, copyright, designs, trade marks and trade secrets. There are differences, however, between some countries – for example the United States presently has a system of patent priority based on date of discovery (although this is under review) rather than (as in Australia and most other countries) based on date of registration.

It was noted above that every Australian university has its own intellectual property policies and procedures and few of them have explicitly adopted the National Principles or Policy
Guide. It was noted, too, that changes to these documents are advisable to clarify intellectual property ownership arising from collaborations. This means that there are potential differences in the ownership of intellectual property among Australia’s universities which can lead to uncertainty of ownership of intellectual property, particularly when several research collaborators are involved. This has been exacerbated by the decision at first instance of the Federal Court of Australia which found that the present framework for intellectual property ownership at Australian universities may be highly questionable\[96\]. The sum of these issues has the potential to make university intellectual property of less interest to industry partners and financiers.

Assuming these issues of intellectual property ownership are resolved, there remain the major issues of formality in obtaining registered intellectual property protection and the associated costs. Australian law requires that a patent will not be registrable if information about it has been made publicly available such as through publication. This creates an immediate potential conflict between the formalities for registration – secrecy – and usual academic protocols – the desire and need to publish. In addition, intellectual property registration in Australia, expensive in itself, does not grant automatic registration elsewhere in the world. The cost of obtaining registration increases as the number of countries in which registration is sought increases, giving rise to the practical issue of costs.

Australian intellectual property legislation, in common with other advanced common law jurisdictions\[97\], with the notable exception of the United States, which has the *Bayh-Dole Act*, makes no special provisions in respect of university ideas.

Over-emphasis on the importance of patents was mentioned by Mansfield (1986, p.174) where he said:

“… patent protection was judged to be essential for the development or introduction of 30 percent or more of the inventions in only two industries—Pharmaceuticals and chemicals … In another three industries (petroleum, machinery, and fabricated metal products), patent protection was estimated to be essential for the development and introduction of about 10-20 percent of their inventions. In the remaining seven industries (electrical equipment, office equipment, motor vehicles, instruments, primary metals, rubber, and textiles), patent protection was estimated to be of much more limited importance in this regard. Indeed, in office equipment, motor vehicles, rubber, and textiles, the firms were unanimous in reporting that patent protection was not essential for the development or introduction of any of their inventions during this period”.

One addition to this small list of industries for which patenting is important could be the burgeoning field of life sciences generally where, for example, developments such as the genome project have added substantially to the body of patents. The work of Mazzoleni

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\[96\] This case was reported on 17 April 2008, University of Western Australia v Gray (No 20) [2008] FCA 498.

\[97\] In this context: the United Kingdom, Canada and New Zealand.
(2005) on the social welfare aspects of patenting suggested that, where the cost of further research and development is high, patents may be necessary to effect industry take-up of university research (with pharmaceuticals being the archetype in this regard) but, in other cases, he suggested it likely that the free dissemination of research results increases social welfare. Owen-Smith and Powell (2001, p.106) found that, as in life sciences, patents can also be important in the physical sciences, although for different reasons. They contended that while life scientists produce improvements in therapeutic compounds or medical devices and should treat patents as tangible property to be protected and sold:

“... physical scientists, whose inventions are typically improvements on established products or processes, will use patents to develop relationships with firms and as chips to use to exchange for the use of other proprietary technology, access to equipment, or other opportunities. In keeping with this more relational approach, physical scientists should (1) expect less direct personal gain from patent royalties, (2) favour non-exclusive licensing arrangements, and (3) be less concerned with finding the ‘right’ licensee, opting instead to open relationships with multiple corporate partners”.

While the number of patents being granted by the USPTO (in particular) has increased substantially over the last decade, much of this has arisen from court decisions and patent office practice expanding what may be patented (Mowery et al. 2001; Faley and Sharer 2005), arguably encouraging defensive patenting. At the same time, patents are seen as a strategic business asset but are becoming less effective in stimulating research and development (Davis 2000). If this view is correct, and the evidence here is persuasive, this has not made patenting, as an integral part of the innovation process, any more important in fields outside life sciences than it was previously (Kingston 2001). In other words, Mansfield’s principal findings still hold.

It should not be assumed that stronger and broader intellectual property rights are desirable, nor that they are a necessary condition for research commercialisation to thrive. Mazzoleni and Nelson (1998, p.281) expressed the view:

“The world economy will not benefit from a general broadening and strengthening of patent rights. In some areas, patent rights certainly are economically and socially productive in generating invention, spreading technological knowledge, inducing innovation and commercialization, and providing some degree of order in the development of broad technological prospects. However, in many areas of technology this is not the case. In a number of these, strong broad patents rights entail major economic costs while generating insufficient additional social benefits. And in some strong broad patents are simply counterproductive. One needs to be discriminating and cautious on this front”.

Mazzoleni and Nelson went further in urging caution by saying (p.282):

“We believe that the advocates of Bayh–Dole underestimate, or simply have not been concerned about, the extent to which Bayh–Dole in conjunction with broader changes in attitudes regarding intellectual property rights would lead to universities patenting research results whose principal input is into further research. We are not advocating here a repeal of Bayh–Dole. But we very much are urging the managers of the patents held by American universities to adopt a policy of non-exclusive and liberal licensing of university patents that hold the promise of being used in a wide variety of ways, and in further scientific research”.
These are cautionary words about the desirability of Australia adopting a statutory environment like Bayh-Dole, although Australia could not stand alone and apart, whatever the broader implications, if it were needed to allow Australian universities to compete.

Hussinger (2005) appeared to suggest that the surge in patenting activity from the mid-1990s arose more for strategic purposes (such as merger and acquisition bargaining power, cross-licensing, and reputation) than from any increase in research activity. Prior to this time, firm secrecy was seen as at least as important and effective as patenting.

At the same time, Narin, et al. (1997) showed the importance of public science in the creation of patents when they found that seventy-three percent of the papers cited by US industry patents were public science, authored at academic, governmental, and other public institutions. This is persuasive of the importance of public science to the industrial advance of the US (and, by implication, other advanced economies where a similar correlation may be expected), and of the dominance of public science (universities and government laboratories) in the creation of knowledge. It is likely that, since 1997, this trend has accelerated rather than declined as industrial R&D laboratories have shrunk and closed.

Intellectual property has been the subject of significant review and consideration by the Australian Government (Singhe, et al. 2005; Howard 2005b; DEST 2003d).

The Productivity Commission (2007) noted that there are some impediments to knowledge dissemination in basic research and made recommendations for law reform to exempt researchers from infringement when they make experimental use of patented intellectual property.

Under the terms of the Australia-United States Free Trade Agreement much of Australia’s intellectual property law has been harmonised with that of the US. In general terms Australian intellectual property law is similar to that found in most advanced economies and operates effectively, being largely neutral as a comparative factor stimulating or impeding TT&C.

4.7.6 Incentives to Participate in Commercialisation

Lee (2000, p.130) developed a hierarchy of motivations for academic faculty to become involved in research collaboration with industry – see Table 4.5. While this table reflects the US position, it provides a cogent summary of the factors at work, and illustrates that academic faculty are not generally motivated by the prospect of personal wealth as much as more prosaic needs and personal satisfaction.
<table>
<thead>
<tr>
<th>Ranking</th>
<th>What academics seek from firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Secure funds for graduate assistants and lab equipment</td>
</tr>
<tr>
<td>2</td>
<td>Gain insight into one’s own research</td>
</tr>
<tr>
<td>3</td>
<td>Field-test application of one’s own theory</td>
</tr>
<tr>
<td>4</td>
<td>Supplement funds for one’s own research</td>
</tr>
<tr>
<td>5</td>
<td>Assist university’s outreach mission</td>
</tr>
<tr>
<td>6</td>
<td>Create student jobs and internships</td>
</tr>
<tr>
<td>7</td>
<td>Gain knowledge useful for teaching</td>
</tr>
<tr>
<td>8</td>
<td>Look for business opportunity</td>
</tr>
</tbody>
</table>

Table 4.5 – Academic Motivations to Collaborate with Industry  
Source: Lee (2000, p.130)

Siegel, et al. (2003b) developed a table (Table 4.6) that, inter alia, sets out a series of what they call primary and secondary motives for investigators, the TTO and industry to participate in TT&C.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Actions</th>
<th>Primary motive(s)</th>
<th>Secondary motive(s)</th>
<th>Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>University scientist</td>
<td>Discovery of new knowledge</td>
<td>Recognition within the scientific community – publications, grants (especially if untenured)</td>
<td>Financial gain and a desire to secure additional research funding (mainly for graduate students and lab equipment)</td>
<td>Scientific</td>
</tr>
<tr>
<td>Technology transfer office</td>
<td>Works with faculty members and firms/entrepreneurs to structure deals</td>
<td>Protect and market the university’s intellectual property</td>
<td>Facilitate technological diffusion and secure additional research funding</td>
<td>Bureaucratic</td>
</tr>
<tr>
<td>Firm/entrepreneur</td>
<td>Commercializes new technology</td>
<td>Financial gain</td>
<td>Maintain control of proprietary technologies</td>
<td>Organic/entrepreneurial</td>
</tr>
</tbody>
</table>

Table 4.6 – Motivations to Participate in TT&C  
Source: Siegel, et al. (2003b, p.115)

Harman (2002, pp.151-152) found in his survey that an eclectic mix of principal investigators from Australia’s Group of 8 research-intensive universities reported increasing their income as a result of commercialising their research, as shown in Table 4.7. Harman expressed the view that these are not significant amounts, but noted that investigators with industry research funding were almost twice as likely to increase their income by 5% or more compared with investigators without such funding.
<table>
<thead>
<tr>
<th></th>
<th>1997 N = 188</th>
<th>2000 N = 219</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>66.0</td>
<td>74.0</td>
</tr>
<tr>
<td>Less than 5%</td>
<td>10.6</td>
<td>15.1</td>
</tr>
<tr>
<td>5-20%</td>
<td>17.0</td>
<td>7.3</td>
</tr>
<tr>
<td>21-50%</td>
<td>4.8</td>
<td>2.7</td>
</tr>
<tr>
<td>More than 50%</td>
<td>1.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.7 – Percentage of Investigators and Increased Income Source: (Harman 2002, p.151)

An extensive evaluation of incentives for Australian university researchers to participate in TT&C was undertaken by Yencken and Ralston (2005) in which they found that financial incentives were important to a large and increasing group of researchers, but only about one-third of Australian universities were operating at what they found to be best practice in terms of incentives.

Henrekson and Rosenberg (2001) examined, inter alia, the importance of incentives in promoting science-based entrepreneurship in universities. They concluded (p.227) that:

“... our analysis suggests that a policy aimed at encouraging science-based entrepreneurship should focus on strengthening individual incentives for human capital investment and entrepreneurial behaviour both within the universities and in business. Key policy areas include attractive tax rates on entrepreneurial income, a tax structure that is not overly progressive, reasonably deregulated labor markets, and a university system characterized by decentralization and competition”.

In particular, they said that there should be sufficient financial incentive and lower disincentives to entrepreneurship (such as lower personal tax rates), that there should be opportunities to accumulate capital without undue state interference, and that there should be flexibility in labour costs and remuneration. At the university level they argued for competition for academic staff and students, and for a decentralised and competitive tertiary sector able to respond to market signals and changes in need and demand. They also believed that the US system in which the university has the right to exploit inventions is better than personal ownership of intellectual property because it gives an incentive to the university to participate in the activity, something that is not generally practical for individuals. Overall, it may be that Henrekson and Rosenberg effectively argued that there must be sufficient financial incentive for individuals to participate in commercialisation, but their case is not compelling that it, alone, is a sufficient condition.
Based on this evidence financial remuneration of researchers is not a primary motivating factor. The most compelling incentives are of two less tangible types: those that provide a benefit to individual academics, and those that diminish some adverse consequence.

Harman (2002) cited evidence from his research that academic researchers in Australia have not received significant financial rewards from the commercialisation of their research. Only 5% of academics were able to increase their income by more than 20% of their basic income (typically around 70% achieved no increase) from “royalties from licensed patents, consulting and other similar means” (p.152). If the results had been cut more finely, it is highly likely that most increased income comes from consulting rather than registered intellectual property because it is the easiest, least complex and most immediate way for academic faculty to make additional income.

Colyvas et al. (2002) examined eleven university inventions from Columbia and Stanford Universities, and concluded that prospective financial incentives played little or no role in motivating faculty members to undertake the research projects. This is not quite the same as providing little or no incentive to commercialise the resulting invention, but speaks to the relatively low importance most academic researchers place on commercialisation when commencing research.

Writing in 2000 Etzkowitz, et al. (2000) seemed to suggest that the principal motivation for the rise of entrepreneurialism in universities was due to economic and financial motivators (p.313): “Entrepreneurial activities are undertaken with the objective of improving regional or national economic performance as well as the university’s financial advantage and that of its faculty”. This would appear to be a rather narrow motivation. It also implicitly identifies one of the problems with looking at university commercialisation as an economic/financial phenomenon, namely, can it serve two objectives efficiently? Can it benefit both economic growth of the community and the financial betterment of the university and its academic staff?

Based on this analysis, personal financial gain by researchers does not appear to be a major motivating factor encouraging researcher participation in research but is assuming greater importance in TT&C, although the data in this regard are equivocal. This conclusion could arise because personal financial gain may be a greater factor in, for example, life sciences TT&C than other areas and may have more importance where TT&C has a longer history such as in some US universities.

Since 2006 the Australian Government has funded a Commercialisation Training Scheme (DEST 2006) which provides graduate researchers with the opportunity to undertake a six month graduate certificate in commercialisation intended to equip them better to undertake
TT&C in the future. The scheme is in its infancy and there is no analysis of its take-up or effectiveness yet available.

4.7.7 Fiscal Regime
As well as the issues surrounding the availability of capital, important fiscal issues include taxation and the financial treatment of gains and losses.

The Australian taxation regime, income tax in particular, and its interaction with various fiscal incentives is quite complex and makes Australia less competitive than some comparable structures in the United States and the United Kingdom. The result of this is succinctly stated by the Intellectual Property Research Institute of Australia (Rider, et al. 2006, p.104):

“The problems...appear to suggest that the tax law may be deterring intellectual property commercialisation altogether. Instead, the only commercially acceptable and fiscally viable option for Australian intellectual property creators and developers may be to license or sell their intellectual property, frequently to overseas operations. Alternatively, they may take the intellectual property offshore themselves to commercialise it in other markets, such as the US, where the fiscal regime is more favourable. Or commercialisation may simply not proceed”.

4.7.8 Capital Availability
Research in Australian universities is arguably well-funded, and an entrepreneur will usually be found to promote a product, process or service that is sufficiently proven and has clear market potential. It is the space between the articulated idea of the researcher and making an idea market-ready that presents the challenge.

The existence of gaps in Australia’s capital market capable of financing ideas through the early stages of development has been identified, particularly amongst entrepreneurs requiring funding in amounts below $2 million (AIC 2003).

The Australian Government has attempted to address the need for speculative capital in several ways, such as the creation of Management and Investment Companies (MIC) and Pooled Development Funds (PDF) (Ferris 2001). It has also altered certain investment and taxation rules in order to attract foreign (mainly US) investors into the field.

However, the source of capital for the commercial development of most ideas comes not from venture capitalists but from sources associated with the researcher, inventor or discoverer such as loans secured against residential property. Venture capital is not the most important source of start-up finance. This was acknowledged in Australian Government analysis (DEST 2002, p.19), where it recited (quoting other sources):

“Contrary to popular belief and perceptions, most noteworthy businesses have quite unremarkable beginnings. Most of the Inc 500 companies bootstrapped their ventures with modest funds provided from credit cards, mortgages and other loans. The median amount
was $10,000. Only five per cent of companies raised funds from professional venture capitalists.

“The reality is that in the US only five per cent of the Inc 500 companies start with venture capital funding and overall, venture capitalists fund only a few hundred businesses a year. That is, of the 500,000 new firms that are founded in the US each year:

- the vast majority are small, low growth, such as laundromats and restaurants;
- roughly 50,000 (10%) receive funding by private equity investors, or angels; and
- only about 500 (0.1%) receive “seed stage” venture capital financing.

“Globally less than 20,000 companies received venture capital in 2000. On the basis of research on entrepreneurship in Australia, we suggest that the ratio for Australia is similar”.

There is no equivalent Australian research that examines this issue from a local perspective but it is unlikely that Australia will be significantly different in this regard to the US.

There appears to be limited scholarly analysis of the impact of venture capital on Australian university commercialisation. Ferris (2001) suggested that without an effective venture capital market, the scope for research commercialisation is greatly reduced. He argued for Australia to be a biotechnology tax-free zone for the next decade to try to capture the benefits arising from research in this field. It has been noted that Australian biotechnology researchers have been quick to exploit the potential of share market IPOs for development capital, and that the role of venture capitalists and other sources of finance has been increasing in importance (Wells, et al. 2003).

4.7.9 Clusters

Regional universities in particular appear to develop a special relationship with their local communities. This is manifest in the support and shared interests between universities and geographically close industry.

Extensive analysis of US universities led Tornatzky, et al. (2002, p.14) to state:

“Although high-technology regional economies are almost always anchored by great research universities, not all great research universities are surrounded by a booming regional technology economy. Nor do those universities’ graduates automatically stay in their universities’ communities to help build technology enterprises. In fact, a growing literature on interstate ‘brain drain’ demonstrates that in the absence of the rudiments of a technology based regional economy, the best and brightest most likely will leave. We are convinced that aggressive mission driven research universities can counteract that trend and contribute to the building of regional knowledge economies”.

While Tornatzky, et al. were talking of the great US research universities, their conclusion that high-technology regional economies are underpinned by great research universities underlines the importance of universities in the development of regional economies.
Lambert (2003) was of the view that universities and business benefit from proximity when he said (p.6): “... proximity matters when it comes to business-university collaboration”, particularly when dealing with SMEs.

While clusters of industries may promote innovation and domination of an industry (Porter 1990, 1998), there is a view that clustering alone is not conducive to innovation (Beaudry and Breschi 2003).

Professor Ron Johnston (2003) took a practical view of clusters in Australia and concluded that clusters are “…a potentially effective mechanism for enhancing competitive advantage…”, particularly for regional development, but there are few workable examples of functioning clusters in Australia (he identified fewer than thirty) and they cannot be artificially created. In his study he did not note any links between clusters and universities, although they could be inferred in a few cases.

4.7.10 Technology Parks and Incubators

Learned literature is far from conclusive about the efficacy and value of technology parks and incubators, principally on the basis that there is no systematic framework by which to understand them and few suitable metrics available to assess their performance (OECD 1997; Siegel, et al. 2003c; Phan 2005)

There is little evidence demonstrating the efficacy of technology parks in stimulating innovation in Australia. For example, Gunasekara (2005), who studied a number of universities to identify their role in regional innovation stimulation in Australia, concluded that (p.533):

“Although important [in] capital formation projects from a university’s viewpoint..., the evidence is mixed regarding the benefits of science parks as engines of innovation, particularly in Australia. This has been attributed to a number of factors, not least of which is a poor understanding of the purpose of such mechanisms and the ready availability of the requisite infrastructure and services, particularly in core-metropolitan locations, without the need for co-location”.

4.7.11 Smaller and Regional Universities

The first and obvious question is: what constitutes Australia’s smaller and regional universities? According to Universities Australia96 there are thirteen regional universities97.

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96 Until 2007 Universities Australia was known as the Australian Vice-Chancellors’ Committee, or AVCC.
97 Retrieved from: www.avcc.edu.au/documents/publications/stats/Key_University_groups_by_CDC_1996-2002.xls#NGUA1 21 Feb 2007. They are: Charles Sturt University, Southern Cross University, The University of New England, The University of Newcastle, University of Wollongong, Deakin University, La Trobe University, University of Ballarat, Central Queensland University, James Cook University, University of Southern Queensland, University of the Sunshine Coast, Charles Darwin University

Page 71
Each of these universities has the characteristic of having its seat of government outside a major metropolitan area except La Trobe University, which has a significant regional presence in addition to its main metropolitan campus\(^{100}\). There is no definition of what constitutes a “smaller” university, however, they are largely self-defining, and anything with a student population below 20,000 EFTSU would appear to have this character\(^{101}\).

With one or two exceptions, there appears to be little enthusiasm among regional universities to engage in TT&C. For example, in the latest National Survey of Research Commercialisation (DEST 2007, Table 30), of the public universities that supplied information to the question: the number of dedicated commercialisation staff employed, during 2004 the twelve regional universities (excluding LaTrobe University) employed an average of about 0.8 FTE (2002: 0.5), while the 24 metropolitan universities employed an average of more than 4.8 FTE (2002: 4.0) (the lowest, the University of Canberra nil, and the largest, the University of Queensland 23.5). The mode and median for commercialisation staff at regional universities was 1 FTE, while for metropolitan universities the mode was 1 and the median 3.5.

At the same time, research commissioned by the Department of Education, Training and Youth Affairs in 1999 (Turpin, et al. 1999, p.6) suggested that smaller and newer universities have a research niche, albeit a relatively small one (italics in original):

“Another important feature of the Australian system is that research activities are concentrated within a small number of institutions. For example, the top quartile of institutions accounts for 70 per cent of all research expenditure. The second quartile accounts for a further 20 per cent of research expenditure and the two lower quartiles account collectively for only 10 per cent of research expenditure. Research output patterns, in terms of publications, patents, etc. show a similar pattern across the different institutions in the system but are less concentrated.

“However, in spite of this concentration, recent studies show that some of the newer and smaller institutions which are filling quite specialised research niches are proportionally more reliant on industry funding for their research activities. Consequently, many of this group of universities have become extremely innovative and entrepreneurial in forging links with industry”.

The role and impact of regional universities on their local area has been the subject of limited academic analysis. In Australia, Harman and Ollif (2004) at the University of New England conducted a case study on contract research at a regional university, while there has been some overseas research published on the impacts of technical universities upon nearby geographical areas (Audretsch and Lehmann 2005), and on technology transfer from

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\(^{100}\) DEST (2003b, p.327) is rather more equivocal about what constitutes a regional university, saying “There is no accepted definition of a regional university”.

\(^{101}\) For the purposes of the Productivity Commission, a university with a student population below 20,000 EFTSU is treated as a small university (Productivity Commission 2003). Australia has 14 (out of 39) universities with EFTSU exceeding 20,000 while, for comparison, the US has 106 (sources: DEST 2006 University Handbook; US Center for Measuring University Performance).

The role of campus leadership and other supportive strategies have been identified as important issues in research commercialisation at non-elite universities (Bradshaw, et al. 2005).

A recent Australian analysis of the role of universities provides some further guidance on the effect of universities in regional development (Gunasekara 2005). Gunasekara found that universities in regional areas play a more developmental than generative role (that is, they support local enterprise rather than generate new enterprises) with little influence upon agglomeration or the formation of clusters which, in regional areas are influenced more by local conditions of environment and resources than the presence of a university.

The Australian Government has examined issues relevant to technology and regional Australia, such as mapping Australia’s regional technology and innovation capability (DEST 2003a). In relation to regional issues, the Government made the following observation (p.22):

“Generally, the further people live from major cities, the less they have access to computers and the internet. Communities and businesses in regional, rural and remote areas face higher prices for bandwidth services. However, in some places various factors come together to create a concentration of particular industries within a certain region, with clusters developing in some cases (eg the wine industry in the Hunter Valley and tourism in Far North Queensland). These factors include unique natural resources, labour pooling and skill formation, regional specialisation, educational institutions, equipment supply and shared infrastructure”.

In their analysis on the impact of technology transfer and commercialisation in economic development, Reamer, et al. (2003, p.xvii) found that:

“… [researchers] conclude that firms are more likely to interact with sources of public R&D that are relatively close by. (Among the studies, the median distance is 75-100 miles.) University research, knowledge about how to apply university research, and knowledge about how to manage a relationship with a university are all relatively tacit [knowledge], so proximity is preferred. However, while firms interested in using public R&D prefer proximity, they also find advantage in being near other firms in their industry, a diverse environment, and business services. Such needs are best met in larger cities. So while public R&D in any location can stimulate industrial innovations, its impact tends to diminish in smaller areas”.

On one hand this sounds pessimistic for regional universities – firms prefer larger cities, but at the same time proximity counts. However this analysis does not distinguish between any of the four principal types of research, and it is likely that, using the data from this research, proximity may be important where consulting and contract research are involved. But, as university TTOs said, their research is generally directed towards world-best practice and usually destined for a global market, in which case proximity is less important. The experience of Aust Regional Uni2, in particular, bears out this conclusion, because its strength in commercialisation is principally in the consulting and contract research areas,
While metropolitan universities, in particular the Group of 8 research-intensive universities, direct much of their research toward results that have global implications.

As shown later in Part V, however, high-technology SMEs will seek consulting and knowledge from universities wherever they are located without regard to distance or whether a university is away from the metropolis. This may be peculiar to the case study companies, but means that smaller and regional universities are capable of creating effective TT&C niches.

**4.7.12 Effectiveness of Present Strategies**

There are several measures used to evaluate the effectiveness of commercialisation strategies. Most of these are developed for research institutions generally, with relevant application to universities. Considerable effort has been put in to developing, for example, metrics for commercialisation (DEST 2005a), and measuring CRC outcomes (BioAccent and Capital Hill 2002).

The Australian Institute for Commercialisation has been advised (Allen 2003a) that the economic impact of commercialisation of publicly funded R&D (including some university spin-offs) has been substantial, as shown in Figure 4.8.

**THE ECONOMIC IMPACTS OF DIRECT COMMERCIALISATION OF PUBLICLY FUNDED R&D**

The above figure is based on an analysis of data from case studies, CSIRO studies, CRC studies, Esple Report data and data from the 2002 AUTM study.

*Figure 4.8 – Economic Impact of Commercialisation* Source: Allen (2003a, Table 4.2 at p.50)

The Allen report, like most reports that examine the issue, advised that governments and capital must be patient - there is a lag of 10-20 years between initial research investment and tangible economic impacts. By 2020 it estimated that continued commercialisation performance improvement could be worth $20 billion p.a. in turnover and $18 billion in exports to the Australian economy (2002 dollars).
This assessment contained a number of caveats (Allen 2003a, p.12):

- 60% of the economic benefits over the twenty year period were realised only in the last five years;
- No more than 2-3 “star” and ten “solid performers” are responsible for most of the economic benefits. Of the ten case studies of successful commercialisations reviewed, eight evolved from medical research and two from ICT – this suggests a very narrow base of success, and reinforces the pre-eminence in Australia of life sciences research;
- The performance shown in these figures remains well behind “best practice” levels of the US and Canada;
- “While improving commercialisation practices could perhaps in total double revenues captured by the research performing organisations, it is unlikely that revenues to these institutions would be able to be increased much further”;
- “…it would not appear that high overall economic impacts are likely to be found in the area of revenues accruing to research performing institutions. Even at best practice levels, total returns to institutions are unlikely to represent more than 5 to 10 per cent of the total public research expenditure”. And, in fact, very few universities achieve even this. In 2004 Australian universities’ licence revenue as a proportion of research expenditure averaged 1% (DEST 2007, Tables 30 and 33). Only seven universities achieved in excess of this average: the University of New England (16%) and the University of Queensland (4.4%) being the stand-outs.

For all the effort put into commercialisation and taking good ideas to market, scarcely more than a handful of companies\(^{102}\) that have been created are used as models and case studies (Allen 2003a; Allen 2003c). As Allen (2003a, p.3) said about the results of research commercialisation (university and PFRO): “Currently we have 2-3 ‘star’ performers, about 10 solid performers and then a large pool (a couple of hundred) of small companies based on publicly funded research”.

At the same time, there are real and significant costs to universities in operating TTOs and engaging in TT&C. According to DEST (2007, Table 30), the total cost of commercialisation incurred by all Australian universities in 2004 was $24.1 million, or approximately 70% of the revenue derived by them from LOAs, although in the case of top-performing universities this was much lower, such as the University of Queensland where this ratio was 34%.

\(^{102}\) The companies that typically appear are: Cochlear; ResMed, Ventracor, Proteome, Radiata, First Nucleotide Change, IATIA, Biotia, Amrad and GroPep. Other analyses report other companies, but these are often very early-stage companies with prospects but are not proven businesses.
There is also wide disparity between the reported TT&C performance of Australian universities. Using the latest figures (DEST 2007), four universities\textsuperscript{103} (out of thirty-six) were consistently responsible for 50\% or more of invention disclosures and patents filed. One university, the University of Queensland, was consistently responsible for 25-30\% of all disclosures and patents reported among Australian universities. The Group of 8 research-intensive universities accounted for 62\% of reported invention disclosures and over 70\% of patents. For comparison, the five ATN universities accounted for 14\% of disclosures and 8\% of patents. This left twenty-three universities to account for the remaining 24\% of disclosures and 22\% of patents.

On the income side, in 2004, total LOA gross income for thirty-six universities amounted to $34.46 million. Of this, two universities accounted for $19.90 million, or 58\% of income, while six universities (five of them Group of 8 research-intensive universities) achieved income exceeding $1 million and accounted for 86\% of income. Nine universities reported no income from LOAs.

Based on 2004 figures, Group of 8 universities accounted for over two-thirds of all new start-up companies (with the University of Queensland alone responsible for almost one-quarter in total), and only eleven universities had one or more start-ups. All these data show a heavy skew towards a few universities, with most achieving little demonstrable impact. This is consistent with data sets from other jurisdictions.

Most of the financial benefits derived from commercialisation do not flow to researchers or the research provider but to the entity that exploits the idea (Allen 2003a; Allen 2004; DEST 2004b). This leaves significant scope to research and analyse the reasoning behind Australian universities’ embrace of commercialisation.

Research in this area suggests that the key to a successful commercialisation environment involves two principal components: “hard assets” such as infrastructure, people and institutions; and effective “soft assets” (Lambert 2003\textsuperscript{104}; AIC 2005), which involve intangible but real characteristics such as effective networking and mutual trust between parties. The AIC (2005, p.27) also described these as being relational (soft assets) as well as transactional (hard assets), and said that the \textit{relational} component of business becomes much more important as the risk increases.

\textsuperscript{103} Not always the same four universities, except for the University of Queensland.

\textsuperscript{104} Lambert does not use the term “soft assets”, but his analysis certainly emphasises that they are essential to effective commercialisation.
The relational aspect of business is not easily analysed or described; trust is something that relies on characteristics such as mutuality of interests, confidence, understanding of others’ needs and wants, and risk sharing, and usually requires time to evolve. It is aided by institutional factors such as agreed norms of conduct described through laws such as those dealing with contract and commercial behaviour, but these alone will never be sufficient.

There is an implicit understanding in much of the research and analysis done in this area as to the importance of soft assets, but it seems that these assets are often expected to grow in the event that the more formal aspects of the environment are appropriately established. It is reasonably simple for a government to establish a funding scheme for incubators, but it is another thing, altogether, to require people working in an incubator to work harmoniously and to exhibit mutual trust – this is a rather more subtle thing.

### 4.7.13 Co-operative Research Centres

A number of studies have found the Australian Co-operative Research Centre Program to return good results (BioAccent and Capital Hill 2002; Howard 2003; Insight Economics 2006).

Notwithstanding the favourable results found in these analyses, the Productivity Commission (2007, pp.28-29) described a result more consistent with universities’ views of CRCs as disclosed in case studies developed in this project when it said:

“... [the] Cooperative Research Centre (CRC) program received mixed responses from participants, some arguing there are high returns while others pointing out low ultimate impacts, high start-up costs and ongoing compliance burdens. Current costsharing arrangements seem to direct high levels of subsidies to the business collaborators, as they are primary beneficiaries of the Centres”.

### 4.8 Australian Universities’ Research Commercialisation Offices

What should be the role of a commercialisation office? It was noted earlier that income from commercialisation should not be the principal objective of commercialisation – income will flow if other factors permitting the flow of ideas and skills are in place. The role of a commercialisation office is (Carlsson and Fridh 2002, p.199):

“... for the university to research results for the public good. Success in this endeavor is only partially reflected in income generated for the university or the number of business start-ups. The degree of success depends not only on the nature of the interface between the university and the business community but also on the receptivity in the surrounding community as well as the culture, organization, and incentives within the universities themselves”.

UniQuest, a successful Australian TTO, cites its charter as “…to identify, package and commercialise university technologies and expertise” (UniQuest 2004, p.4). UniQuest sees itself as having two major interfaces:
• with industry, business and government (investment opportunities in early-stage, promising technologies and innovations; access to world-class intellectual property, research expertise, and facilities; packaging and management of multidisciplinary teams for local and international development projects; and specialised consulting and expert opinion services across a wide breadth of disciplines); and

• with university researchers (commercialisation expertise and management; intellectual property protection; management of consulting and R&D contracts (including administration, marketing, legal drafting and review, and indemnity insurance); faculty business management systems; and training and education regarding intellectual property and commercialisation).

At the other end of the size spectrum, Swinburne University of Technology, a smaller university, conducts its commercialisation through Swinburne Knowledge, which states its role as being “… broadly to facilitate, support, and monitor some of the University’s commercialisation activities”105. It says that, as a smaller university, it believes the best commercial returns are achieved through spinning-off companies.

The earliest Australian TTO was established in 1959 by the University of New South Wales. A sample of the dates of establishment of TTOs at Australian universities is shown in Table 4.9. Few of these TTOs still operate in their original form.

<table>
<thead>
<tr>
<th>Commercialisation Office</th>
<th>Year Established</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unisearch Ltd (University of New South Wales)</td>
<td>1959</td>
</tr>
<tr>
<td>Techsearch Inc (University of South Australia)</td>
<td>1971</td>
</tr>
<tr>
<td>Curtin Consulting Services Ltd (Curtin University)</td>
<td>1971</td>
</tr>
<tr>
<td>Technisearch Ltd (RMIT)</td>
<td>1972</td>
</tr>
<tr>
<td>Insearch Limited (University of Technology, Sydney)</td>
<td>1976</td>
</tr>
<tr>
<td>ANUTECH Pty Ltd (Australian National University)</td>
<td>1979</td>
</tr>
<tr>
<td>UniQuest Limited (University of Queensland)</td>
<td>1984</td>
</tr>
<tr>
<td>Luminis Pty Ltd (Flinders University)</td>
<td>1984</td>
</tr>
<tr>
<td>Montech Pty Ltd (Monash University)</td>
<td>1986</td>
</tr>
<tr>
<td>UNITAS Consulting Ltd (University of Tasmania)</td>
<td>1992</td>
</tr>
</tbody>
</table>

Table 4.9 – Start Dates of Some Australian TTOs Source: Allen (2003a)

Data from the United States in Table 4.10 show the number of university TTOs started each year since 1970, with an obvious acceleration in the early 1980s after the *Bayh-Dole Act* was enacted.

![Figure US-1. Technology Transfer Program Start Date of U.S. Universities, 2005](image)

**Table 4.10 – Technology Transfer Program Start Date of US Universities**

European university TTOs have an average age of approximately eight years (ASTP 2006, p.2), with older TTOs having more staff than younger TTOs. There are no direct data on whether older European TTOs have better outcomes than younger ones.

There is an apparent correlation between the length of time a university has been involved in commercialisation (the age of the commercialisation office) and the success of the university in commercialisation (as measured by the metrics discussed earlier). In the United States there is a fairly clear correlation between the length of time that a university has operated a TTO and the TT&C results reported to AUTM: the older the TTO, the greater the results achieved. At the same time, many of the older TTOs were established pre-Bayh-Dole and represent universities such as Stanford and MIT that have had a long history of success in commercialisation.

5 **Barriers to Research Commercialisation**

5.1 **Approach**

5.1.1 **Collecting the Data**

Research Question 1 is answered below using qualitative content analysis.

There is a large body of information published on the commercialisation of Australian university research: by the government, universities, companies, stakeholders such as the
AIC and industry groups, and by other researchers. Reference to barriers, problems and other issues associated with university research commercialisation is a common theme in much of the literature. The data for this analysis comprised relevant literature of two principal types: journal articles, and government and related reports. Journal articles which addressed the issue of barriers to commercialisation were compiled into one group for analysis, while government and related reports were compiled into another. Government and related reports are listed at Appendix 3.

Literature relevant to this research question was compiled and indexed so that reference back to original sources could be done and results confirmed. All information was compiled in either soft, computer, form, or as hard copy.

5.1.2 Analysing the Data

Coding units used in the content analysis were built progressively as data were reviewed, and comprised the barriers and other issues relevant to the commercialisation of Australian university research. Each barrier and other issue was derived from the documentation by identifying the barrier or issue, identifying its source(s), transcribing the key quotes or features of each in order to build a rich field of information, and from this preparing memorandums analysing, summarising and drawing conclusions from the data; in every case maintaining a system of cross-referencing between reasoning, conclusions and data sources.

Further detailed explanation and discussion about qualitative content analysis is located in Part III, Methodology, in Section 7.4.

While the result of this portion of the analysis is not particularly original, it is a necessary and useful step in the overall analysis process in that it provides a list of important issues which informs the remainder of the project and provides a key level of intellectual support for the propositions that are developed in Chapter 6.

5.2 The Barriers to Research Commercialisation

There are many factors that can constitute barriers to the commercialisation of research in universities. These range from factors within the control of universities, to matters of government policy and legislation, through to the economic environment, social culture and other exogenous factors. A number of studies have identified barriers to research commercialisation, and each has prepared its own list of barriers. Relevant sections of some of the more influential reports are listed below.
An Australian study (ARC 2000) identified the key barriers as:

- The quality of the research base and the maintenance of science and technology skills;
- the availability of companies willing and able to take up the results of research;
- the strength of links between the research base and industry;
- availability of venture capital;
- the quality of management skills;
- an appropriate regulatory environment; and
- a competitive business environment.

In terms of barriers and challenges, the Lambert Report (Lambert 2003) made some valuable points in relation to the UK, which are equally relevant to Australia:

- “The best forms of knowledge transfer involve human interaction…” (p.31). This is a major theme of the report and emphasises the importance of individual relationships in successful commercialisation;
- “… a lack of clarity over the ownership of IP in research collaborations” (p.4);
- “… the variable quality of [university] technology transfer offices” (p.5);
- “… too much emphasis on developing university spinouts…and not enough on licensing technology to industry” (p.5);
- “Universities are playing an increasingly important role in regional economic developments…” (p.5);
- “… proximity matters when it comes to business-university collaboration” (p.6), particularly when dealing with SMEs;
- “Business is critical of what it sees as the slow-moving, bureaucratic and risk-averse style of university management” (p.6), although it noted there have been improvements in recent years.

Further salient points in the Australian context are made by DEST (2002, p.viii) (italics in the original):

- “One aspect of universities that may be particularly challenged by their involvement in research commercialisation is their governance. Their Acts, State Government auditing requirements, and the structure, authority, membership and practices of governing bodies may each raise, and in some cases have raised, evident inefficiencies, tensions and conflicts. There is a need to review the elements of governance of universities to ensure they provide an appropriate framework to allow for, encourage and manage research commercialisation.
• The Bayh-Dole Act in the US has been called the Magna Carta of research commercialisation. Australia does not face the situation of the US in 1980. IP rights are held by researchers or their institutions. Hence there is no apparent need for legislation. However, the kick-start effect of a major government intervention does warrant appropriate action. The National Principles for Intellectual Property, appropriately strengthened, applied and monitored, together with encouragement to universities to establish broad targets, could provide the basis for significantly raising the profile and awareness of research commercialisation.

• The capture of ownership and exploitation of intellectual property, has become of paramount importance in global competitiveness, and hence an increasingly important issue at the national level. The recent announcement by the US National Institutes of Health that it would claim IP ownership in proportion to its share of funding in projects conducted outside the US threatened the IP value and ownership of such projects. Vigilance, representation and appropriate policy may be necessary to protect the ownership of IP generated in Australia.

• While IP identification is best conducted by researchers, it is not a function to leave to the researcher alone. The UniQuest model of placing a ‘commercialisation manager’ in each faculty represents best practice, as they can play the roles of ‘idea finder’ and ‘idea developer’. The key challenge of raising the awareness and IP identification capabilities of research staff requires training and other support programs. KCA and AIC may have a role in developing and promoting such courses.

• There is an emerging tension between the growing requirement for collaboration between researchers and institutions to achieve effective research teams, and the requirement of venture capitalists for ‘clean IP’, where ownership is clearly determined. The National Principles for IP Management should be revised to provide clear guidelines for the negotiation of IP ownership in cases where more than one institution is involved.

• There are few forms of financial support for early-stage research commercialisation activities. The ARC specifically excludes support for attendance at international conferences, where contacts with industry partners might be established. The NHMRC has established a modest competitive industry development grant to support proof-of-concept research. Research funding agencies should examine their support for research commercialisation and consider establishing significant competitive schemes to assist with the costs of pursuing research commercialisation.

• Research commercialisation success is largely driven by considerations of scale. While these attributes of scale are fairly readily available to the larger and research-intensive universities, the smaller and regional universities do not have this capacity. This regardless that they well may (and do) possess pockets of research expertise capable of generating valuable IP. There would seem to be a need to encourage networking between smaller and regional universities to share their research commercialisation expertise. This might be a role for KCA and/or AIC and for case managers involved with local (eg. BITS funded) incubators."
The AIC identified a significant list of impediments to commercialisation (including university commercialisation) (AIC 2002)\(^{106}\), the major twelve themes of which were:

- People – especially entrepreneurial development;
- Culture – particularly a disjunction between imperatives driving different parties: researchers, industry and financiers;
- Knowledge and awareness – understanding and developing processes that suit the Australian environment;
- Taxation issues – there are many tax issues that are counter-productive in a risky environment;
- Education and training – especially as it concerns selecting and training staff for involvement in commercialisation;
- Funds availability – the lack of funds at certain stages of development;
- Intellectual property – especially the loss of IP through poor management;
- Company links – issues such as the small size of Australian industry and market and the need to link with international business and investors;
- Best unbiased advice – an apparent lack of reliable advisors in Australia capable of giving good advice and developing a sound relationship with researchers;
- Benchmarking – Australia needs to review constantly its performance in commercialisation;
- Exposure to markets – Presently research is fragmented and rarely world-scale;
- Standard of science and science strategy – a need to concentrate on research that can produce tangible innovations.

By 2004 the AIC had refined its list of twelve barriers to nine major issues (AIC 2004a) and elaborated on specific concerns within each heading.

The Business Council of Australia and AVCC commissioned a substantial analysis of university commercialisation in 2004 (Allen 2004) which identified six “drivers” of research commercialisation performance, all of which it said need to be present to achieve optimal outcomes. Clearly the absence of or particular problems with any of these drivers constitutes a barrier. The drivers listed were (pp.18-19):

- the legal frameworks for IP in Australia and IP policies in place in universities – unless ownership of IP is clear and discoveries are disclosed and protected at the appropriate time, commercialisation opportunities are lost;
- the commercialisation management structures and systems in place within universities – the presence, or lack of, structures and systems that ensure commercialisation opportunities

\(^{106}\) Attachment A to this paper by the AIC: Perceived Impediments to Commercialisation.
associated with IP discoveries are progressed by appropriately resourced and skilled staff will impact commercialisation timelines and outcomes;

- The quality of research being produced by universities – a considerable body of evidence highlights that it is excellent, ground-breaking, research that is most likely to eventually generate significant commercial returns. The generation of high quality IP is a necessary condition for the generation of commercialisation outcomes;

- The availability of early stage venture finance – development of a research breakthrough into a commercial product or service requires access to significant levels of risk capital. Early stage development finance can come from universities themselves, venture capital markets, angel investors or companies that wish to bring the product to a marketable stage. In the absence of access to development finance, research breakthroughs are unlikely to be commercialised in a timely fashion;

- The presence of strong local receptor businesses – a significant avenue for the commercialisation of research is its adoption and further development by receptor companies. In the absence of local receptor companies with the knowledge and financial resources required to adopt and develop university research, research may instead be adopted and developed by overseas companies, resulting in the loss of significant economic activity offshore; and

- The behaviour of participants within the research commercialisation system – if relationships between academics, university commercialisation staff, venture capital providers and receptor companies fall short of best practice standards, optimal commercialisation outcomes will not occur no matter what IP policies and legal frameworks are in place.

A report by DEST (2003c) on national and international research-business linkages identified three frequently reported concerns (p.5):

- Cultural and operational differences between the public and private sectors, which can impede collaboration;

- A lack of visibility of Australian research and development to international players;

- A limited capacity of small and medium sized firms to connect with Australia’s science, engineering and technology base.

Ferris (2001) referred to a number of cultural matters as well as a lack of capital. In particular he noted that there is a disconnect between invention and commercialisation for five reasons:

- A culture of risk aversion;

- A tradition of trade barriers for the purpose of job protection, leading to a self-defeating culture of reliance on protection rather than innovation;

- A pervasive cultural cringe – things are always done better elsewhere;
• a culture of social egalitarianism leading to an aversion to individual success (except in sport) – the so-called tall poppy syndrome; and
• a lack of sufficient venture capital.

Zhao surveyed the literature and identified eight barriers to university research commercialisation (Zhao 2004c, pp.233-234):
• a shortage of funding for services that support commercialization;
• a lack of venture capital supporting the ‘proof-of-principle’ process, and relatively low overall R&D expenditure in Australia as a whole;
• disincentives to the establishment and funding of start-up companies created by the current taxation laws. The taxation regime in Australia, particularly with respect to capital gains tax, has worked against the attraction of venture capital for research commercialization. The taxation system is undergoing reform, but whether the reformed taxation structure will encourage investment in research commercialization is not yet known;
• a lack of support from business and industry, and too few businesses that have been willing to collaborate with universities to develop research products;
• a general lack of entrepreneurial expertise within universities due to the fact that most university researchers are not entrepreneurs, and because the culture of academe does not favour entrepreneurs;
• insufficient time available for researchers to acquire the necessary business skills required for commercialization;
• a lack of management skills and efficiency whereby R&D can be turned into commercial success; and
• a lack of effective measures to assess the extent of success in creating wealth by commercializing R&D.

Two papers are rather more pithy in their analysis of what constitute barriers. The first, from Canada (ACST 1999), identified four principal barriers that prevent Canadian universities from achieving their full potential in commercialisation:
• The absence of a coherent national university intellectual property policy (p.19);
• A lack of support and resources in university commercialisation offices (p.21);
• Uncompetitive business conditions in terms of taxation, ESOPs and the ability to invest pension funds (pp.21-22); and
• Low levels of investment in university research (pp.22-23).
The second, by Adamson (2004) identified three key elements that need to be fixed in order that universities have effective commercialisation:

- Implement sound and effective commercialisation processes;
- Employ the right people in the commercialisation office; and
- Spread the rewards, including to the commercialisation office staff, in order to create the right motivation.

Some of the challenges, barriers and potential barriers described in this review are within the control of the universities themselves, others within the control of government, while others are either cultural and intrinsic, or exogenous and subject to influences beyond the control of Australia and its government. The ability to overcome or ameliorate any barriers may require, therefore, concerted action on the part of several actors.

Just as it was identified earlier that different types of research may need different approaches to TT&C, there may well be barriers that are particular to individual types of research. The most obvious area of research with potential for distinctiveness is life sciences because of its particularly high regulatory barriers and long lead times to market, which, in the Australian context, have been examined by Johnston, et al. (1999).

There are also the barriers that arise from industry, such as a lack of understanding by industry of the process of academic discovery, cultural and gender barriers between academia and industry, conflict over financial incentives, conflicts of interest, insufficient university resources, and insufficient university time (Sobol and Newell 2003). There is also an arguable position that the continuing obligation of universities to a common good may limit their ability to commercialise (Argyres and Liebeskind 1998).

At the same time, commercialisation through intellectual property licensing and spin-off companies, which normally involves a registered interest in intellectual property, has to invoke formal procedures. The difficulty here from the academic faculty viewpoint is the effort required to make disclosures versus the benefits obtained. Many academics view the disclosure process as unnecessarily long and involved and of peripheral relevance to them, particularly given that they can obtain better career returns by engaging in other activities. A further important factor at work is the perceived efficiency of the TTO in handling disclosures and its success at commercialisation. The balance of the equation in favour of commercialisation can depend critically on individual TTO performance, as demonstrated by successful TTOs. Owen-Smith and Powell (2001) attributed the variations in commercialisation success to faculty perceptions of the benefits of TT&C, the quality of the TTO, and the institution (through its history, environment, capacity and reputation) as a
collective enterprise. Owen-Smith and Powell (2001, pp.112) found that: “… inconvenient or frustrating interactions with TTOs may be enough to convince ambivalent inventors that the benefits of IP protection do not outweigh the costs”, but that success, on the other hand, is self-reinforcing: (p.113):

“Where faculty are highly aware of other’s successes, prestige is associated with commercial success. When academic and commercial rewards are linked, incentives to patent are enhanced. In this kind of setting, frustrations with the patent process may be overcome by the general positive reputation of the multiple benefits of IP protection and even ambivalent inventors may begin to disclose”.

From this summary and analysis a list of barriers and challenges that confront Australian universities attempting to undertake commercialisation can be developed, as follows (apart from the first item, this list is in no priority order):

- Linkages and relationships between the three principal classes of actor: researchers, industry and financiers (usually identified as the most important factor);
- University legislation, policies and procedures (intellectual property policies; academic promotion policies; risk management; managing conflicts of interest; and human resources policy rigidity limiting opportunities for university-industry staff exchange);
- University support for commercialisation through such activities as establishing effective frameworks within which commercialisation operates as well as mechanisms to identify, capture, protect, disseminate and exploit the ideas created through research;
- Ensuring that the costs of commercialisation are realistic compared to the benefits obtained, financial and otherwise;
- Ensuring that the historical mission of the university to encourage the free-flow of information is not compromised, consistent with the need to ensure that the community obtains maximum benefit from novel ideas with commercial potential;
- The relatively small size and scale of research and industry clusters extant in Australia (life sciences research largely excepted);
- The relative lack of entrepreneurial and commercialisation skills and propensity amongst university academic staff;
- The lack of capital available for the commercialisation of ideas, particularly during early-stage development;
- A fiscal regime that is arguably less supportive of commercialisation; particularly compared with the United States, and more particularly given the mobile nature of capital;
• An intellectual property regime (covering legislation and registration of intellectual property) that is somewhat complex and expensive and does not always ensure clear-cut ownership of intellectual property;

• A National Innovation System (NIS) that is less mature than some other key economies and which promotes research in fields where Australian industry lacks the capacity to absorb the volume of new ideas generated;

• A commercialisation regime (such as it is) that is substantially oriented towards research-intensive universities and offers little recognition of the diversity found among Australian university missions and capabilities; and

• An Australian industry that lacks depth, is relatively risk-averse and, in important areas, foreign-owned and inclined to seek innovations in their home countries.

This list of barriers is used to inform and develop the structure of the case study interviews – as can be seen in the templates shown in Appendix 1 – and is a key input to the propositions developed in the next Chapter.

6 Developing the Propositions

From a review of the literature, the history and development of TT&C, and a consideration of the barriers to university research commercialisation, a number of key issues arise which lead, in turn, to a number of propositions relevant to the Research Questions. The issues and the propositions are set out here.

The principal issues to be examined in this project are derived from the literature and the earlier barriers to commercialisation, and are as follows:

• The impact that university commercialisation structure and processes have on TT&C performance;

• Incentives for university research staff to engage in commercialisation;

• The support for entrepreneurship and the university culture as it concerns TT&C;

• Early stage financing and venture capital;

• The quality and depth of linkages between universities and industry;

• The handling of intellectual property in research TT&C;

• The role played by Co-operative Research Centres in TT&C;

• The characteristics of local Australian industry;

• The role of industry clusters;

• The role of intermediaries in the commercialisation process;
• The role of technology parks and incubators in university commercialisation;
• The qualities required by smaller and regional universities to succeed in TT&C; and
• The role of government.

Based on this list of issues a number of propositions have been developed, set out in Table 6.1, for testing in the Australian context. These propositions are used to inform the structure of the analysis undertaken on each research question in Parts IV and V of this thesis. The answers to each research question are, in turn, used as input to answering the propositions which are discussed again near the end of this thesis in Section 11.2.

<table>
<thead>
<tr>
<th>Number</th>
<th>Issue</th>
<th>Proposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Structure of the TTO</td>
<td>The structure of the TTO and the processes used within the university influence success in TT&amp;C</td>
</tr>
<tr>
<td>2</td>
<td>Incentives to engage in TT&amp;C</td>
<td>Research staff are motivated by incentives to undertake TT&amp;C activity</td>
</tr>
<tr>
<td>3</td>
<td>Entrepreneurship and culture</td>
<td>A culture of entrepreneurship and support is vital if a university is to succeed at TT&amp;C</td>
</tr>
<tr>
<td>4</td>
<td>Access to early-stage capital</td>
<td>In order to succeed at TT&amp;C universities must have access to early-stage capital to provide funding for proof-of-concept development and to undertake detailed market evaluation</td>
</tr>
<tr>
<td>5</td>
<td>Industry linkages</td>
<td>Linkages between universities and industry are the vital element in successful TT&amp;C</td>
</tr>
<tr>
<td>6</td>
<td>Intellectual property</td>
<td>A workable intellectual property regime is a necessary pre-requisite to successful university TT&amp;C</td>
</tr>
<tr>
<td>7</td>
<td>Co-operative Research Centres</td>
<td>Co-operative Research Centres improve TT&amp;C performance</td>
</tr>
<tr>
<td>8</td>
<td>Characteristics of local industry</td>
<td>Local industry has to be capable of absorbing university research outputs if university TT&amp;C is to flourish</td>
</tr>
<tr>
<td>9</td>
<td>Industry clusters</td>
<td>Industry clusters aid universities and industry in TT&amp;C performance</td>
</tr>
<tr>
<td>10</td>
<td>Role of intermediaries</td>
<td>Intermediaries operating between universities and industry improve TT&amp;C performance</td>
</tr>
<tr>
<td>11</td>
<td>Technology parks and incubators</td>
<td>The presence of technology incubators and technology parks stimulate better TT&amp;C performance</td>
</tr>
<tr>
<td>12</td>
<td>Regional and smaller universities</td>
<td>Regional and smaller universities must satisfy different criteria to other universities if they are to succeed at TT&amp;C</td>
</tr>
<tr>
<td>13</td>
<td>The role of government</td>
<td>The role of government in stimulating TT&amp;C is to establish an environment that encourages parties to participate</td>
</tr>
</tbody>
</table>

Table 6.1 – List of Propositions to be Tested by the Research (Source: Author)
PART III - METHODOLOGY

7 Methodology

7.1 Introduction

Part III describes in detail the research methodology used in this project. Sections 7.2 - 7.6 describe the research design in detail, and discuss each of the three techniques used: qualitative content analysis, case study, and narrative review, and the use of methodological triangulation when answering Research Question 4 on the take-up of university research by Australian industry. Section 7.7 describes the methods used in data collection and analysis, while Section 7.8 discusses the credibility (reliability and validity) of the results, and Section 7.9 completes the Part with a brief discussion on ethical issues faced in this project.

In answering the research questions and testing the propositions there are a number of factors that direct the researcher to an appropriate research design. First, the research questions themselves require observation from at least two particular perspectives: that of the university; and that of industry. The perspective of government (federal and State) will also be important. Second, in this case the researcher has “…little control over events, and… the focus is on a contemporary phenomenon with some real-life context” (Yin 2003b, p.1). Third, three of the four research questions seek an answer to questions of “how” particular behaviour can be encouraged (therefore requiring an understanding of their environment and characteristics). Fourth, there is a significant body of secondary data available that could be used if it can be coherently analysed.

In designing an approach to this research, there is also the practical issue that the population of principal interest: universities, and businesses that commercialise university research, is already heavily surveyed and analysed. The likelihood of being able to stimulate sufficient or adequate responses to comprehensive survey instruments or lengthy discussions was believed to be remote. Despite this challenge, primary data were collected through interviews with individuals involved in university research commercialisation from both university and industry, and substantial documentary data were collected from people and entities of interest. Fortunately, during the course of this research the Australian Government Department of Education, Science and Training (DEST) published its periodic survey of tertiary institutions’ commercialisation activities (DEST 2007) which had the benefit of providing reliable secondary data covering a recent period.
Taking account of these factors, the principal research techniques used in this project involve qualitative content analysis, case study method, a narrative review based on published research and reports, and methodological triangulation. Qualitative content analysis, case study method and narrative review all permit the use of primary and secondary data, as well as the use of additional techniques such as numerical analysis of data, which is used on several occasions to provide insights into particular issues. Triangulation of the results is used on the research question involving industry by using, first, case study method on industry cases developed by the researcher, and second, using a narrative review drawn from the literature and other secondary sources. For the purposes of triangulating industry data it was originally intended to use a qualitative meta-analysis of published case studies of industry with which to compare the primary data of the case studies developed by the research. It was found, however, that published case studies did not contain sufficient depth of information to permit any worthwhile analysis to be conducted so an alternative method of triangulation was developed using narrative review applied to published research and reports.

### 7.2 Research Design

To answer the first question: *What are the systemic barriers to research commercialisation within Australian universities?* documentation was reviewed using qualitative content analysis in order to identify the barriers and other relevant factors in a systematic way. The methodology used is described below and the answer to the question is set out above in Chapter 5.

The second and third research questions: *How could Australian universities overcome the systemic barriers to the commercialisation of university research?* and *How, in particular, could Australia’s smaller and regional universities enhance their research commercialisation capacity and performance?* are answered principally by the use of multiple-case studies using primary data.

The fourth research question: *How could the uptake by industry of Australian university research outcomes be improved?* is answered principally by the use of multiple-case studies using primary data, and a narrative review of the literature and secondary data. The use of two approaches permits methodological triangulation in order to give added credibility to these results.

### 7.3 Case Study Method

As a research tool, case study method has a somewhat indifferent pedigree and is regarded by some researchers as a technique of last resort. In no small measure this is due to the
limited literature on the technique and the lack of general agreement amongst scholars on its merit as a research (as distinct from teaching) tool, particularly in respect of the analysis of the case or cases. Indeed, the literature on analysis of cases is thin. Yin (2003a, pp.10-11) cited common concerns about case study method as including:

- lack of rigour: sloppiness; failure to follow systematic procedures; allowing equivocal evidence or biased views to influence findings and conclusions;
- providing little basis for suitable generalisation; and
- taking too long and resulting in massive unreadable documents.

Bozeman and Boardman (2003, p.47) said of case study method:

“The classic weakness of the case study is a limited ability to generalize. The classic answer to that weakness is ‘we cannot generalize but we can, with caution, draw inferences based on our knowledge of context.’ The contextual features of case studies are, of course, what makes case studies interesting and useful while, at the same time, posing difficulties in drawing general propositions”.

Well handled, case studies can provide an effective way to a cogent understanding of an environment where there are “many more variables of interest than data points” (Yin 2003a, p.14). Yin (2003a, p.7) claimed that case study method is “...the preferred method of examining questions of ‘how’ and ‘why’ when examining contemporary events in which relevant behaviours cannot be manipulated”. The environment in which this research is conducted is an archetype of this type described by Yin.

The US General Accounting Office (GAO) described six types of case study (GAO 1990, p.9), although these can probably be conveniently collapsed into three major types (Yin 2003b, p.5): exploratory, descriptive and explanatory, which may be then expanded into single- and multiple-case studies. The type used in this project was explanatory (also called “causal” by Yin), which “…presents data bearing on cause-effect relationships – explaining how events happened” (Yin 2003b, p.5). It was the objective of this research to use case study method to answer the questions which start: “how…”, thus requiring analysis and understanding of the cause-effect relationships impinging on university research commercialisation.

It is reasonable to expect that the more cases that are analysed the more robust the research outcomes (GAO 1990; Yin 2003b), although multiple-case studies look more for replication than for any type of survey consistency (Yin 2003a; GAO 1990). This project sought replication in what Yin (2003a) called ‘literal replication’, that is replication of factors within a consistent group. In the case of this project there were two consistent groups: the benchmark group of five international universities; and the eight Australian case study
universities. Consistency within, and then between, each of the two groups provided a strong indication of generalisability of results.

In this research there were additional reasons for selecting multiple universities for analysis. Australian universities are characterised by being members of one of several groupings, the principal four being\(^{107}\):

- **Group of 8**\(^{108}\), representing Australia’s eight oldest-established universities\(^{109}\) with the strongest research reputations and largest research budgets;
- **Australian Technology Network**\(^{110}\) (ATN), representing five of the country’s leading technological universities\(^{111}\);
- **Innovative Research Universities**\(^{112}\) (IRU), representing six of Australia’s universities that were established during the period of great growth in university numbers in the 1960s and 1970s\(^{113}\), and
- **So-called New Generation Universities**\(^{114}\), effectively an informal group of ten newer universities.

Group of 8 universities receive the bulk of government funding for university research, so representative case studies should be included in this project. The ATN universities evolved from institutes of technology (in some jurisdictions outside Australia known as polytechnics) and possess a distinctive profile; and, similarly, metropolitan universities not in either category and regional universities could be expected to possess their own particular characteristics. Research Question 3 required specific understanding of regional and smaller universities. The selection of at least two universities in each of these categories permitted some degree of multiple-case analysis within each group and, taken all together, formed quite a large group of universities from which to develop cases and conduct analysis. For this reason, a total of eight universities was selected for this multiple-case study. Given that


\(^{108}\) [www.go8.edu.au](http://www.go8.edu.au)

\(^{109}\) The University of Adelaide, The Australian National University, The University of Melbourne, Monash University, The University of New South Wales, The University of Queensland, The University of Sydney, The University of Western Australia.

\(^{110}\) [www.atn.edu.au](http://www.atn.edu.au)

\(^{111}\) Curtin University of Technology, University of South Australia, RMIT University, University of Technology Sydney, Queensland University of Technology.

\(^{112}\) [www.irua.edu.au](http://www.irua.edu.au)

\(^{113}\) Flinders University, Griffith University, La Trobe University, Macquarie University, Murdoch University, University of Newcastle.

\(^{114}\) Australian Catholic University, Central Queensland University, Edith Cowan University, Southern Cross University, Victoria University, University of Ballarat, University of Canberra, University of Southern Queensland, University of the Sunshine Coast, University of Western Sydney.
Australia has thirty-eight public universities, eight universities also represents a substantial selection of all Australian universities.

Two particular weaknesses of case study method are the linkage between propositions and case descriptions, and interpreting case descriptions so as to allow the generation of theory. The first of these potential weaknesses is avoided in this project by constructing the case studies along the lines of the propositions to be tested so that the propositions thread throughout each case. There is no clear answer to the second of these weaknesses apart from ensuring that the various criteria for testing and confirming the validity of the results are satisfied, as per Yin (2003a, pp.33-39), including: construct validity; internal validity; external validity; and reliability, issues which are addressed below. A further device in this project that assists in using case descriptions to generate theory (to the extent that it is needed to answer the research questions) is the use of additional sources such as interviews with others such as venture capitalists and a strategist, and the use of reliable secondary sources.

7.4 Qualitative Content Analysis

Qualitative content analysis is used to answer Research Question 1 (as described above). Content analysis is the appropriate technique to use because, as Neuendorf (2002, at p.15) stated:

“... a content analysis summarises rather than reports all details concerning a message set. This is consistent with the nomothetic approach to scientific investigations (i.e., seeking to generate generalizable conclusions)...”.

Content analysis represents a formal approach to qualitative data analysis (Collis and Hussey 2003, p.255). It can be used to analyse written documents or other material such as audio interviews (Gilham 2000). The method is flexible, being: “...applied in qualitative, quantitative, and sometimes mixed modes of research frameworks and employs a wide range of analytical techniques to generate findings and put them in context” (White and Marsh 2006, p.22). And it is this characteristic of being flexible while permitting rigour that makes it an attractive method to use. The qualitative content analysis process is described elegantly by Mayring (2000, Sect.1) as involving: “...an approach of empirical, methodological controlled analysis of texts within their context of communication, following content analytical rules and step by step models without rash quantification”.

There are criticisms of content analysis as having an unclear theoretical basis and producing trite results (Silverman 1993), and there can be risks in relying on public documents because they may contain omissions or be an incomplete statement of the environment or are written for a public audience rather than a specialist one (Collis and Hussey 2003, p.258). Criticism
of the theoretical basis may be difficult to sustain given the popularity of the method and its common use, while the quality of the results will depend on the work the method is asked to perform – in this case finding a list of barriers and other factors relevant to university commercialisation and describing the characteristics of each of these – which represents a reasonably simple and straight-forward task of no particular complexity. A large number of documents from a wide range of sources is used in this analysis, including material directed to specialist audiences. Consequently, the documentation often includes commentary relevant not only to university research, but to publicly-funded research generally. While the list that results from analysis of this material may well identify more barriers and other factors relevant to commercialisation than apply to universities alone, at the same time there are likely to be barriers that apply across the spectrum of commercialisation (such as barriers relevant to dealing with industry) that are generic and apply to all commercialisations. On the basis that it may be wiser to identify more potential barriers for later analysis than miss some by being too restrictive at an early stage, a broad list of barriers to, and other relevant factors affecting, university research commercialisation was developed from the data.

Case study method and qualitative content analysis share the characteristic of treating almost everything as data, for example: documents, interviews and numerical analyses can constitute data in both methods (Yin 2003a). To this extent, therefore, it should be possible to analyse and interpret data collected for case study using content analysis. There are risks in this approach, in particular the risk of “method slurring” (Baker, et al. 1992; although their comments were in respect of Grounded Theory, the concerns can arise when using other methodologies) or “muddling qualitative methods” (Becker 1993) in which elements of different methods become intertwined and difficult to distinguish leading to potential problems of analysis.

There are other parallels between case study and content analysis. Both use non-statistical sampling methods, described in content analysis as theoretical sampling (Boeije 2002) and, in the case of multiple-case studies, replication logic (Yin 2003a, pp.46-53). Similarly, both seek convergence in their data: in content analysis demonstrated through data saturation (when no new information emerges during coding), and in multiple-case study described as “converging lines of inquiry...aimed at corroborating the same fact or phenomenon” (Yin 2003a, pp.98-99).

It is probable that, as long as a researcher is aware of the risks attendant to the use of several methods and distinguishes when each is respectively used, it is legitimate to segue between case study and content analysis providing the points at which the analytical methods change is sufficiently obvious and no intellectual clarity is compromised.
The coding units derived from the first step in the process described here (which are derived from the “barriers” to commercialisation) were used to inform data collection in later stages. Using theoretical concepts to analyse existing qualitative data or data collected in other research has support in the literature from Strauss and Corbin (1998) and Szabo and Strang (1997). This is subject to at least one caveat: that the data set is large enough to allow the data analysis and theoretic sampling to proceed appropriately. Given the large number of cases used in the analysis this caveat should be satisfied, however there are limitations on the depth of the data captured, the implications of which are discussed in the analysis of the data in a later section.

7.5 Narrative Review

One of the least developed but often used methodologies in science and social sciences is that of narrative review (Rumrill and Fitzgerald 2001). As described by King and He (2005):

“Narrative reviews present verbal descriptions of past studies focusing on theories and frameworks, elementary factors and their roles (predictor, moderator, or mediator), and/or research outcomes, (e.g., supported vs. unsupported) regarding a hypothesized relationship. Narrative reviews are of great heuristic value, and serve to postulate or advance new theories and models, to examine important and/or controversial topics, and to direct further development in a research domain”.

In this research, narrative review was used to review relevant literature and documents in order to identify the current state of scholarship on issues identified as important in the case studies so as to permit a degree of triangulation of these results with the case studies. It does this in the manner described by Rumrill and Fitzgerald (2001, p.168), namely the researcher should, “identify a research area in need of review, identify inclusion criteria for studies, select studies that meet the inclusion criteria, identify themes that emerge from the set of studies, and draw conclusions”. In this case the research areas were those covered in the propositions, while the criterion for inclusion of a study was that it addressed one or more of the areas of interest. The studies were then analysed to identify themes from which conclusions may be drawn. The conclusions from the narrative review were then correlated with the findings from the industry case studies in order to assess consistency of the results with those from those case studies.

Narrative review has been criticised on a number of grounds (Green and Hall 1984; Rosenthal and DiMatteo 2001; Tranfield, et al. 2003) including there being no standardised approach to its execution and, particularly, the potential for researcher bias. However, in the way it is used here, it is argued that researcher bias is unlikely to arise because by the time narrative review is used in the research, the conceptual framework of issues has already been established and, as long as literature selection is not biased, using it to test the validity of results from the primary data is a reasonable approach. At the same time research by
Briggs (2005) showed that potential researcher bias in narrative review is no greater than in alternatives such as meta-analysis, suggesting that any particular technique is no more likely to be infected with researcher bias than any other. As in much qualitative research, the efficacy of the result may come down to reviewing as much relevant material as feasible and using sufficient objective care in the analysis.

This research has involved the review of many hundreds of publications – official and learned in the main – and the consideration of so many of these as can be reasonably included and are pertinent. The risk of researcher bias is further minimised through the results of the narrative review being used as confirmatory of primary data rather than being used as the principal source of results.

7.6 Triangulation

Triangulation is a term used in measurement that denotes multiple calculations to estimate the location of a site, generally in two dimensions. Usually, the greater the number of calculations, the greater the accuracy of the estimate, although, using reliable techniques, two calculations are sufficient to locate a site in two-dimensions with precision. In research, triangulation means deriving an answer to a research question in more than one way (Collis and Hussey 2003, p.78). It helps eliminate subtle influences upon researchers while it is likely to: “...illuminate or nullify some extraneous influences” (Stake 1995, p.114). The purpose of triangulation is to give added validity to research results so that, while strictly it should be considered under the heading of validity, it is a separate technique used in this research and so is described in a little detail here.

Triangulation may use qualitative or quantitative approaches. There are several types of triangulation used in research with many renditions as to what constitutes acceptable practice. For example, Duffy (1987, p.131) suggested that triangulations involve one or more of four techniques, namely: analysing data in more than one way; using more than one sampling strategy; using different interviewers, observers or analysts in the one study; or using more than one methodology to gather data. Stake (1995, pp.112-115), quoting Denzin (1984) with approval, suggested that acceptable triangulation protocols include: data source triangulation; investigator triangulation; theory triangulation; and methodological triangulation. These views identify several potential ways in which to achieve different views of the same phenomenon for the purpose of cross-validating propositions and answers to research questions.

Triangulation in this research was achieved by methodological triangulation, namely the use of different qualitative methodologies: case study and narrative review.
7.7 Data Collection and Analysis

7.7.1 Research Question 1 – Identifying the Systemic Barriers

The process of data collection and analysis used in answering Research Question 1 is described earlier in Section 5.1

7.7.2 Research Questions 2 and 3 – Overcoming the Barriers - Universities

(a) Collecting the Data

The purpose of data collection here was to permit the development of case studies built around the propositions derived from barriers and other key issues identified in answering Research Question 1. A total of thirteen university case studies were developed – eight in Australia, and five in other jurisdictions. Two principal sources of data were compiled to assist in the development of the Australian case studies: interviews with staff of Australian universities associated with research commercialisation, and with venture capitalists and industry; and documentation available from the Australian universities and other reliable sources including the government and stakeholders including Universities Australia, Group of 8, the AIChE, KCA and similar entities. A similar process was used to compile the case studies of the five benchmark universities. Staff of universities involved in the interviews were either the Director of the TTO or a senior member of the TTO staff and, in two cases (Go8 Uni1 and Canadian Uni2), included another senior university staff member directly involved in commercialisation.

Interviews were conducted according to a prepared script based around the principal issues that had been identified earlier. The interviews were structured as a series of closed questions to elicit specific information on known issues of importance and open questions in order to obtain the views and experiences of the interviewees. They were conducted at the premises of the interviewee at dates and times suitable to the interviewee, and lasted between one and three hours. All interviews were recorded and transcribed substantially verbatim so as to preserve accurately the key comments of participants. A copy of the interview outline used with Australian universities is attached as Exhibit A of Appendix 1, and a copy of information supplied to interviewees is at Exhibit B of Appendix 1.

In addition to the interviews in North America and New Zealand, discussions were held with a leading UK university commercialisation entity, and documentation assembled from a wide variety of sources including university associations such as the Association of University Technology Managers (AUTM) in order to prepare a benchmark model of good practice research commercialisation.

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115 Two interviews were conducted by telephone: Aust Regional Uni1 in Australia, and NZ Uni in New Zealand.
116 The Oxford to Cambridge Arc (O2C Arc), see Section 8.3.3.
Documentation was compiled in whatever form it was available – most in soft copy, but some in hard copy. All material was indexed for convenient reference and cross-checking of sources.

Each case description making up a case study was written using substantially the same structure in order to make multiple-case analysis easier to conduct. The structure of each case description comprises two major parts: information about the university itself; and detailed information covering commercialisation at the university. The description of the university uses a straight-forward structure comprising three sections which permit a reader to understand the essential characteristics of the university: Background; Establishment and Governance; and Vision, Mission and Goals. The section on commercialisation contains rich descriptions detailing each case study university. Each of the headings in the commercialisation section of the case description is derived from the list of barriers and propositions.

After each of the university and other case descriptions were prepared, but prior to analysis, each case description was sent to respective interviewees with an invitation to make suggestions for amendment in order that the descriptions could reflect, as faithfully as possible, the environment extant in each university. All requested changes were included in the final case study.

(b) Analysing the Data

Information gained from the interviews and documentation was used to prepare a case study on each university. Analysis of the interviews was done by the researcher transcribing each comment of the interviewee into one of the headings in the case study consistent with the structure developed based on the propositions. While this proved time and resource intensive it is believed to produce a sound result because the words of the interviewees can be seen in the quotes of their direct speech which permeate both the written-up cases and this thesis. In this way each interviewee is seen to be speaking in their own words with minimal filtering by the researcher. This allows the analysis to comprise a great deal of direct quotes from the interviewees, providing a strong basis for the interpretations and conclusions drawn.

Because each case study was structured consistently to permit effective analysis, it was also possible to cross-reference information between individual case studies and the source data for purposes of reproducibility and validity.

The eight Australian case studies permitted multiple-case analysis on several levels. First, it was possible to analyse across the eight university case studies on certain factors common to universities (such as intellectual property policy and academic staff promotion) in order to understand and explain the barriers and other issues common across Australian universities.
Second, it was possible to compare barriers and issues common to particular types of universities such as regional and smaller universities (three in the sample), and to extract and analyse different groupings such as the Group of 8 universities and the ATN universities. The data compiled through the interviews with and documentation obtained from comparable overseas jurisdictions were used to identify and understand the characteristics of universities that excel in TT&C as a basis for comparison against Australian practice. While it was intended that best international practice could be used as an idealised case against which to compare Australian universities as a whole, or with particular groupings of Australian universities, this proved unnecessary as the research unfolded.

### 7.7.3 Research Question 4 – Overcoming the Barriers - Industry

(a) Collecting the Data

Answering this question involved methodological triangulation as discussed above, using two separate but complementary sets of data: one set comprising primary data in which detailed case descriptions were prepared using interviews and documentation for analysis using case study method; and the other narrative review using secondary sources.

Research commercialisation has occurred in a wide range of fields, so that selection of primary cases for analysis that reflect accurately the general experience is neither simple nor trivial. The case study companies selected here comprised a group of SMEs in one particular city – Brisbane – concentrated substantially in one industry – electronics. To this extent the results have to come with the caveat that they may reflect a narrow set of circumstances. Nonetheless, the consistency of views found – that is, the literal replication logic (Yin 2003a) necessary in multiple-case studies to be reasonably satisfied that the results are valid – was quite satisfying. The validity of the analysis was further reinforced by using methodological triangulation.

In the same way as in the case of the universities, case descriptions were prepared in draft, with each case description then sent to the respective interviewee with an invitation to make suggestions for amendment in order that the descriptions could reflect, as faithfully as possible, the case under study. A copy of the interview instrument used with industry is shown in Exhibit C of Appendix 1.

(b) Analysing the Data

To compare results obtained using two methodologies requires that the results be in a form to facilitate comparison. For that reason the components of analysis in each methodology are the same, as far as practicable, and based on the barriers and propositions identified earlier.
Analysis of the case studies involved the preparation of a case description based on the interviews conducted and the documentation obtained relevant to each. As before, this information was cross-referenced between each case study and the source data for purposes of reproducibility and validity.

Using the same structure a narrative review was conducted on a large body of secondary data, principally official and learned literature, to constitute the basis for data triangulation with the primary data.

The results of the primary case studies and the narrative review were then subject to a comparison (Section 10.7) to identify whether any substantial differences existed between the results. Where there were no substantial differences it was taken that the results were convergent for the purposes of triangulation; where they were different, and the differences explicable, the results were sufficiently convergent subject to any caveats or exceptions noted; and where they were different with the difference not readily explicable, this was noted and made the subject of a recommendation for further research.

### 7.8 Credibility of the Results

#### 7.8.1 Factors to Consider

The literature identifies two principal categories of challenge to research credibility:

- **validity**, or “... the extent to which the data collected truly reflect the phenomenon being studied” (Ticehurst and Veal 2000, p.23)

- **reliability**, or “... the extent to which research findings would be the same if the research were to be repeated at a later date, or with a different sample of subjects” (Ticehurst and Veal 2000, p.24).

While validity clearly applies to research methods involving positivistic elements (for example, are survey instruments designed so that they collect the data claimed?), it is not always applied to phenomenological research. This project uses qualitative, phenomenological, techniques throughout but, for the reasons discussed below, validity as well as reliability remains an issue of credibility. In particular, issues of both validity and reliability are of vital importance in case study research (Yin 2003).

Yin (2003, p.34) described the elements of research credibility, with particular emphasis on case study methods but which, *mutatis mutandis*, apply generally to other methods, in the matrix shown in Table 7.1. Each of these elements is discussed below.


<table>
<thead>
<tr>
<th>Tests</th>
<th>Case Study Tactic</th>
<th>Phase of research in which tactic occurs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct validity</td>
<td>• use multiple sources of evidence</td>
<td>• data collection</td>
</tr>
<tr>
<td></td>
<td>• establish chain of evidence</td>
<td>• data collection</td>
</tr>
<tr>
<td></td>
<td>• have key informants review draft case study report</td>
<td>• composition</td>
</tr>
<tr>
<td>Internal validity</td>
<td>• do pattern-matching</td>
<td>• data analysis</td>
</tr>
<tr>
<td></td>
<td>• do explanation building</td>
<td>• data analysis</td>
</tr>
<tr>
<td></td>
<td>• address rival explanations</td>
<td>• data analysis</td>
</tr>
<tr>
<td></td>
<td>• use logic models</td>
<td>• data analysis</td>
</tr>
<tr>
<td>External validity</td>
<td>• In theory in single-case studies</td>
<td>• Research design</td>
</tr>
<tr>
<td></td>
<td>• Use replication logic in multiple-case studies</td>
<td>• Research design</td>
</tr>
<tr>
<td>Reliability</td>
<td>• use case study protocol</td>
<td>• data collection</td>
</tr>
<tr>
<td></td>
<td>• develop case study database</td>
<td>• data collection</td>
</tr>
</tbody>
</table>

Table 7.1 – Elements of Credibility in Case Study Research Source: Yin (2003a, p.34)

Credible research permits results to be generalised which is an important issue in this project as the ability to apply the results more generally is a desired outcome. Generalisability is “… the extent to which you can come to conclusions about one thing (often a population) based on information about another (often a sample)” (Vogt 1993, p.99), or “… the degree to which the findings of a research study can be generalised to other settings and situations” (Ticehurst and Veal 2000, p.118) and is as relevant in qualitative research as it is in quantitative research (Gummesson 1991).

7.8.2 Validity

(a) Construct Validity

Techniques used in the design of this project to minimise risks to construct validity include:

- Using multiple sources of evidence including in-depth interviews, public information available from the case study entities, government and other reliable reports, and a large body of literature relevant to the topic;

- Maintaining a chain of evidence between the original material, the case descriptions and then to the analysis of the cases; and

- Allowing the review, by interviewees, of each case description prepared by the researcher so that each case description is valid.
(b) **Internal Validity**

Techniques used to minimise risks to internal validity include:

- Extensive explanation building in the analysis phase of the project;
- Seeking patterns through the data – looking to find consistency of approach; and
- Identifying and explaining models and identifying, where relevant, rival models and explanations.

(c) **External Validity**

The principal methodology used to analyse the primary data was multiple-case study. Considerable effort was put into identifying replication logic at three levels: among the benchmark cases (five cases); among the Australian university cases (eight cases); and then between these data two sets.

As it concerns industry case studies, external validity was enhanced by using methodological triangulation.

### 7.8.3 Reliability

Reliability of the results was ensured in two principal ways. First, by compiling an extensive database which included the case studies (all interviews being electronically recorded and transcribed), the large number of reports and literature captured and reviewed, and the process of analysis. Second, by designing and employing a case study protocol (referrable to the other analytical processes) which included:

- Maintaining a chain of evidence between the original material, the case descriptions and then to the analysis of the cases;

- Selecting a relatively large number of cases to analyse across the spectrum of Australian university experience (in fact over 20% of all Australian universities);

- Using methodological triangulation in answering research question 4 dealing with how industry could be encouraged to take up the results of university research; and

- Testing the Australian university cases against international best practice as identified in other advanced economies.

The approach used in this study permits the results to be generalised using all three techniques described by Firestone (1993): sample-to-population extrapolation, analytic generalisation and case-to-case translation, although clearly the results may not be applicable completely and uncritically because of the different operating and philosophical environments in which individual universities exist. This conclusion is due to the large
number of Australian case study universities developed (over 20% of the entire population) during the project. Understanding this, the results of the research should be generalisable subject to recognition being given to the different cultures, capabilities and positioning of respective Australian universities.

Industry case studies were not readily generalisable across all Australian industry because they dealt with one segment of industry only. Nonetheless, they may be reasonably generalisable across a similar segment of industry, namely Australian SMEs in high technology.

### 7.9 Ethical Issues

This research involved the handling of human subjects, principally through interviews, but also using follow-up emails and conversations, and the collection of a substantial body of documentation. In each of these cases ethical considerations applied.

In respect of human subjects, dealings were approved by the university human ethics committee based on the subjects being exposed to minimal personal risk as a result of participation in the project. This obligation was met through the following techniques:

- The project did not to elicit any information about intimate private details of the participants;
- The project was conducted for legitimate purposes and undertaken by a well qualified and experienced investigator using a high level of skill and care;
- Participants were well-informed of the aims, focus, value and benefits of the project, and were provided with background material to permit them to make an informed judgement on whether to participate;
- Informed and voluntary consent was obtained from participants prior to the start of interviews;
- Participants who agreed to be interviewed were able to withdraw at any time or refuse to answer any questions;
- Anonymity and confidentiality of participants was strictly maintained to avoid attributing any particular point of view or comments to a single individual except to the extent that participants consented to such disclosure in the development of case studies\(^\text{117}\); and

\(^{117}\) In fact all interviewees willingly signed a consent form in which they agreed to have statements made by them attributable. However it was the view of the author that it would be prudent to protect interviewees from direct attribution, hence the identity of interviewees and their organisations are masked in this thesis.
• Copies of interviews and the transcripts of interviews will be maintained for at least five years after the end of the project.

The instruments used in preparing for and conducting interviews are contained in Exhibits A, B and C of Appendix 1.

Documents collected for the project were available from either the public record or were supplied with the informed consent of the individuals or corporate entities involved. Where an assurance of confidentiality was provided by the researcher in respect of any interview, information supplied or documentation, this assurance was respected. Any confidential information was used only in aggregate form in a way that would ensure that individual informants could not be identified.

In respect of interviews, other information supplied and documents used, the researcher was scrupulous to ensure that they were used in a manner faithful to the original and the results contained in this report do not contain any intentional distortion or misrepresentation.
PART IV – ANALYSIS - UNIVERSITY PERFORMANCE

This Part covers Research Questions 2 and 3, which deal particularly with universities, namely: how could Australian universities overcome the systemic barriers to the commercialisation of university research? and how, in particular, could Australia’s smaller and regional universities enhance their research commercialisation capacity and performance? It has two major themes: the first is the identification of international best practice in TT&C (covered in Chapter 8); and the second is to identify Australian university practices, to identify any replication of characteristics among universities succeeding in TT&C, and to compare these to the international benchmark (Chapter 9).

Chapter 8 is a long chapter that explains by describing and analysing in some detail the commercialisation environment found in four comparable jurisdictions: North America (covering the US and Canada); the UK; and New Zealand. Case study universities in the US (two universities), Canada (two universities) and New Zealand (one university), as well as literature, are used to illustrate the environment in those countries while the UK environment is described solely from the literature. The results from this chapter provide the benchmark against which Australian case study universities are compared in Chapter 9.

The beginning of Chapter 9 provides a description of its structure and the process of analysis used. The principal methodology used is case study. The chapter undertakes a detailed examination and analysis of the characteristics that have the potential to distinguish universities’ TT&C performance based on the issues identified in the propositions developed earlier. The detailed analysis undertaken in this chapter permits robust conclusions to be drawn, in particular about the qualities possessed by universities performing well in TT&C irrespective of jurisdiction. These qualities are summarised and explained at the end of the chapter.

8 Best Practice Research Commercialisation in Comparable Jurisdictions

8.1 Common Themes

There is a view that universities in developed economies are changing and becoming more “entrepreneurial”. For example, the school of thought identified by Etzkowitz and others in which commercialisation is often characterised as the ‘third mission’, or a part of a ‘triple helix’ of activities embracing government, industry and universities (Etzkowitz and Leydesdorff 2001).
While this is generally true, analysis demonstrates that there is no “typical” university commercialisation model, and there is a great range in the way that TT&C tasks are completed by universities. One university, Imperial College London, not only spins-off companies from the university, but has spun-off its TTO to form Imperial Innovations plc which is listed on the London Stock Exchange\(^{118}\).

Some governments provide assistance to TTOs in the form of finance for commercialisation such as in the UK under University Challenge funding. In the US, on the other hand, most funding comes from private sources with the encouragement of government through schemes such as the Small Business Innovation Research Program (SBIR) and the Small Business Technology Transfer Program (STTR) (explained below).

Some universities have committed substantial capital funds through the invention-innovation cycle from early- to mid-stage development through to venture capital to bring an idea to market. For example, the University of Arizona, which claims the largest student body in the US, has substantial venture capital available through its commercialisation company, Arizona Technology Enterprises LLC, of up to $10 million at the proof-of-technology stage alone. Some universities commercialise through wholly-owned companies, while most do it through unincorporated entities that form part of the university itself.

One persistent theme in university TT&C is the dominance of life sciences (Vitale 2004), the other significant fields being physical sciences and engineering, and Information and Communications Technology (ICT). This was noted above as reported among US and Australian statistics, but it is also evident from the case studies. For example, US VC noted that “[we] would rather have … a biotech company or an IT company because the payoffs are currently bigger, whether you’re selling the company” or an IPO, or whatever, “because the valuations, whatever multiple you are using: cashflow, earnings, revenue, or whatever, are higher in IT and biotech. The reason for that is that those kind of companies have been able to be grow faster” (US VC Interview 2007). Similarly, US Public University reported that while life sciences has declined in the past five years as the major source of inventions, it still represents about 50% of disclosures, with the majority of the balance being physical sciences, particularly IT and engineering (US Public University Interview 2007). And this trend is confirmed by the experience of Canadian Uni2 where all eleven professional business managers in the TTO are in three fields: life sciences, physical sciences & engineering, and ICT (Canadian Uni2 Interview 2007).

\(^{118}\) Listed on the London Stock Exchange under the mnemonic: IVO. Further details from its website: www.imperialinnovations.co.uk
There are probably two major reasons why US universities have led the world in TT&C. The first relates to the ability of US universities, certainly the private universities, to fund TT&C activities because of their substantial financial strength arising from a history of philanthropy for the benefit of universities, a factor that continues to the present day. As well as providing a high degree of financial independence, this endows universities with a distinctive entrepreneurial streak. The second reason is the consistency of national public policy as it concerns university TT&C. Whether or not Bayh-Dole is an ideal policy, and whether or not it needs amendment to adapt to changing circumstances:

“... [one] of the great strengths of Bayh-Dole was that it provided no additional funding, therefore it never needed re-authorization...and so we’ve had in the US the benefit of twenty-seven years now of consistency of policy” (US Private University Interview 2007).

A third, and somewhat less corporeal, reason for the success of university TT&C in the US is the culture of entrepreneurialism that permeates the society. While not unique to the United States, it is a particularly potent element of the national psyche and colours much public and private decision-making.

The examples of TT&C illustrated in this chapter represent world’s best practice in university research commercialisation and describe the benchmarks against which the Australian case studies are examined later.

8.2 North America

Universities in the US have become the de facto, worldwide standard for what Clark (1998) termed the entrepreneurial university. The apogee of research commercialisation in North America is probably represented by two particular universities in the United States: MIT and Stanford. These two universities were successfully commercialising research through licensing and spin-off companies for decades before the introduction of the Bayh-Dole Act in 1980, and still represent international best practice in commercialisation. The universities of Columbia and California are also notable as commercialisation leaders among North American universities and provide some useful lessons, while the Wisconsin Alumni Research Foundation (WARF) remains one of, if not the, premier exemplar of life sciences commercialisation (although it now does much more) in North America since its foundation in 1925. There are also individual universities that have developed leading attributes as a result of community inspiration, such as AZTE (Arizona Technology Enterprises LLC), a wholly-owned subsidiary of the Arizona State University Foundation that is responsible for technology commercialisation from the University of Arizona, and which includes substantial associated funding for ideas throughout the process, from the laboratory through to industry acceptance.
This section describes the characteristics, practices and experience of four universities, two in the United States and two in Canada\textsuperscript{119}. It also synthesises information obtained during interviews with a US venture capitalist and a US strategic thinker\textsuperscript{120} involved in university commercialisation, as well as from the literature and public sources. The headings in this section follow the structure used later in analysing the Australian case study universities in order to allow for comparison between North American and Australian practice. To put North American practice into perspective, there is first a description of the environment in which the benchmark universities operate.

A large body of analysis dealing with the Canadian university TT&C environment has been undertaken by various Canadian governments (mainly the federal Government), and university and business associations\textsuperscript{121}. Scholars have also been active in this field in Canada, and references to their analyses are included in this chapter where they are relevant.

\subsection*{8.2.1 General Environment}

The United States has held world technological pre-eminence since at least the end of the Second World War but, largely because of the globalisation of industry, its marginal advantage is becoming muted. This loss of leadership is recognised by many eminent bodies in the United States such as The National Academies of Science (NAS, \textit{et al.} 2006) and the Domestic Policy Council (2006). It is causing the United States considerable concern which it is addressing through actions such as the American Competitiveness Initiative which was announced by the President of the United States in his State of the Union address in 2006\textsuperscript{122}.

According to the Carnegie Foundation for the Advancement of Teaching\textsuperscript{123}, the United States has 284 universities among a total 4,386 post-secondary institutions. Because of inconsistency in the use of names such as university, college, institute and the like in the US, the actual number of institutions equivalent to a university in other jurisdictions would be

\begin{flushleft}
\textsuperscript{119} Interviews were conducted at universities described in the analysis below as: US Public University, and US Private University in the US; and Canadian Uni1, and Canadian Uni2 in Canada. Both US case study universities have had controversy in their recent past about TT&C.

\textsuperscript{120} Interviews were conducted with a venture capital firm called in this thesis US VC; and with a strategic thinker called here US Strategist.

\textsuperscript{121} Premier among the organisations that examine related issues in Canada are: the federal Parliament and Government and its agencies, particularly Industry Canada and the Advisory Council on Science and Technology (ACST); the university granting agencies, particularly the Canadian Institutes of Health Research (CIHR), the Social Sciences and Humanities Research Council (SSHRC) and the Natural Sciences and Engineering Research Council (NSERC); other Canadian research agencies include the National Research Council; the Canada Foundation for Innovation; the Conference Board of Canada; the Canadian Advanced Technology Alliance (CATA Alliance); and the Association of Universities and Colleges of Canada (AUCC).

\textsuperscript{122} The US also suffered an earlier crisis of concern about its loss of technological pre-eminence during the 1970s and early 1980s, leading to a raft of initiatives, the \textit{Bayh-Dole Act} among them, that are usefully summarised in the article by Bozeman (2000).

\textsuperscript{123} \url{http://www.carnegiefoundation.org/index.asp}
\end{flushleft}
much higher than 284. For example, there are approximately 214 university members of the
NASULGC and 430 university members of the AASCU, the dominant university
representative entities in the US, apart from the AAU. There is overlapping membership
amongst these organisations, so that there are probably well in excess of 400 universities as
such in the US, with a further large number of specialist medical, law and other colleges
offering undergraduate and graduate training and conducting research.

According to AUTM membership data there are approximately 326 universities or colleges of
higher learning that have at least one person who is a member of AUTM. This represents a
large proportion of “universities” with staff who are members of AUTM but, if taken across the
spectrum of all post-secondary education institutions, it is quite a low proportion (around
7%)\(^{124}\). At least in part this low proportion may be attributed to the fact that there are a large
number of colleges and post-secondary institutions in the United States that are not actively
engaged in post-graduate education or research but, even allowing for this, the number
appears surprisingly low. For comparison, some 49 Canadian universities employ technology
transfer staff who are members of AUTM. This means that of Canada’s approximately 92
universities\(^{125}\), over half appear to be actively engaged in technology transfer\(^{126}\). In fact, since
1998 all but the smallest Canadian universities and university colleges had active TTOs
(Fisher and Atkinson-Grosjean 2002).

Turning to research intensive universities, the American Association of Universities (AAU)
represents sixty US and two Canadian universities and focuses on issues that are important
to research intensive universities. Sixty research intensive universities out of a population of
approximately 400 universities represents a proportion of 15%\(^{127}\). But whether we are dealing
with 400 universities or 60 universities in the US that are concerned with technology transfer,
or some number in-between, the number of universities active in the technology transfer
environment in the United States is substantial, but not so large that it is amorphous and
incapable of being described with some accuracy.

\(^{124}\) The US environment is also complicated by the existence of university systems, where a number of
universities are, for some purposes, part of a system while, for other purposes, are counted as separate
universities. The University of California system is probably the best known system, but many States have multi-
university systems.

\(^{125}\) These figures include universities and colleges affiliated with AUCC, the Association of Universities and
Colleges of Canada: http://www.aucc.ca/can_uni/our_universities/index_e.html

\(^{126}\) The numbers in this paragraph are calculated by the author based on AUTM member affiliation data published
by AUTM in February 2007. For further comparison, 15 of Australia’s 39 universities, or 38%, have staff who are
members of AUTM.

\(^{127}\) Compared to Australia’s Group of 8 research intensive universities out of a total population of 39 universities,
representing over 20% of all universities.
AUTM provides the best industry figures available, and these show the relative importance of technology transfer to the US economy. For fiscal year 2005, the latest information available, in the US alone, the contribution to the economy is estimated to be at least (AUTM 2007b):

- $42 billion plus in R&D expenditures at U.S. academic centres;
- 4,932 new licenses signed in 2005;
- 28,349 current, active licenses;
- 527 new products introduced into the market in 2005;
- 3,641 in the 8 years from FY98 through FY05. That is 1.25 new products based on academic inventions introduced every single day over the last 8 years;
- 628 new spin-off companies created in 2005. That is 1.7 new companies every day of the year. Each is based on what is hoped to be a platform of academic technology that will address market needs through the application of invested money by well-paid employees;
- 5,171 new spin-offs since 1980. That is more than one company every two days during 9,133 days of innovation.

But the results are highly concentrated in a limited number of institutions. For example, of the approximately $1,593 million in licensing income reported for the 2005 year (AUTM 2007b, Data Appendix) across 153 universities, almost half ($720 million) is attributable to two universities, with 70% attributable to eleven universities, and 78% to sixteen universities. While, clearly, a large number of universities did not participate in the AUTM survey, the available data show that licence income is highly concentrated. Thirteen of the sixteen universities that account for 78% of licensing income are member universities of the AAU.

Commercialisable research results are highly concentrated in one field as well. For two years about 1996-1997 AUTM collected data on the proportion of commercialisation in various fields and “they found that about two-thirds of the activity and about eighty percent of the income was from life sciences” (US Private University Interview 2007). This is reflected in the research funding available in the US: “… the NIH has a $26 billion extra-mural research budget, NSF has $5 billion… just follow the funding”. The DoE and Defence budgets, while large, are not easily allocated into categories (US Private University Interview 2007).

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128 The sixteen universities are: University of Wisconsin, MIT, University of Minnesota, University of California, University of Rochester, University of Washington, University of Florida, Wake Forest University, Emory University, New York University, University of Massachusetts, University of Iowa, Harvard University, University of Michigan, University of Colorado and East Virginia Medical School.

129 The US Private University Interview 2007 giving rise to this view is of particular authority because the interviewee for some years directed the AUTM data collection on which the observation is based.
According to the Association of Universities and Colleges of Canada (AUCC) Canada has ninety-two universities\textsuperscript{130}. If correct, this means that Canada has one university for each 330,000 Canadians, compared to the United States which has one university for each 750,000 citizens\textsuperscript{131} and Australia with one for each 540,000 Australians. Most likely, based on the categorization of a university having undergraduate, post-graduate and research components, Canada has some 60 universities in this category, making its ratio of universities to population must closer to that of Australia. As noted earlier, two Canadian universities\textsuperscript{132} are members of the Association of American Universities, the principal grouping of North American research-intensive universities.

AUTM data for Canada disclosed that for fiscal year 2005, the latest information available, the contribution of university TT&C to the Canadian economy from the thirty-six institutions that responded to the survey is estimated to be at least (AUTM 2007c):

- Over $4.2 billion in R&D expenditures at 36 Canadian institutions;
- 565 new licenses and options signed in 2005;
- 1,433 invention disclosures and 685 patent applications (an increase of 20\% over 2004) in 2005;
- 37 new spin-off companies created in 2005;
- Licence income of $52,863,816.

As in the US, Canadian results are highly concentrated in a limited number of institutions. For example, of the approximately $4.234 billion in research expenditure reported for the 2005 year (AUTM 2007c, Data Appendix) across 36 institutions, almost two-thirds ($2.764 billion) is attributable to nine universities. Of the $52,863 million in licence income reported, over 50\% is attributed to just two universities\textsuperscript{133}, while five institutions are responsible for over 70\%. While, again, a large number of universities did not participate in the AUTM survey, the available data show that most indicia are highly concentrated. Similarly, the fields in which Canadian research is producing results are concentrated. At Canadian Uni1, life sciences accounts for 58\% of disclosures and 51\% of spin-off companies with the balance in physical sciences and IT (Canadian Uni1 Interview 2007) which is typical of universities actively involved in life sciences research.

\textsuperscript{130} According to the AUCC website as at June 2006: \url{http://www.aucc.ca/index_e.html}
\textsuperscript{131} Based on a total of about 400 universities in the US, calculated earlier; however, taking account of the 4,000 or so institutes of higher learning in the US, this ratio is, most likely, much lower.
\textsuperscript{132} They are McGill University and the University of Toronto.
\textsuperscript{133} The University of British Columbia and the Université de Sherbrooke.
Canadian members of AUTM noted a common problem faced by TTOs in developed economies (AUTM 2007c, p.12):

“...more than 50% of the personnel working [in Canadian TTOs] have five years or more experience. Yet on the other hand, retirements and other changes of employment status have recently caused upheavals in some offices. Anecdotal information continues to point to a challenge in attracting personnel well-suited to the peculiarities of the commercialization profession”.

Industry experienced in dealing with the best US universities believes that “... [it] is absolutely crucial, in today’s world, for a university that does a lot of R&D, to establish a good tech transfer office” (US VC Interview 2007).

US Strategist expressed the view that in the United States the role of not-for-profit foundations is beginning to change the way research into some matters, particularly pharmaceuticals and other life sciences, is being conducted. Universities are becoming unable to fund development, while the costs and risks of getting new drugs and procedures to market are deterring companies, while government is declining to use public monies and act as neutral risk-taker. He opined that foundations and the like represent “new forms of collaboration that did not exist in this country, or around the world. You have some people who are thinking of the higher good...”. In essence, any company that wants to exploit the research that Foundations fund may do so, “but what we’re not going to do is [fight] over the research and the research agenda and who [wins] along the way”. Disputes over the ownership of the intellectual property are much less likely to be permitted by foundations (US Strategist Interview 2007).

A major shift that appears to be occurring in some sectors is the proliferation of open-source ideas that by-pass the patent system and its litigious culture, and permit large companies to become more nimble than they have been. An example in the US is Eli Lilly, which has enormous internal intellectual capacity, but was experiencing difficulty in keeping up with competitors in its market segments. In response, it created E. Lilly for the purposes of encouraging innovation. This entity identifies the biggest challenges its business faces and asks interested researchers to come to it with proposals to solve the problems, including the costs associated with implementing the proposal.

“At the end of the day, we either outright purchase the intellectual property of your solution, or we partner. Proctor & Gamble [has exploited this approach, so that] more than 50% of Proctor & Gamble products are coming from this open-source innovation, that is, people who have no intention of working for Proctor & Gamble are making incredible livings by saying: ‘we are going to create a product’; sometimes it’s universities and universities, sometimes it’s universities and the private sector, sometimes it’s entrepreneurs; ... open-source innovation is what created Wikipedia... which is worth a couple of billion dollars” (US Strategist Interview 2007).
Enterprises which have embraced an open-source approach to business include IBM through its “jam events”134 in which it claims 300,000 of its employees have been involved since 2001 leading to the creation of ten new businesses.

Despite the financial power of the large corporations in the US and the impact of sponsored research from industry, the government still supplies something like 70% of funding for US university research (US Private University Interview 2007) which means that the government, in particular the federal Government, exercises great control over the conduct of research.

Some interviewees in this research expressed concern about the declining level of trust that exists today in US commerce. “Trust cannot be bought, sold, [or] traded, it has to be inherently built into the relationship” (US Strategist Interview 2007). Professor Georges Doriot, commenting on the qualities needed to make relationships in commerce work cited three characteristics: “an interactive mix of mind (analysis), heart (personal attraction and commitment), and soul (values and ethics)” (Gupta 2004).

8.2.2 Regulatory Environment

A number of Acts and instruments intrude into the US university research commercialisation environment, the most important of these being federal legislation, and include the Bayh-Dole Act, the Small Business Innovation Research (SBIR) Program and Small Business Technology Transfer (STTR) Program135.

As it concerns this research, the principal change brought about by the Bayh-Dole Act in 1980 was to vest title in intellectual property arising from federally-funded research in the university that undertook the research subject to certain conditions being met. This altered the previous position where, subject to agreement to the contrary, the federal agency that funded the research (mainly Defence, the Department of Energy, the National Science Foundation and the National Institutes of Health) took title to resultant intellectual property. Prior to the enactment of Bayh-Dole approximately seventy-five universities136, including Stanford and MIT, had negotiated agreements137 by which the university took title in the intellectual property developed, so that they were already engaged in research commercialisation prior to the Bayh-Dole Act. Nonetheless, the Act had the effect of

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134 Information on this can be found at: https://www.collaborationjam.com/
136 Number from US Private University Interview 2007
137 These were known as Institutional Patent Agreements
encouraging more US universities to establish TTOs as evidenced by the statistics compiled by AUTM – there being some 21 TTOs prior to 1980, and at least 152 by 2005 (AUTM 2007b).

The *Bayh-Dole Act* also had the intent of encouraging the exploitation of a university’s intellectual property through small business. According to AUTM (2003) it has had this effect such that, by 2003, US universities, hospitals and research institutes reported that 65.3% of licenses and options executed were with start-up and small companies combined, and 34.6% were with large companies, as compared with 66.6% and 33.4%, respectively in 2002.

According to the US Small Business Administration (SBA), which has responsibility for implementing the SBIR program:

“[the] statutory purpose of the SBIR Program is to strengthen the role of innovative small business concerns (SBCs) in federally-funded research or research and development (R/R&D). Specific program purposes are to:

1. stimulate technological innovation;
2. use small business to meet Federal R/R&D needs;
3. foster and encourage participation by socially and economically disadvantaged SBCs, and by SBCs that are 51 percent owned and controlled by women, in technological innovation; and
4. increase private sector commercialization of innovations derived from Federal R/R&D, thereby increasing competition, productivity and economic growth.”

The SBIR was started in 1982 and has been reauthorized to continue until 2008. It is open to all for-profit, American-owned, and independently operated businesses with 500 or fewer employees. Federal agencies are required to set aside a small part of their research and development funds to support the program. Under the SBIR program, a company identifies research it needs to have done and writes a 25-page proposal. If the proposal is accepted, the company will receive up to $100,000 for Phase 1. The company can subcontract up to 30% of Phase 1 funds to research departments, including university departments. If Phase 1 research goes well, the agency may invite the team to submit a Phase 2 proposal. Phase 2 proposals cover two years and can provide up to $750,000. Subcontractors such as universities can share equally in these grants. Phase 3 contracts are also available. This money comes from private companies or other government agencies.

The importance of the SBIR program to biotechnology development in the US was highlighted in evidence cited by Audretsch (2001). He noted that the SBIR program at the NIH for 1999 alone exceeded $300 million. Similarly, the US Department of Defense used

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138 Quoted from par. 1(c) of the Small Business Innovation Research Program Policy Directive issued by the SBA, a copy of which may be located at: [http://www.sba.gov/sbir/SBIR-PolicyDirective.pdf](http://www.sba.gov/sbir/SBIR-PolicyDirective.pdf)

139 This description is derived from Sobol and Newell (2003, pp.269-270).
the SBIR program to fund biotechnology, and invested over $240 million between 1983 and 1997. He said (p.13): “There is compelling evidence that the SBIR Program has had a positive impact on developing the U.S. biotechnology industry…”.

But the SBIR Program is not limited to biotechnology alone, and has been described as the world’s largest seed capital fund and the secret to a great deal of the United States’ eminence in high technology through support for young ventures (Connell 2006).

In addition, the US Administration has made an Executive Order (Number 13329) the purpose of which “is to ensure that Federal agencies assist the private sector in its manufacturing innovation efforts”\(^{140}\).

### 8.2.3 Character of the University

It was noted earlier that a significant majority of the universities responsible for the bulk of the licensing income from research commercialisation are member universities of the AAU. This result is not surprising given that AAU members comprise most US research-intensive universities, and suggests that a benchmark model of US universities should embrace many of the characteristics of member universities of the AAU. This conclusion is subject to the important exception that some universities not members of this group are recognised as good at research and commercialisation, such as shown by Tornatzky, et al. (2002)\(^{141}\).

There are apparent differences between public and private universities in both their attitude and degree of support that they provide to TT&C. Private universities appear more inclined to see TT&C as a desirable activity while public universities are not always prepared to embrace TT&C with enthusiasm. As US Public University said: “…we give [faculty members] the freedom not to be commercial. I think [our university] has a bit of a history there, that there is some real concern on campus even right now at the level of commercialisation that we do” (US Public University Interview 2007). This general attitude is reflected, too, in the availability of funding through the university to support early-stage and later-stage development of discoveries and inventions although, in the case of US Public University, being located in the Bay Area with access to some of the world’s deepest pools of venture capital, this is unlikely to present an insurmountable problem.

The first, and arguably the key, criterion against which universities were assessed as successful in TT&C in the Tornatzky, et al. (2002) study of commercialising universities in the


\(^{141}\) The two universities that scored best as being “actively and successfully participating in, or linked to, state and local economic development” were not members of the AAU: Georgia Tech and NC State. Two other universities of the twelve identified in that study also were not members of the AAU: Virginia Tech and the University of Utah.
US was the Mission, Vision and Goal Statements. For without genuine belief in the importance of TT&C as a core value of the university, it is unlikely to develop; MIT had its Vannevar Bush and Karl Taylor Compton, and Stanford its Frank Terman. This view is no less recognised by the Canada Foundation for Innovation (2002, p.11) when it said “...commercialization success is...affected by the level of commitment from the universities themselves to commercialization”. North American universities that are successful in TT&C genuinely believe in its importance to the community and the university. The next criterion for success is the establishment of a TT&C environment to which the university adheres for a period of many years, most likely measured in decades, to allow the faculty members, industry and TTO staff to develop relationships and processes that work and become understood by all the participants. US Private University observed that MIT is a unique institution - it has no medical school but is one of the best performing TT&C universities in the United States. The Director of OTT said: “...they have had the same management team running technology transfer for twenty years, so they adopt a consistent set of philosophies and principles and investment. I think MIT is a unique institution” (US Private University Interview 2007). And probably the third most important criterion is an adequate volume of high-quality research.

There is also an apparent generational change of attitude and approach to university TT&C, where younger researchers are more inclined to seek external, non-institutional, funding and are more willing to engage in TT&C. US Strategist, speaking of experience in the United States, expressed it this way:

“You have a new generation of young principal investigators in this country under the age of forty, who are more ambitious and connected to understanding basic research and product research [to better mankind]. Now they may not want to be entrepreneurs, but you have a generation under forty, and... Australia may be the same way, [researchers] … over fifty-five and sixty... they love the research enterprise, they love the basic research, [and they don’t want to engage in commercialisation]” (US Strategist Interview 2007).

### 8.2.4 Commercialisation Structure

A common characteristic among North American TTOs is their diversity of structure. The Canadian Prime Minister’s Advisory Council on Science and Technology, ACST (1999, p.11) reported that Canada had:

“…a wide range of organizational models for operating commercialization offices. Some are owned and operated by the university; some are owned by the university but managed by arm’s length corporations whose activities are guided by boards of directors; some models involve a hybrid whereby innovation responsibilities are shared between in-house expertise and outside experts; and some universities collaborate in designing shared commercialization infrastructures while others establish their own infrastructure”.

It went on to say “Each model has merit and each university requires the flexibility to endorse the model that best meets its unique circumstances”.

US Public University provides a typical example of a TTO at a US university. The university created one office in 2004 to provide a "one-stop shop" for industry research partners to interact with the campus. This office reports to the Vice-Chancellor for Research and consists of two groups: one dealing with technology licensing (12 employees), and one with industry alliances (7 employees). Prior to 2004, there were two separate offices: a technology licensing office; and a sponsored projects office.

“One of the problems that we noticed, just a couple of years ago, basically, when we reorganised under one office, was that the Sponsored Projects Office really focused mostly on federal grants”, such as NIH and NSF grants, “and they didn’t service the industry-sponsored research as well as they could have”. The common management of the two “helps a little bit in terms of keeping closer contact between [the two offices], with the expectation, of course, that those sponsored research projects tend to generate significant licensing opportunities for the university because they are more directed towards ways in which particular companies are interested” (US Public University Interview 2007).

US Public University opened its own separate TTO for the first time only in the 1990s.

Similarly at US Private University which employs 14 people in TT&C, almost half (6) are in technology licensing. The first function established was the Venture Fund:

“... which was started in late 1974, first investment 1975; and technology transfer was added a couple of years later; that was it until 1997 when we added entrepreneurial assistance. Incubation was going on elsewhere in the university and was not brought under our control until 2006, and Corporate Business Development was about a year ago, too” (US Private University Interview 2007).

Even large sophisticated universities such as Canadian Uni2, which began commercialisation activities in the 1980s, have struggled to find the optimum TT&C model. For about twenty-five years until 2006 it undertook commercialisation through a separate but wholly-owned company. For most of its life this company had a tenuous financial existence because it was expected to become self-financing through its commercialisation activities. When it was clear that this was not going to happen, the company was given a degree of financial independence in 2000 through the university extending a $10 million line of credit. When, by 2006, the line of credit had been exhausted the university elected to terminate the mandate to commercialise research held by the company and return the function in-house under the management of the Vice-President (Research) (Canadian Uni2 Interview 2007).

This is an example of the difficulties experienced by universities as they work to find the best working model for their particular circumstances, and the fact that one model is unlikely to work in all circumstances.

Canadian Uni1 TTO is a unit within the office of the Vice-President Research. The TTO commenced as a part of the Office of Research Services in the 1980s and has always been a unit of the university. In the mid-1980s this office extended its brief to include industry liaison with the aid of 5 years’ funding from the Provincial Government. At the time of formation it was expected that this Office would be self-funding within 5 years. In 1987 the
TTO was separated from the Office for Research Services as a separate unit. The university has a wholly-owned for-profit company for the purpose of allowing the TTO to do things that require a corporate structure such as limiting liability in some cases, permitting access to some federal funding programs available to industry (but not universities, as such), and to undertake some hands-on business incubation prior to spinning-out particular companies (Canadian Uni1 Interview 2007).

Of the 151 US universities that responded to the most recent AUTM survey (AUTM 2007b, p.18), half reported five or fewer full-time staff, with one-third reporting three or fewer\(^\text{142}\). The mode in respect of staff employed in the TTO was six, with a range between one and fifty, reinforcing the grouping towards the smaller office. Only two TTOs reported a staff number greater than fifty. To give this some perspective, UniQuest in Australia reports over seventy employees.

Most North American universities operate on the model of a single office where all the TT&C resources are located centrally. This approach is reflected in (or maybe results from) the relatively small number of staff at most North American TTOs. The typical number of employees at a US university TTO is six, a number too small to accommodate any alternative structure.

Where the function is not outsourced there are two practical alternative models to the central office where permitted by the size of the TTO: the “hub and spoke” model and the “front-office/back-office” model. The hub and spoke model involves having a central resource of capabilities in such areas as intellectual property management and contract negotiation (the hub), supplemented by business managers embedded in university research areas on a permanent basis (the spokes). Because it embeds TTO staff with researchers across the range of university technologies, the hub and spoke model requires a large number of staff, which means that it is an option only open to universities with substantial research expenditure and the number of disclosures to justify the cost. There has been considerable debate in North America\(^\text{143}\) on the issue of structure with no general consensus as to the optimum model for any given circumstance. Some, like the University of Michigan, operate a spoke only in one or a few academic departments. Each of the US universities interviewed for this study operate principally along the central office model.

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\(^{142}\) These numbers are FTE

\(^{143}\) For example, the issue of the efficacy of a central office TTO versus hub-and-spoke was the subject of much debate over several days in February 2007 amongst members of the North American TTO community in the large on-line network: Techno-L. (24 and 25 February 2007 – records are available)
The front-office/back-office (FOBO) model used by the TTO at Canadian Uni1 is a variant of the hub and spoke model. The university tried and subsequently abandoned the hub and spoke model; the university said that:

“We tried for a number of years with the hub and spoke where we would have an individual down at various sites and what we found was that that doesn’t work very well. It doesn’t work very well because the individual is isolated from everybody. He is not part of the home base, and a lot of what people learn here they learn around the water cooler...” (Canadian Uni1 Interview 2007).

The FOBO model involves central resources in the back office, like the hub and spoke, but employs groups of co-located business managers that specialise in particular fields. For example, the life sciences front-office is located at one hospital affiliated to Canadian Uni1, but works with all other affiliated hospitals. In this way the university believes the group obtains the benefits of working together as a group (rather than being embedded with the researchers as in the hub and spoke model) while still being identified by the target researchers as a specialised group to which they can relate. As the university said:

“...around 2001 we set up a formal hospital office, and that's were we played on the front-office/back-office component. And the front office down there at that time had six [employees] now has seven or eight people in it, and that creates a large-enough group that they have enough synergy amongst themselves to be self-supporting, and yet they still have to come back here in terms of finance, patent management, contract management, internal legal services, communication, all of that back-office stuff” (Canadian Uni1 Interview 2007).

Staff at larger North American TTOs generally possess outstanding academic qualifications. At US Public University, life sciences licensing officers are all PhDs, while licensing officers in physical sciences possess more of a business background with some MBAs and patent experience. Canadian Uni2 TTO staff all possess technical degrees, with all life and physical science staff possessing PhDs, while at US Private University, of the thirteen professional staff of OTD, six hold doctorate degrees (and another an MD), three hold MBAs (including two of the PhDs), and two hold Master’s degrees, while two are paralegals. Similarly at Canadian Uni1, where the thirty-five TTO staff include nine PhDs, five MBAs, two lawyers, and one accountant, with all other professional staff holding a technical qualification including some up to Masters level. Staff possessing this level of training and experience are difficult to find in the numbers needed and are difficult to retain. They are also an expensive resource, and universities experience challenges in remunerating staff in some cases, particularly where the TTO is within the university structure and is obliged to pay salaries on a par with other faculty members and staff. This is in contrast to TTOs that have been structured as companies where, generally, management has greater flexibility in the amount and way it can remunerate staff. Each of the North American case study universities commented on the difficulty of appropriately paying staff and the attraction, in this regard, of having a commercialisation company rather than a TTO within the structure of the university. The challenge presented by the structure chosen was expressed by Canadian Uni2 when it said:
“With the internalisation of the group, it really takes a set of functions that could probably be better managed with the flexibility to provide incentive instead of putting people on a salary grading, and I think the impact of that will be that we will have, as long as we have commercialisation and tech transfer responsibilities internalised within the university, we will have a lot of churn and we will be in a constant training mode with people who come in, learn the business and then spin-out to be part of the opportunities... Paying people who are very entrepreneurial on an incentive basis is very important and we don’t have that flexibility” (Canadian Uni2 Interview 2007).

One critical weakness regularly identified by most TTOs in their skill-set is industry experience. Canadian Uni1 said succinctly: “I think an area where we would be light in terms of qualifications is in deep industry experience” (Canadian Uni1 Interview 2007). And it is not sufficient to fill this gap with a person who has simply “worked in industry”. Where Canadian Uni1 TTO employed a person out of big industry he obviously floundered in the environment of a small-medium entrepreneurial business which is characteristic of most TTOs.

The difficulties attending the structures presently used by TTOs in North America invite consideration of alternatives. US Strategist argued that the paradigm is changing, particularly with the emergence of open systems innovation and the other pressures arising from government desires to use research results to enhance economic development and address the grand challenges arising from the likes of homeland security and environmental concerns. US Strategist argued that this leads to pressure on TTOs to behave less like technology transfer offices and more like offices of innovation and commercialisation, a role for which they are generally ill-equipped largely because only a handful of the staff have sufficient skills in commercialisation. What is needed is a fresh view – to see the TTOs as a part of a research enterprise. (US Strategist Interview 2007).

In the view of US Strategist the future involves an acknowledgement of the new and different roles facing TTOs. An example of a new intermediary is the TTO Director at the University of North Carolina (UNC) who has, basically a title that includes technology transfer, commercialisation and economic development.

“So you have some examples [of expanded functions]: UNC, Arizona State University (AZTE)...You’ve got a handful of places that are beginning to take on this role or expand their role.

“You had in Florida, UTech, which has homogenised itself. What is happening is that off-campus agreements are beginning to form... you’ve got firms that are becoming brokers under contract; you’ve got people beginning to outsource... You’re seeing rivalry as the very earliest stages of open-source competition. ...This is the other piece that’s tied to this: what we’re realising is that there are several pathways for research enterprise exploitation. Given that 90% of what we are talking about never goes through the office of technology transfer. ...some of it [intellectual property] is going out the back door... and there are a lot of ways to share knowledge...” (US Strategist Interview 2007)

A continuing conundrum for universities in Canada is the source of funding for the TTO. Most TTOs in Canada (as in the US) will not show an accounting profit and have to be subsidised in some way. Even TTOs on their way to profit within research-intensive universities will take
many years after their foundation to achieve profitability and therefore need funding to support them in their formative years. By way of example, Canadian Uni2 has re-formed its TTO and is working towards demonstrating its profitability. As the TTO Director said:

“...because] we have had, traditionally, to draw the resources made available for commercialisation in Ontario from the general revenues of the university, there is an argument that that’s taken out of the classroom, particularly when commercialisation wasn’t as focused-upon as it has been. There’s a lagging funding for commercialisation activities relative to government policy orientation on it, and we’re drawing from a very weak base... we’re quite below the national average on per-student funding” (Canadian Uni2 Interview 2007).

This demonstrates the difficulty in funding TT&C activities, particularly in the early years. Governments expect universities to perform TT&C activities for the common good including stimulating regional and national economic development, even when TTOs are financially marginal or unprofitable, while supplying no specific funding for the activity. Universities either take this from endowment (where it exists and is permitted) or recurrent funding. Most government recurrent funding is for teaching so that the university may have to appropriate some of these funds to the purposes of TT&C, something that is made more difficult when, as in the case of Canadian Uni2, it already receives comparatively low levels of funding for teaching. This has improved to some extent in the last two years by the Provincial Government providing funding for some TTO positions under the Ontario Research Commercialization Program.

In order to remedy the perceived deficiency in TTO staffing numbers and skill levels in Canada, the ACST (1999, Recommendation #3) recommended that, in addition to current spending on technology transfer, “[the] federal government should invest new and additional resources to strengthen the commercialization of universities in an amount equal to 5 percent of its investment in university research...”. Such an amount would equate to $50 million in 1999 dollars (being 5% of the $1 billion invested in research by the federal government), a very significant sum.

8.2.5 Commercialisation Process

Just as there are a variety of TTO structures among North American universities, there are differences in the way the TT&C is performed. Factors affecting the process include whether the university owns the intellectual property (not an issue in the US in the case of federally-funded research, but still an issue in some Canadian universities), the availability of university early-stage funding, the size of the university, the size and nature of the medical and life sciences schools (life sciences represents the majority of licensing, and the presence of a medical school affects the ability to conduct some development such as clinical trials), the presence and use of intermediary firms, the availability of venture capital, and the preferred route for commercialisation (licensing or spin-off). Generally speaking, North
American universities do not become involved in faculty members’ consulting assignments which are treated as private arrangements.

TT&C starts with disclosure to the TTO by a faculty member of a relevant invention or discovery. While academics are often obliged by university rules to make disclosure of discoveries and inventions, generally there appears little concern on the part of the TTO in the event that disclosure is not made and a faculty member chooses instead to publish, with the exception of sponsored research where the results may not be the faculty member’s alone to make public.

Each disclosure is then subject to an examination, test or gate of some description to determine whether it has commercial potential to justify the expenditure of effort and money to patent. At US Public University, when deciding whether and how an invention should be commercialised following disclosure to the Office “we look at a number of aspects, [the first] would be a technical evaluation of the disclosure in terms of ‘is it patentable?’, ‘is there a lot of prior art?’, ‘what potential value do you see, just as a patent?’” (US Public University Interview 2007). This decision is made by the licensing officer in conjunction with the faculty member. Conversely, US Private University will usually file a patent upon disclosure in order to preserve a position and then wait for some months before making a decision, based on further discussions with the faculty member on whether the patent should be pursued.

Canadian Uni2 has a rigorous process for life sciences in particular:

“We have been accepting, over the past few years, only 10% of the invention disclosures that we see. So our screening process has a fairly fine grid, and when we accept them, we think they have a fairly good chance for commercialisation - it is only these that are going to go to the review panels” (Canadian Uni2 Interview 2007).

Canadian Uni2 has a large proportion of life sciences disclosures because it has an associated teaching hospital with faculty cross-appointments between the university and hospital. Canada also has a large proportion of young life sciences companies, a major reason being that spin-offs tend to be favoured in Canada because of the general lack of receptor companies.

Canadian technology transfer professionals and scholars are of the view that commercialising university research should rest in the first instance with the university (Canada Foundation for Innovation 2002, p.20).

Canadian Uni1 prefers the licensing route for commercialisation over a spin-off where this is practical:

“A spin-off is going to take to close to ten times the amount of work and effort, [while], in terms of the return, we’re not doing this based on financial return as our sole indicator, so
the spin-off has economic return, it has political return and, in fact, it does have, in many cases, a very strong financial return” (Canadian Uni1 Interview 2007).

On the other hand, Canada is said to have a policy favouring the establishment of spin-off companies over licensing (Riddle 2004). Clayman and Holbrook (2003) analysed data on university spin-off companies since 1995 and reported that Canada appears to be successful in keeping spin-off companies going, with a 73% survival rate. They also reported that biotechnology is the major focus of spin-off companies, at 52% of all spin-offs.

There is some disquiet about the growing commercialisation in which US universities engage. Press and Washburn (2000) expressed alarm that sponsored research is putting at risk the paramount value of higher education - disinterested inquiry, while universities are operating ever more like for-profit companies. Nelson (2001) expressed concern at the potential compromise commercialisation is imposing on open science. On the other hand, Thursby and Thursby (2002) suggested that the increasing emphasis on TT&C in US universities has brought about a culture change rather than compromised research integrity: “... to an increased willingness of faculty and administrators to license and increased business reliance on external R&D rather than a shift in faculty research” (p.90).

Every university involved in TT&C seems to have developed its own commercialisation process. The University of Virginia Patent Foundation is a leading example of an institution that employs a sophisticated technology transfer process. Its operating manual sets a benchmark for commercialisation processes (UVAPF 2004) that provides a useful benchmark against which to test models involving ideas created otherwise than by contract research. At the same time, it is interesting to observe that this process is quite similar to that necessary for any ordinary business decision. For example, two of its steps are as important in any business decision as they are in TT&C: market analysis\textsuperscript{144} (or market research – that is: is this idea valuable; to whom is it valuable; and to what extent?); and marketing (who wants it; how do they want it packaged; how should it be priced; and so on?). Even in sponsored research, where the industry partner is known, marketing remains essential because a researcher needs to have located the industry partner before the research begins, and should have established agreements on matters such as how risks and rewards will be shared.

Universities have frequently approached TT&C somewhat opportunistically, often looking at each new idea as a discrete item to be commercialised. A more sophisticated approach involves scanning the totality of a university’s intellectual property (and other intellectual property sources) in order to identify clusters of ideas that may have greater value than one

\textsuperscript{144} On the issue of early stage market research in commercialisation, see, also (AIC 2004b)
idea alone. The University of California system, which operates over 10 campuses, developed software to permit the collection and combination of intellectual property that was not, if left as one-off pieces of intellectual property, sufficiently broad or deep to be of commercial value. This permitted UC to see whether a more valuable, commercialisable mass of intellectual property might be assembled from these smaller parts. It was found that there was potential benefit by grouping intellectual property that had not been evident in stand-alone intellectual property (Sime 2004). This technique has also been used by the Virginia Polytechnic Institute and State University in conjunction with a major corporation (DuPont) in one particular technology area (nanotechnology) (Martin, et al. 2004). However, presently at US Public University, the TTO noted that the inability to assign intellectual property can complicate the process of trying to assemble different fragments of intellectual property in order to create a more useful bundle, although this rarely seems to be a difficulty experienced in practise (US Public University Interview 2007).

8.2.6 Commercialisation Performance

A common problem facing universities engaged in TT&C, governments and every other participant in the environment is to establish a set of metrics that accurately reflects a university’s TT&C performance. This concern was expressed frankly by US Strategist:

“Existing technology transfer offices have the wrong structure and have to respond to too many diverse demands and expectations. As a result of these difficulties, the metrics used to measure their performance are internally inconsistent and fail to reflect what they should be doing, and what they are doing. One of these metrics is the number of patents, yet patents are beginning to become less significant as open-source innovation becomes more common. The reason for the decline of patents is their use as aggressive weapons, in conjunction with litigation, to exclude competitors and to occupy ground that they may not be entitled to enjoy” (US Strategist Interview 2007).

AUTM, probably the world leader as the representative body for university technology transfer professionals, has developed a range of metrics in order to assess the performance of universities in TT&C. These include input measures (such as the amount of R&D funding, and TTO staff numbers) and outputs (numbers and value of licences, numbers of spin-off companies and their value, the number of resulting products introduced to the market) (AUTM 2007b). But what constitutes suitable metrics is not a closed issue. It is almost a case of measuring what is available rather than what would best reflect reality. As the Canadian ACST (1999, p.14) said:

“... [the] success of a university commercialisation office should not be measured by the number of licenses it negotiates or the number of spin-off firms it creates. Commercialisation offices should endeavour to maximize the value of the companies which license their innovations and maximize the value of the companies they create. If they are successful in maximizing their clients’ value, universities will maximize the economic and social returns to Canada as well as themselves.”
This laudable proposition would appear to require, however, sophisticated economic and social measurement tools that may not be readily available.

Using data that are available, simply because they are available, as a proxy for commercialisation performance could be self-defeating. Most US TTOs do not create an excess of income over costs, but their value is greater than can be reflected in financial accounts. In the view of US Private University there are probably two principal measures that provide some useful insight into commercialisation performance: measures of results, including income to the university; and current measures of productivity, such as the numbers of deals done and their continuing value. US Private University believes that such measures as the number of spin-off companies is not a valid measure, unless it measured, for example, a sustainable company as expressed through the numbers of people employed in the spin-off company (US Private University Interview 2007).

The Office of Technology Transfer (OTT) at US Private University is not given specific performance targets. The OTT is given a patent budget within which it must manage, and the manager informs the university how much he expects to make in the coming year. “As long as I make more money than I spend, they seem to be happy”, reflecting an enlightened attitude that is concerned to make technology available to the public without the imposition of targets. This attitude reflects the thinking of the university President, and the management of OTT believes that this is the appropriate way to manage commercialisation (US Private University Interview 2007). The same approach is evident at Canadian Uni2 where the university has not imposed specific performance targets on the TTO, although there is the possibility that these may be introduced later once it has been re-structured and operating for some time. Nonetheless, the TTO itself presently evaluates how it should measure its own performance. On the basis that some industry-consistent performance measures are used by AUTM there is a likelihood that, simply because they are available, these may form the basis of some future reporting obligation because they are likely to appeal to government funding agencies (Canadian Uni2 Interview 2007).

The unsuitability of patents as an indicator of university TT&C performance is evident in the fact that:

“… in the United States… the USPTO is 600,000 patents behind and they claim it’s going to take 3-5 years to clear up”. And, second, the increasing use of patents as a tactical weapon is creating aversion to their use. In some areas business attempts to patent-build around a significant technology opportunity and then sue any apparent patent infringer, a fact that “is stifling the interest” in patenting genuine ideas (US Strategist Interview 2007).

United States universities do not generally take copyright to material produced by faculty members (with the exception of software) so that the likelihood of the university commercialising output from liberal arts and the HASS sector generally is probably remote.
US Public University reports that it has not seen any substantial potential for revenue generation from the liberal arts areas and does not presently see any likelihood that commercial ideas will emerge from this area (US Public University Interview 2007).

### 8.2.7 Commercialisation Office Performance

The ideal situation for all universities is to have a TTO that not only pays its way, but contributes substantial amounts of unencumbered income to the general purposes of the university. Riddle (2004, p.17) reported that in 2001 Canadian universities and research hospitals received $47.6 million in royalty revenue and incurred $28.5 million in TTO operating expenses. He said: “[underlying] the aggregate data, is the fact that for many Canadian institutions the cost of running a commercialisation office currently exceeds their revenues”. This view is consistent with data compiled and reported by The Times Higher Education Supplement relevant to UK universities (HES 2006) in which it claimed that most UK university TTOs do not pay their way.

The experience of US Public University, a “premier major research” US university, was that:

> “...In terms of our office, our expectation is that we will just about bring in enough in licensing to justify the office. Certainly, if you look at the overall activity in terms of the total license income that comes into the university, our office brings in more in licensing than we currently spend, but not that awful lot [more]” (US Public University Interview 2007).

And this is after the TTO at such a sophisticated university has been operating for over sixteen years. In the opinion of an experienced technology transfer officer at US Public University:

> “If one were just to be starting up a new office at a university that didn't have one, or had a very weak one, I think you would have to expect at least five years, and maybe ten years before you could have an expectation that the office would be generating an income equal to its expenses...” (US Public University Interview 2007).

The Director of Technology Licensing at US Private University who has for many years been involved in collating and analysing university TT&C data for AUTM confirmed that a minority of US TTOs generate income in excess of costs. He said:

> “Even on the most expansive measure [by allocating all the income to the commercialisation office]...only about two-thirds of US institutions make more than they spend on technology commercialisation.” At the other extreme, where TTOs are attributed only the revenue that the university keeps, then about one-third of offices make more than they spend. It has been at this level for many years (US Private University Interview 2007).

As to the criteria generally required for institutions to make money from commercialisation, they are:

> “… your office needs to have been around for at least...fifteen years, you need to have half-a-billion in research [expenditure], and you have to have twenty people in the office.... Kathy Koo [said] it took fifteen years at Stanford... And, when you look at individual institutions, there is an enormous difference between the mean and the median, and what that is saying
is that a small number of institutions have got real lucky” (US Private University Interview 2007).

There is no reason to believe that the criteria for success articulated here for US universities would be significantly different in other jurisdictions.

Because TTOs are frequently seen by university management as cost centres, they are often given limited resources. This often seems to persist even when the TTO is paying its way or is profitable. This may be attributable, in part, to the relatively long times it takes TTOs, including US and Canadian TTOs, to become cash-flow positive. It can become difficult for a TTO to demonstrate a cash-flow positive position if it is subject to the regular re-structuring which many are. There is a risk, of course, that any TTO viewed as a cost centre and not as an essential component of the university-industry linkage may become subject to staff reductions or otherwise allowed to wither for want of capital. US Public University TTO was established in 1991 and restructured in 2004, yet it remains relatively small with a total of fewer than twenty total staff for a university with a research budget in the region of $600 million per annum. The university may not be achieving its full TT&C potential with such a relatively small staff level. Additional staff in the Office has the potential to increase the amount of intellectual property licensed and income generated:

“Certainly in terms of maximising the commercial return and to maximise out-licensing, we could use a lot more resources”. The number of staff could be increased for this purpose because, at the moment “we end up spending most of our time on, really, the best technologies, and other technologies that might be able to be [commercialised]… we don’t have the time to spend on them”. Potentially, a doubling of staff could lead to a doubling of income (US Public University Interview 2007).

A further potential constrict on the performance of the TTO identifiable in the quote above from US Private University is this: there has to be significant triage done on technologies presented to the TTO because of the limited resources it possesses, encouraging staff to work only on the technologies and with researchers that have apparently the greatest potential, perhaps prejudicing the prospects of commercialising otherwise worthy technology. This could not only lead to a loss in potential commercialisation to the university, with the attendant loss of income, but could mean the loss of potentially useful technology to the community, while it could also lead to the demoralisation of researchers who may, as a result of rejection by the TTO, become less inclined in the future to spend time making disclosures or attempting commercialisation. It has the potential for technology to begin leaking from the university through other routes with consequent loss of income.

The financial performance of North American TTOs is also truncated by the fact that their income is derived principally from licensing, with an increasing amount derived from spin-off companies, but with no income derived from faculty consulting assignments (which are generally treated as private arrangements) nor from sponsored research. For example, at
Canadian Uni2 the TTO does not receive direct income from negotiating sponsored research, but is remunerated through general income paid by the university that recognises negotiating sponsored research as one of the essential activities undertaken by the TTO for the university (Canadian Uni2 Interview 2007).

There is a view prevalent in Canada that there is a shortage of people with the mix of skills needed in technology transfer (Canada Foundation for Innovation 2002, p.22). Suitable staff are in short supply because they “…require an in-depth understanding of the academic, financial and industrial sectors. They should possess an unusual combination of research, business, legal, interpersonal and communications skills” (ACST 1999, p.11). Even assuming such people are available and prepared to work in a university, Canadian universities have difficulty in remunerating staff at an appropriate level, certainly where the TTO is a unit within the university wherein salary levels have to be comparable with other university staff as distinct from being a separate company where salary levels are more flexible (Canadian Uni2 Interview 2007). Substantially the same problem faces US universities when seeking TTO staff with the skills and experience needed to discharge the duties expected.

8.2.8 Knowledge and Awareness

University researchers are, generally speaking, not natural entrepreneurs. Their willingness to engage in TT&C may be enhanced by a number of factors such as rewards, but the first and most basic requirement to getting faculty members engaged in TT&C is educating them in what it is and how it is done. This is true no less in North America than anywhere else.

US Public University has attempted training of academic faculty in TT&C “… in the past, but we haven’t been very successful. And I think the reason, typically, is that the faculty aren’t interested, in general, unless they are specifically involved in something that they need it for, then they want it”. Some of the most effective programs at US Public University are run in the business school where they have courses in entrepreneurship and conduct business planning competitions. (US Public University Interview 2007). Similarly, Canadian Uni2 conducts ad-hoc commercialisation orientation sessions to groups of students and faculty members. It also actively tries to:

“... generate interest in intellectual property and commercialisation by going out and meeting with the faculty and the chairs of the Departments and their faculty members to encourage invention disclosure and to encourage engagement with us. Because we undertake to represent them as their agent, we are very much in the mode of attracting them as clients to use our services”.

While not done under the auspices of the TTO, the university Business School conducts a business planning competition and uses TTO cases as case studies for their EMBA students.
to develop business plans and prepare pitches to venture capitalists (Canadian Uni2 Interview 2007).

Universities have generally embraced the concept of offering grants and prizes to encourage or support entrepreneurship and innovation. There are also close relationships between the TTO and academic departments in which TTO staff teach some entrepreneurship and business modules (for example, at US Private University and Canadian Uni2).

Engagement in TT&C is also influenced by the prevailing university culture, and the United States has some outstanding examples of commercial acculturation in universities such as MIT and Stanford. It is a case of success breeding success where it is done well.

8.2.9 Incentives for Commercialisation

It is likely that, like company employees, the right, title and interest in intellectual property generated by university-employed researchers is owned by the employer\(^{145}\) but, unlike company employees, university-employed researchers are given a right to share in the profits from an invention. The general approach to sharing the benefits of commercialisation with faculty members in North American universities is to grant them a proportion of income from licences. Link and Siegel (2005) reported that licensing activities among US universities are improved by increasing pecuniary incentives to academic faculty members. US Public University is typical in that it has a policy dating from approximately 1998 under which investigators receive 35% of licence income calculated after the costs of patenting and other direct costs associated with the licensing process (but excluding the costs associated with the TTO). The balance goes to the university which allocates it: 15% to the Department, 10-15% to the State fund, and 25% to a general campus research fund. It is important to share the financial benefits of commercialisation with academic faculty because:

“… most of the university technologies are such early stage that in order to have a successful commercialisation, you really need the input and continued assistance of the faculty, and the only way to stimulate that is to give them some reason to do that”.

Indeed, it is a requirement of the Bayh-Dole Act, “in order for the university to take title, it has to have some structure that [permits] some of the revenue to go back to the inventors…” (US Public University Interview 2007).

At US Public University:

“… [if] the faculty get no reward for patenting and commercialisation they’re not going to bother, because it doesn’t help them as much with their career. Their tenure and their status

\(^{145}\) However this assumption may have been overturned to a large degree in Australia by virtue of a decision of the Federal Court in University of Western Australia -v- Gray (No 20) [2008] FCA 498 delivered on 17 April 2008. It is likely that this decision will be appealed but, whatever the outcome, it serves to demonstrate a degree of uncertainty under which universities and their TTOs operate as it concerns intellectual property ownership rights.
within the community is [determined] primarily on their research [and] their publications; and whether they have a patent doesn’t enter into it nearly as much...” (US Public University Interview 2007).

Some universities offer royalties that vary between different disciplines, but generally offer around 30% of net royalties from an invention, although both greater and lesser amounts apply in some institutions.

The increasing use by universities of taking equity positions in companies in lieu of licensing royalties reported by Feldman, et al. (2002) raises the issue of remuneration of academic researchers when the potential income is more speculative (return on equity rather than a royalty stream). This may be seen as more attractive in some cases and by some faculty members, but it also raises the issue of whether and what proportion of equity should be shared between the university and faculty members. As a first-pass estimate researchers would, presumably, be entitled to the one-third (or whatever the relevant proportion) of equity received by the university, thus reflecting the proportion to which they would have been entitled had it been income, although there appears to be no reported research on this matter.

Unlike the United States, it is reported that Canadian universities do not permit academic staff who have obtained research funding to buy out their teaching obligations, that is, to pay for another to be employed to fulfil teaching duties. This may limit the willingness of Canadian academic researchers to engage in both research and commercialisation, and was identified as one of the reasons underlying Canadian universities’ relatively worse performance vis-à-vis the United States, in commercialisation (ACST 1999).

### 8.2.10 Linkages with Industry

Linkages with industry are fundamental to the performance of a university in TT&C and to the performance of a university TTO. For TT&C to work, effective linkages and relationships with industry, above all else, must exist. Yet research shows that it is consistently the greatest weakness in a university’s efforts to promote TT&C (Lambert 2003). US Public University conceded that this “is one area where we could do more”. Apart from the industrial affiliates program, linkages with industry tend to be ad-hoc, although it depends on the Department involved, because “… some of the Departments have [closer interaction], but our Office doesn’t really manage it from that side...”. This is due, at least in part, to the relatively small number of licensing staff in the TTO (US Public University Interview 2007).

To attempt to overcome weaknesses in industrial linkages in the physical sciences, US Public University has organised an industrial affiliates program. This program “… is to try … to cultivate that interaction”. The university has a number of consortia:
“... particularly in the physical sciences. There are a couple of consortia that have twenty, thirty companies that come together; they pay some small annual fee to be part of this consortium, and then they get an option on any technology that gets developed [from the funding of the consortium], and that is quite useful in terms of interaction with industry”.

Companies pay in the order $20,000 to $50,000 per year to participate in a consortium. There are none of these in life sciences at present. Generally, where there is “... a consortium, part of that usually is to have a yearly or semi-annual meeting where everybody that was funded by a consortium gives a report, talks about their research, and the companies all send representatives” (US Public University Interview 2007).

US universities generally encourage a close relationship with industry in order to stimulate sponsored research but also for the more altruistic reason of benefiting the community. An example of this at US Private University was the establishment in the United States of the first industry-university research commercialisation intermediary institution based on a European model. The centre: “... conducts applied research for local and international industry. Its mission as a non-profit institute is to develop next generation manufacturing technologies for industry based on emerging US and European research” (US Private University Interview 2007).

A major and continuing link between universities and industry is in sponsored research which often involves the university TTO in negotiation. “We do about $65 million per year worth of contract research... the contracts go through our office. We don’t tend to count that in our metrics [but] we will, and it reflects much stronger basic industry relationships than people give us credit for” (Canadian Uni2 Interview 2007).

Despite its many years in TT&C Canadian Uni2 is still working to develop a successful model for working with industry. Where previously industry linkages had been conducted in something of an ad-hoc manner, the TTO is now developing a more structured approach to dealing with industry using “showcases’ where industry is invited to presentations describing university research and driving connections through other university links such as the Development Office (links with alumni) (Canadian Uni2 Interview 2007).

Canadian universities generate relatively more spin-offs and less in licensing revenue than comparable universities in the United States, a situation that is attributed by researchers to the fact, at least in part, of limited receptor industry capability for technology in Canada’s private sector (Canada Foundation for Innovation 2002; Canadian Uni2 Interview 2007).

Canadian Uni2 has not found SMEs to be suitable receptors for university research output. While SMEs are agile, “... [they] are not ready acceptors of early-stage new technology that takes a lot of development, which is typically what comes out of the university”, nor do they
have sufficient money. The university has not licensed technology successfully to a SME (Canadian Uni2 Interview 2007).

The Canadian Government is clearly concerned to try to ensure that the benefits of research are retained in Canada, for example Recommendation #1 of the ACST (1999) report was:

“... [the] federal government should require an explicit commitment from all recipients of federal research funding that they will obtain the greatest possible benefit to Canada, whenever the results of their federally funded research are used for commercial gain”.

Arguably, there are two key missing structural components in Canada’s research network relevant to research commercialisation: the first is corporate research laboratories; and the second is not-for-profit organisations that connect research with the market, like Battelle in the US, Fraunhofer in Germany and ITRI in Taiwan (Canada Foundation for Innovation 2002).

The Canadian Government has made attempts (ACST 1999) to encourage the participation of small businesses, including spin-off companies, by giving them preference in licensing university intellectual property, albeit dependent on finding appropriate businesses and equitable terms, which may constitute a considerable hurdle. In addition, there are concerns about the quality of spin-offs as suitable business receptors capable of exploiting university research output, as noted by Canadian Uni2:

“...my personal worries about spin-offs are the management team, the capitalisation and the market access and how long it takes to build into the market. Licensing can solve the market issues, but there are other factors around the terms of the deal”. Canada also has to face the fact that it is working in a global economy, which means that it may have to license to international companies, not only Canadian ones. “...we've got to change our mind frame” (Canadian Uni2 Interview 2007)

One of the challenges in licensing software and other technologies to industry, particularly when it is high-volume low-margin technology, is the need for a rapid turn-around. Canadian Uni1 has addressed this through software it has developed for the purpose, a web-based application for marketing and licensing on-line.

8.2.11 Technology Parks and Incubators

There is a clear difference of opinion between advocates of the worth of incubators and technology parks and those that view them as unnecessary and being mainly real estate investments. Most of the leading US universities identified by Tornatzky, et al. (2002) in their survey had an associated research park, incubator or similar facility, a factor that clearly impressed the authors; although in many cases, the facilities were quite young at the time of the survey and their longevity had yet to be proven. On the other hand, people who have been in the business of identifying and supporting young spin-off companies for many years
are somewhat more sceptical about their value. The General Partner of US VC, who has been involved in numerous spin-offs over many decades, made the following observation:

“You can’t start a company with a manager. A company’s got to be started by an entrepreneur. An entrepreneur doesn’t really fit into an incubator. So I think all the incubators in the world are a waste of time. And, of course, I’ve spent a lot of time working with development people at the State level... They just want to do the right thing as they see it. They want to take the taxpayers’ money and they want to build these incubators, and what they end up being is poor real estate investments. And the reason is that an entrepreneur doesn’t work that way. I have never seen a successful incubator, whether it’s funded by the State or whether it’s funded by private [funds]. Entrepreneurs don’t want to go into an incubator where there’s a... telephone ... and a Xerox machine down the hall – they just don’t want to do that, they want to be off in their own place. Incubators are just a waste of time and money” (US VC Interview 2007).

The sentiment expressed by US VC is consistent with the views found at both US case study universities. While US Public University has access to a number of technology parks and incubators in the Bay Area and refers some potential start-ups to them, “[my] opinion has been that it is very rarely successful in terms of economics – I’m not sure that it really pays... And I think there’s a philosophical question about that... if [a] commercial idea is really commercial, it ought to pay for itself” (US Public University Interview 2007). And while US Private University has two large incubators, one for life sciences and one specialising in photonics, the fact is that:

“... universities have very high cost structures ...I think we’re now [of the view] that they’re nice to have for our own spin-outs for a period, but the President said to us: ‘Why...do you bring external companies onto campus? We’re never going to make money from them. The only reason to bring them on-campus is if they’re going to become part of the intellectual climate of the university - [for example], take students and give them internships, talk about their business plans in the School of Management and stuff like that’, so that’s what we’re doing” (US Private University Interview 2007).

In Canada, the ACST (1999) is rather sceptical about the results obtained from research parks and incubators. Indeed, the genesis of the financial difficulties experienced by the TTO at Canadian Uni2 lay, at least in part, in funding it provided to a university incubator:

“It was not successful simply because it wasn’t properly funded and it wasn’t fully occupied. We were trying to do it out of our existing budget, which included this line of credit and it consumed an enormous part of this line of credit, which was really not core business for us and consumed a lot of resources. I suspect it consumed more than anybody ever thought” (Canadian Uni2 Interview 2007).

8.2.12 Intellectual Property

Arguably the greatest impact on US university commercialisation came about as a result of an Act supported by both sides of Congress, the Bayh-Dole Act. Between 1979 and 1984,

\[^{146}\] Congress also enacted a number of complementary Acts around this time including the Stevenson-Wydler Technology Innovation Act 1980 (dealing with technology transfer from government laboratories) and the National Cooperative Research Act 1984 (limiting the effect of anti-trust rules on certain co-operative conduct between researchers and industry), however they are not relevant to the present argument. Both Acts have been amended in material terms since their enactment.
the number of patents issued annually to universities more than doubled (from 177 to 408) and more than doubled again to 1,208 between 1984 and 1989 (Mowery, et al. 2001). It is continuing to grow arithmetically, reaching over 10,000 by 2005 (AUTM 2007b). Over a similar duration the number of university technology transfer offices in the US increased from 24 in 1980 to 150 by 2005 (AUTM 2007b).

The principal effect of the Bayh-Dole Act was to permit universities to have perfect title in intellectual property developed as a result of federally-funded research at the university subject to certain conditions. Prior to this Act, title in intellectual property was vested in the federal funding agency (subject to some notable exceptions involving Institutional Patent Agreements mentioned earlier), resulting in desultory exploitation rates which the Act was intended to turn-around (Sobol and Newell 2003). Researchers such as Mowery, et al. (2001) postulated that the Bayh-Dole Act did not lead to an increase in university patenting, while later research by Shane (2004) suggested that it did in those fields where licensing is an effective method of technology transfer. On balance, the Act has resulted in increasing levels of exploitation of university-generated intellectual property, but it does come at some cost. One particular feature of the Act is that universities are not permitted to assign the title in intellectual property vested in them. One result of this has been that licensing (rather than spin-off company formation) has become the most common means of exploitation through industry, although, as US Public University pointed out, while Bayh-Dole restricts some of the university’s flexibility in this regard, it does not appear to cause a problem “… because the restrictions are… somewhat minor in terms of actually making a commercial deal” (US Public University Interview 2007).

Notwithstanding the complexity of engaging in TT&C prior to the passage of the Bayh-Dole Act, many leading universities had been involved in research commercialisation for some years by entering Institutional Patent Agreements with federal funding agencies permitting the universities to exploit intellectual property resulting from research. (US Private University Interview 2007). According to Nelson (2001, p.14):

“…a significant increase in patenting and licensing was going to happen in any case. The passage of Bayh-Dole legitimatized these trends, almost surely speeding them up and magnifying them…[but] in our view, the broad developments were inevitable, in the absence of policies and decisions to head them off, or to temper them”.

Colyvas, et al. (2002, p.62) argued to the same effect:

“These two developments [new areas of life science research and a relaxation in what was patentable by the USPTO] were leading to increases in university patenting and licensing prior to the passage of Bayh-Dole, and in our view the principal effect of Bayh-Dole was to accelerate and magnify trends that already were occurring”.

Consistent with this view, there is evidence that leading US research universities such as Stanford and the University of California were increasing the size and scale of their TTOs
before the enactment of the *Bayh-Dole Act* and that there were other more influential factors inspiring the growth of technology transfer (Mowery, *et al.* 2001). Indeed Mowery, *et al.* (2001, p.117) considered that the need for universities to grant exclusive patent rights to companies in order to develop and commercialise research results “...flies in the face of the position that patents tend to restrict use of scientific and technological information, and that open publication facilitates wider use and application of such inventions and knowledge”.

High rates of intellectual property exploitation are reported in institutions with an exceptional commercialisation record. For example, it is reported that 60% of new patents at MIT are licensed within one year (Canada Foundation for Innovation 2002, p.18). At the same time, however, while patents are an important method of university TT&C in the US – probably more than anywhere else in the world – they still represent a relatively small proportion of the total intellectual output of a university. A potent example of this can be found at MIT, one of the United States’ most active TT&C universities, where it is reported that patents represent approximately 7% of the knowledge transferred from its laboratories (Agrawal and Henderson 2002).

It is a common condition of employment of academic faculty in the United States that faculty members are obliged to assign all right, title and interest in intellectual property they generate to the university. So, whether research is funded federally (and subject to the *Bayh-Dole Act*) or privately, the university ends up owning rights to intellectual property arising from faculty member involvement in research. Students and visitors are similarly obliged to assign their interest in intellectual property arising from sponsored research.

Where the rules are less rigid than in the US, and individual institutions have the right to develop their own intellectual property policies, there may be a lower rate of exploitation. For example, it was reported (Riddle 2004, p.1) that only 68% of Canadian universities actively manage their intellectual property.

There are no national rules (laws or policy guidelines) in Canada affecting how universities may deal in intellectual property, with each university free to make its own rules as it sees fit, subject to any obligations arising from funding or other agreements with external parties such as industry partners. There have been previous attempts to establish a Canadian Intellectual Property Policy, such as that by the Expert Panel on the Commercialisation of University Research (ACST 1999), but these have not been adopted. In some ways this diversity of approach may disadvantage Canadian universities vis-à-vis US universities because of the risk of uncertainty as to intellectual property title. Pressure from Canadian granting councils upon universities to adopt a uniform approach to intellectual property ownership reflects their concern on this issue. Support for a consistent approach to intellectual property amongst
Canadian universities has been encouraged (Canada Foundation for Innovation 2002). Canadian universities presently negotiate intellectual property issues with staff on a university-by-university basis as collective employment agreements come up for renewal. This position is unlikely to change without external pressure from relevant levels of government.

At Canadian Uni2 the rules presently prescribe joint ownership between the inventor and the university upon invention, after which the parties may elect to have the university exploit (whereupon the inventor receives 25% of the net income) or the inventor may exploit (and receive 75% of the net income). Not surprisingly, approximately 92% of university faculty members choose to exploit inventions personally (although half of these still engage the TTO to assist) notwithstanding that this requires them to undertake significant commercial activities themselves – with the attendant commercial risks that this may bring and the compromise to the faculty member’s other activities as a result of the expenditure of time involved. To attempt to overcome this situation at Canadian Uni2 the university is proposing to offer inventors a large proportion of income (but less than 75%) providing the TTO undertakes all TT&C activities (Canadian Uni2 Interview 2007).

While certainty as to who owns intellectual property at Canadian Uni2 has not usually been an issue, there have been occasions when a problem has emerged as a result of previously undisclosed interests. This has made the university “process careful” and it tries in all cases to have researchers assign all intellectual property to the university in the first instance, after which the university will assign it back to the inventor in the event that the inventor elects to exploit an invention personally (Canadian Uni2 Interview 2007). Similar arrangements exist in other Canadian universities. While this overcomes some difficulties, it does not remedy the problem of the undisclosed interest and creates a rather onerous paper trail. Canadian Uni1 appears a little more concerned about the complications arising from intellectual property ownership uncertainty when venture capital is required:

“…common policy or common principles would be helpful, [but] the principles are not even there… intellectual property is rarely developed by an individual, it's developed by a team...[and] if you do it across multiple institutions it really gets kind of tricky, and if these are potentially investable opportunities, the VCs [shy] away from these because they [say] ‘you can’t show me clear title here’” (Canadian Uni1 Interview 2007).

Another of the potential pitfalls in the Canadian laissez-faire approach is the risk of unfair outcomes arising from a power imbalance when many parties are involved in discoveries, as there usually is, such as between professors and graduate students, which becomes even more complex when multiple institutions are involved (Canadian Uni1 Interview 2007).

But the Canadian approach is not all downside, because the flexibility of ownership of intellectual property offered to researchers has sometimes operated to their advantage by
allowing researchers to negotiate with Canadian universities on the matter of ownership of research outcomes, making the Canadian approach attractive in some cases (Canadian Uni2 Interview 2007).

There is ample evidence that Canadian universities and the federal Government do not intend to affect an individual academic’s right to publish, whether or not some obligation to disclose a discovery to the university may exist (ACST 1999).

There is also a difference in the intellectual property needs and demands of life sciences when compared with those of physical sciences and ICT, largely arising from the difference in the market and regulatory demands of the two. Life science regulatory approvals can take many years so that time to market is almost always measured in years and sometimes decades, while physical sciences and ICT have market cycles generally between a few months and a few years. This means that patents are often less important in physical sciences and ICT (where time to market is often the crucial issue) than they are in life sciences:

“...I think that the IT, engineering technology tends to be incremental rather than revolutionary – it is rarely patented or protected in any meaningful way by patent. It is always tied to the individual and so you can’t just transfer it and let somebody else deal with it, it almost always has to go with the individual...”. (Canadian Uni1 Interview 2007).

While North America has resources to assist in connecting universities with each other and industry, it has proven difficult to combine patents amongst universities and it appears that it is rarely done among universities except when there is explicit collaboration on a research project. Parts of industry, however, do search university inventions and seek to combine ideas and patents in order to exploit combined intellectual property. US Public University reported that it has had difficulty in packaging patents:

“... mainly because we have [the] inventor’s interest in the technology being developed, and so we have to be careful in terms of combining technologies that we don’t slight one inventor or make that inventor feel slighted because this other technology is being combined and maybe it’s getting more of the revenue than he is getting, and ‘of course his technology is more important than theirs’” (US Public University Interview 2007).

It appears that university TTOs rarely, if ever, seek to combine their patents with those of other universities. The use of facilities such as on-line databases of ideas and patents appear to be exploited usually by industry and are rarely of interest to other university TTOs (US Public University Interview 2007 and US Private University Interview 2007).

8.2.13 Early Stage Financing and Venture Capital

The journey between making a discovery or invention and getting the idea to market is rarely simple. The time taken to market will depend to some extent on the technology involved (life sciences, in particular, almost always takes longer), but every idea needs some development
before it has been sufficiently proven to be marketable. This journey requires know-how and money, and it is the availability, or lack, of sufficient money to advance the idea that can influence the time taken to get an idea to market. The significance of this and the difficulty in getting finance for the early stages of an idea was described elegantly by the TTO Director at Canadian Uni1 in the following way:

“The vast majority of the research that is undertaken at [our university] is government-grant funded academic research. Consequently, inventions that are disclosed to the [TTO] are typically at a very early stage along the development path to commercialization. Because of the high technical risk and long timeframe for developing products from such early-stage inventions it is often difficult for the [TTO] to attract the commercial partners (licensees or investors) that are required to develop the technology further towards the marketplace. Furthermore, traditional grant funding sources are no longer receptive to funding these inventions because their development has moved beyond the bounds of pure academic research. This leads to the unfortunate situation where many promising inventions are in danger of languishing between the realms of basic research and commercially viable technology, often due to the need for relatively small investments of development dollars. This disconnect is colloquially known as the “Technology Funding Gap” (Canadian Uni1 Interview 2007).

This means that the funding needed to take the idea along the journey to market has to be found from some source that is not associated with the research itself.

There are two parts to funding discoveries and inventions. The first, called here early-stage financing, involves providing funding at reasonably small levels – typically not exceeding $250,000 (but sometimes as high as $2 million) – to take an idea from bench or laboratory stage to proof-of-principle or a little beyond. It may be granted to a researcher in more than one tranche. The second, typically called venture capital (VC), involves funding at much higher levels either to get an idea to market, or to prove its worth to a company so that it may be sold-on. By this stage much of the technology risk has been removed, although some market risk remains. The amount of money involved in VC is as large as needed for the idea involved.

Early-stage financing of inventions and discoveries is provided by most of the leading North American universities, but not all. For example, US Private University provides what may be viewed as the typical early-stage financing arrangement, involving two tiers of financing. The first tier enables researchers to generate commercially relevant data, reach key milestones, or develop a prototype in order to help bring raw technology to a mature enough state where it can be either licensed or form the basis of a new company. The awards are intended to accomplish specific applied research tasks. Typical awards will range from $25,000-$50,000, with a maximum award of $50,000. These will normally be one-time awards geared toward specific technology milestones. There are usually six such awards each year from a total amount available from the university’s own money of up to $300,000 a year. These funds are recharged annually from other successful commercialisations. The second tier helps faculty members start new companies based on technologies that they invented at the
university. Each year 2-3 projects are selected for an investment by the university of $50,000-$200,000 which will form either debt or equity. The selected companies also benefit from assistance from the OTD Innovation and Entrepreneurship Group, with the intention of developing an independent, successful, self-sustaining company. Early stage funds are sustained through injecting profits from other commercialisation activities into them on an evergreen basis, ensuring that they continue (US Private University Interview 2007).

The Canadian experience is similar to that of the US in terms of the amounts and points at which funding is provided, although the government provides most of the funds which means that funding relies on continuing government interest in the sector.

Venture capital is characterised as being “early-stage, high-risk, high-return, long-term, high-technology investment” (US VC Interview 2007) and may come from university or private funds. VC can be involved at any stage in the development process, including early-stage development, depending on the risk profile that the fund is prepared to accept, a decision that is contingent on the sophistication and experience of the fund managers. Private universities, such as US Private University, often have a substantial fund at their disposal as a result of donations and investment. US Private University has a venture capital fund that invests in commercialisable ideas, with particular emphasis on investing when university intellectual property is involved. The fund usually acts as a general partner or co-investor, investing alongside top tier venture capital funds as a strategic part of the investment syndicate. As a general partner the fund looks to investments in the range $2-5 million, while, as a co-investor, it will “typically invest between $500,000 and $1 million initially, depending upon the stage and capital requirements of the company. We act as a co-investor and require a separate larger venture fund to lead the round”. US Private University has about $40-50 million venture funds available on an evergreen basis which was created by the university with seed funding of about $11 million. The university is presently looking at dividing the investment functions handled by the TTO into two parts: a seed fund that the TTO will control that is not looking for a return; and some that will be managed for a return. Historically, the university has made much better returns on its investments in university spin-offs (US Private University Interview 2007).

Notwithstanding the funds available to some universities, they:

“...struggle to pay for the patenting and for the office of technology transfer. And to make direct, dedicated, at-risk [investments] of our own money in these technologies, I think universities would sooner give up ninety-five percent of the economic benefit and limit their exposure, as well as limiting their up-side” (US Private University Interview 2007).

The aggregate amount of venture capital available for investment depends on the incentives provided by government. Tax incentives are important for a private investor to be engaged in
genuine venture capital. For example: capital gains tax, and R&D incentives. “Government can create more and better kinds of incentives… [government] should be trying to influence the way people behave – that’s what government does…” (US VC Interview 2007).

The need for private venture capital in the United States is very clear in the case of public universities where even, for example, US Public University does not have internal funds to assist faculty members in forming spin-off companies. There are very strict conflict of interest guidelines which oblige faculty members to separate private interests from research obligations, as well as which the university does not permit the use of campus facilities to assist start-up companies. These restrictions and limitations do not apply to private universities where greater flexibility generally exists.

Canada does not have the depth of venture capital that exists in the United States. Canadian Uni2 noted this deficiency not only in terms of cash but of management skills in the industry. The lack of venture capital is also evident in a lack of risk capital particularly at the early stages of development. For this, Canada, like Australia, is reliant almost entirely on publicly-sourced early stage funding, which has only recently become available in Ontario through the Ontario Research Commercialization Program (ORCP). ORCP program funding is to be allocated over three years: physical sciences and IT getting $1.7 million; and life sciences approximately $2.7 million. Proof of principle funds of up to $120,000 can be allocated to individual ideas in three tranches, with first amounts typically around $10,000 to test an idea, such as performing a basic market review, a second tranche of $50,000 to make a prototype, with a second $50,000 available provided there is some matching fund from another source and with consultation with the Ministry (Canadian Uni2 Interview 2007). Based on its experience with venture capitalists, Canadian Uni1 is seeking greater independence in its funding, so it is approaching venture capital funding from the university side rather than the venture capital industry side. It has set itself the target of raising $140 million over five years to invest in university ideas and has raised $50 million so far from the CFI, industry and the Provincial Government (Canadian Uni1 Interview 2007).

The view of the late Professor Doriot of Harvard Business School was that, if you have a good idea, money will find you (Gupta 2004). Decades of experience lead US VC to the same opinion. In his experience:

“… we mostly search ideas out. It is rare for a good idea to come over the transom. [In my experience] we saw a huge number of investment opportunities come across the transom, but we never invested in a single one. The good ideas always came to us from another venture capitalist who we know and had dealt with, or as a referral from a company we were already invested in. We are all well connected, we each have our [trusted sources]… and we all know each other, so we learn about a new idea quickly” (US VC Interview 2007).
8.2.14 Entrepreneurship and Culture

Of all the factors that encourage entrepreneurial behaviour among North American faculty members, the freedom to pursue personal commercial interests through consulting is one of the strongest. This is evident from the experience of US Private University:

“I think that [giving professors a day a week to pursue business interests such as consulting and spin-off companies] is a critical part of the US success, and I only really learnt that when I had someone come and teach in my class about federal labs. Now the federal labs don’t give their employees a day a week. And if their employees want to take a year off to start a company, they won’t let them come back. [So] I think letting faculty take leave of absence, [start a company], and then come back [is critical to success]”. Every member of faculty gets a day a week to pursue commercial opportunities (US Private University Interview 2007).

The situation is somewhat similar in Canada, where universities allow academic staff time to undertake private commercial activity such as consulting, but it is not generally as structured as the one-day-per-week available in the US, but can amount to up to 20% of the teaching time (Canadian Uni2 Interview 2007).

North American universities with an exceptional record in TT&C, particularly in respect of the numbers of spin-off companies, are the ones which grant the greatest degree of freedom to academic faculty members to engage in commercial activities. It is not simply a matter of undertaking great research at Ivy League universities, even though they may achieve remarkable discoveries, for that is not the same as commercialisation. As US VC explained:

“Princeton [University] is a place where pretty much everyone is living his or her dream. So, there’s no way you’re going to spin anybody out of Princeton, it’s as simple as that. [And that is true of the Ivy League generally]. The exact opposite of that is MIT… What you could get from Princeton or the Ivy League generally… [is] great technology but, since you cannot spin a person out, what do you do? Because generally it takes at least one person, maybe more than one, to embody the creativity of the technology and to keep it moving forward in the early stages”. What is different between these universities? “It’s a matter of freedom. If you take a Princeton or most schools like Princeton, they have a pretty rigid set of rules”. Faculty members have only one day a week to do what [they] want – consulting, forming a company, or whatever. “But MIT? Who knows where anybody is? MIT is totally free in that regard. There are guys on the faculty at MIT who are running companies… It’s more related to how much freedom there is than anything else… The two [most free] places are MIT and Stanford…” (US VC Interview 2007).

Entrepreneurship is presently enhanced in some universities by cross-appointment of staff. For example, at US Private University some TTO staff have been appointed as academic faculty to take classes in entrepreneurship, while at Canadian Uni2, and many other universities, cross-appointments between clinical areas such as hospitals and the university are quite common.

US Private University TTO, in conjunction with the School of Management, has established an Institute for Technology Entrepreneurship at the university which offers two main features. The Institute offers courses in entrepreneurship and, upon request, assists university faculty
members in establishing new companies. Possibly partly as a result of this, US Private University has observed a decline in the numbers attending commercialisation boot-camps which may reflect either a peaking in demand or demand being met through the other activities of the Institute (US Private University Interview 2007).

Encouraging entrepreneurship is an area where individual universities have exhibited significant innovation. Canadian Uni1 created the position of entrepreneur-in-residence at the university in early 2005 with a serial entrepreneur in the position. The entrepreneur’s role was introduced as part of a broader New Ventures Program to promote the establishment of new ventures; his “…mission [was] to identify and facilitate the creation of healthy companies from [the university] and its Affiliated Hospitals, and to provide them with the environment and resources to achieve their maximum potential”. It has proven so successful that the university intends to expand the program to three part-time entrepreneurs able to provide assistance across a range of disciplines (Canadian Uni1 Interview 2007).

Innovative universities are often trialling new ideas in entrepreneurship such as Canadian Uni1 with its New Ventures Program, which integrates and includes:

“…workshops, courses, networking events, company in a box (which was just access to common legal documents and those sorts of things), mentorship (sitting on boards), early-stage access to capital, and we actually tried our hand at a bit of an accelerator, which was a just a shared office, and it didn’t really work too well in our environment… And that’s been expanded now to what we hope will be a [university] New Venture Program that will bring in the introduction of two funds: an idea fund and a seed fund as well as internships for students at both the undergraduate and graduate level” (Canadian Uni1 Interview 2007).

8.2.15 The Role of Intermediaries

Although not included in the issues addressed when developing the case studies, intermediaries have played a role in university TT&C in the United States for many years. Reamer, et al. (2003, p.xviii) identified three types of intermediary:

- Intermediaries working with technologies from all sources;
- Federal technology transfer intermediaries – focus on transferring technology from federal laboratories; and
- Federal technology contract intermediaries – focus on assisting businesses in obtaining Small Business Innovation Research and Small Business Technology Transfer contracts

The role of intermediaries is recognised in the development of a model for linkages by scholars such as Mohannak (1999), Howells (2006) and Pollard (2006).
Probably the largest and best-known of the intermediaries in the US is the Battelle Memorial Institute\textsuperscript{147} (BMI) which, since 1929, has been involved in research and development including working with universities and other publicly-funded research entities to commercialise ideas. Among its many activities, BMI provides services to enhance small business including identifying technologies, co-bidding to add strength to proposals, and providing mentors and protégés. A more recent development in this regard is the Robert C Byrd National Technology Transfer Center\textsuperscript{148} at Wheeling Jesuit University in West Virginia which claims its core capabilities are technology evaluation and market assessment, partnership development, computer information services and strategic technical services to bridge the gap between university or government laboratory and a commercial operation.

The strength and power of US universities, as well as their willingness to take the initiative, is illustrated by the fact that US Private University has opened a European-style manufacturing intermediary, as mentioned earlier. In Canada the lack of intermediaries to make the link between research and industry has been noted as a major impediment, being done only by government laboratories, and then on too restricted a scale (Canada Foundation for Innovation 2002, p.12).

The United States has a history of not-for-profit organisations possessing huge resources that are prepared to act for the common good. Increasingly, these entities are prepared to fund the great expense involved in medical applications in such a way that permits patent problems to be largely avoided. Arguably, the most successful technology transfer operations in the United States are becoming the:

“... new foundations: Case, Milken, and the like. These guys are coming and they are playing different types of intermediaries. They are saying: ‘we know there are different types of viral infections in the United States which, if we can get these vaccines designed, manufactured and delivered, we can actually do something about it. But the pharmaceuticals don’t see enough money in it. Investors don’t see enough upside to it, no one wants to take the risk, but we know there’s a problem’. Therefore, unlike government, which used to be the neutral risk-taker, [but which] can no longer take the risk because [Congress is no longer prepared to take such risks]. The real funding in this country for risk-taking, and for a whole set of new technology transfer is these foundations”. People are not prepared to wait patiently for solutions to the grand challenges. So “what you have now are impatient forms of capital that are basically [addressing these grand challenges]. So that’s part of these new intermediaries... “ Foundations and the like represent “new forms of collaboration that did not exist in this country, or around the world. You have some people who are thinking of the higher good...”. In essence, any company that wants to exploit the intellectual property may do so, “but what we’re not going to do is [fight] over the research and the research agenda and who [wins] along the way”. Disputes over the ownership of intellectual property will not be permitted by the foundations. “For the moment, foundations are trusted relationships... You are creating new forms of collaboration that do not exist in this country, or around the world” (US Strategist Interview 2007).

\textsuperscript{147} Information about BMI is located at: http://www.battelle.org/

\textsuperscript{148} For more details, see: http://www.nttc.edu/
There is evidence, also, of a change among some university TTOs taking on a multi-function role including technology transfer, commercialisation and economic development. This can be seen at universities such as North Carolina and Arizona State. Universities like these recognise that there are several pathways to exploit the results of the research enterprise.

Venture capitalists have been supplying not only capital but advice and mentoring to emerging companies for many years and represent another form of outsourcing relevant to commercialisation. Venture capital has existed for so long in the US and has evolved to a degree of sophistication that it should rank as another important form of intermediary.

The growing scope for intermediaries like those identified here illustrates a number of points. First, because it changes the dynamics of the way certain innovation occurs, it highlights the need for any university TTO structure to be continually reviewed to ensure that it keeps pace with the rapidly-changing environment in which it exists. Second, the existence of so many loose and amorphous arrangements portends some of the difficulties facing universities that work on the principle of patenting and patent exploitation. Noting the difficulties that patent-holders are experiencing in the US because of delays and aggressive patenting practices, the way ahead for university commercialisation is likely to be increasingly a melange of practices with the emphasis on working for the public benefit continuing to be the strongest motivation.

8.3 United Kingdom

There are interesting lessons to be learnt from some particular developments in the UK. Three developments are considered in this section: Imperial Innovations – a commercialisation company spun out of Imperial College; the creation of an arc of exceptional universities between Oxford, Cambridge and London; and the increasing influence of intermediaries in promoting the commercialisation of university research.

8.3.1 Commercialisation Environment

Recent support for commercialisation from the UK Government arguably dates from a report by John Baker, Creating Knowledge, Creating Wealth in August 1999. This was followed by a report dealing specifically with university TT&C activity by Richard Lambert (2003), the Lambert Review of Business-University Collaboration in December 2003.

While the UK has no legislation dealing specifically with university intellectual property in the manner of the Bayh-Dole Act, two documents have been published that give universities guidance on developing intellectual property policies: A Guide to Managing Intellectual Property (Auril, et al. 2002); and Managing Intellectual Property, The Guide (Auril and
Universities UK 2002). These documents are similar in concept to the Australian National Principles (ARC, et al. 2001) although they differ in substance.

8.3.2 Imperial Innovations

Imperial Innovations\textsuperscript{149} was listed on the London Alternative Investment Market (AIM) in July 2006 (mnemonic IVO), prior to which it was the TTO of Imperial College London. While no longer financially tied to Imperial College, IVO has the right (subject to certain exceptions) to commercialise the unencumbered intellectual property developed within Imperial College’s research departments until 2020. IVO has a revenue-sharing arrangement with Imperial College.

While Imperial College London has been engaged in TT&C since 1986, it formed Imperial Innovations in 1997 for the purpose of realising the commercial potential of research conducted at Imperial College.

Imperial College itself has an explicitly industry-focused research agenda. It claims to be one of the top three UK universities and is a world-leading science-based university of approximately 11,000 students and 3,500 academics.

(a) Commercialisation Structure

IVO is organised into four areas: two technology transfer teams specialising in engineering & technology, and bioscience; new ventures; asset management; and business support. It has four areas of technological interest: healthcare, energy, environment, and emerging technology trends. It combines the activities of technology transfer, company incubation, and an early stage venture capital fund. At the end of financial year 2007 Imperial Innovations had equity holdings in 74 companies (up from 66 in 2006) and during 2006-2007 formed 13 new companies (up from 10 in 2006). As at July 2006 IVO employed 49 people (a rise from 41 in 2006). It has an affiliation with the Royal College of Art which permits it to design and prototype medical device products. IVO has also entered into agreements with two UK hospital trusts to perform technology transfer and incubation services for them.

The company established a Scientific Entrepreneurs Board (SEB) comprising fourteen senior academics to assist the company in its interface with researchers and academic faculty at Imperial College.

\textsuperscript{149} Material for the description here of Imperial Innovations has been derived solely from publicly available sources, in particular: the 2006 Annual Report of Imperial Innovations plc and the websites of Imperial Innovations plc: http://www.imperialinnovations.co.uk/ and Imperial College London: http://www3.imperial.ac.uk/
Imperial College retains its own commercialisation capability in consulting and contract research (and certain other business matters) which do not go through Imperial Innovations.

Imperial Innovations has established share options for directors and allocates shares to employees.

(b) Commercialisation Process

IVO commercialises technology through spinning-off new technology companies and licensing technology to commercial partners. It claims to “…work with industry partners at all stages and… draw on a well established network of inventors, entrepreneurs and management”.

(c) Commercialisation Performance

Imperial Innovations has published details of its activities for the last three trading years, details of which are shown in Table 8.1

<table>
<thead>
<tr>
<th>Year</th>
<th>Invention Disclosures</th>
<th>Patents Filed</th>
<th>Proof of Concept Projects</th>
<th>Licence Deals Concluded</th>
<th>Spin-off Companies Formed</th>
<th>Businesses in Incubation</th>
<th>Businesses in which an Interest Held</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2007</td>
<td>366</td>
<td>77</td>
<td>21</td>
<td>47</td>
<td>13</td>
<td>24</td>
<td>74</td>
</tr>
<tr>
<td>2005-2006</td>
<td>284</td>
<td>61</td>
<td>16</td>
<td>20</td>
<td>10</td>
<td>26</td>
<td>66</td>
</tr>
<tr>
<td>2004-2005</td>
<td>158</td>
<td>47</td>
<td>19</td>
<td>21</td>
<td>9</td>
<td>24</td>
<td>64</td>
</tr>
<tr>
<td>Total Under Management</td>
<td>Over 275 patent families</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.1 – Imperial Innovations Commercialisation Performance  Source: Imperial Innovations 2006 and 2007 Annual Reports

(d) Financial Performance

IVO has a number of sources of recurrent income (in addition to the capital raised on the float) including University Challenge Seed Funds.

Income from licence, royalty and other commercial contracts increased to £2.1 million (2006: £1.8 million) in the year to 31 July 2007 (the reporting date), and reported an adjusted profit of £5.3 million (2006: £4.6 million). Trading in the company’s shares over the period since listing has been quite thin suggesting a reasonably illiquid stock. The shares sold through the IPO at £3.65 per share and, as at November 2007, were trading around £3.75.

8.3.3 Oxford to Cambridge Arc

“The Oxford to Cambridge (O2C) Arc initiative was formally launched in 2003 in order to promote and accelerate the development of the extraordinary and unique set of educational,
research and business assets and activities that characterise the area that stretches between and includes Oxford and Cambridge. The driving concept was to link Oxford and Cambridge, both world famous centres of research and innovation, but each relatively small in international terms, in order to create an ‘arc’ of innovation and entrepreneurial activity that would, in time, be ‘best in the field’ and comparable to such iconic areas of innovation as Silicon Valley in California” (O2C 2007, p.4).

Participants in O2C Arc are shown in Figure 8.2. Within this group, at Cambridge University the cluster of technology companies, particularly biotechnology enterprises, has been well documented and has been responsible for significant benefits to the local and national economy (Pacec 2003; Herriot, et al. 2006). Similarly Oxford University supports a thriving biotechnology cluster (Oxford 2005), while the City of London offers more leading universities, access to one of the world’s leading financial centres and a multi-cultural workforce attuned to international business.

![Creating a World Class KBE – The Arc, The Thames valley and London](image)

**Figure 8.2 – The Oxford to Cambridge Arc** Source: Miles (2007, p.21)

The relative youth of O2C Arc illustrates the point that governments throughout the world are continuing to work on identifying and exploiting their particular strengths, but that no-one yet has the one right answer nor the one right structure capable of capturing the benefits from technology exploitation, particularly that associated with universities. One reason behind the formation of O2C Arc was the concern that: “The difficulty of translating knowledge into successful products continues to bedevil the UK economy” (Miles 2007, p.3, italics in original), a challenge not unique to the UK.

O2C Arc argued that the future for UK high-technology industries lies in what it calls “niche plays” and collaboration amongst firms and between firms and government. It identified three
essential pre-conditions needed to make this approach work: a national strategy; local plans to improve local comparative advantages and utilise those that are national in character; and collaboration, not just locally and nationally, but globally (Miles 2007).

The approach advocated by O2C Arc is relevant to Australia in terms of the need to identify the niches in which the country has competitive advantages, the fact that Australia has groups of research excellence that have yet to exploit their full commercial potential, and that, like the UK, Australia has groups of capability that remain isolated and could benefit from a holistic view. Another similarity with the UK position is the rivalry (such as that between Oxford and Cambridge) that exists between different Australian States, cities and institutions.

**8.3.4 Intermediaries**

The most common form of university TTO involves an entity which is a part of the university, or a wholly-owned company of the university, staffed by TT&C professionals who identify opportunities for commercialisation, assist researchers and negotiate with industry. This model has been supplemented in the US for many years with third party companies that assist universities in the TT&C task, intermediaries, probably the most prominent of these being Battelle Memorial Institute that began in 1929. Since the late 1990s a number of companies in the UK have emerged to assist universities in commercialisation, Imperial Innovations, mentioned above, being one example. But there are now several companies that not only assist but, in some cases, undertake most of the TT&C function for universities through outsourcing.

The nearest to a formal definition of what constitutes a technology intermediary is provided by the World Bank (2000), where it said technology intermediation reduces barriers to technology transfer associated with information, management, technology, and financing. It described the tasks undertaken by an intermediary as including (at Section 5.6)\(^\text{151}\):

- articulation of specific technology needs and selection of appropriate options;
- education, information dissemination, and communication;
- identification of skill and human resource needs;
- selection, training, and development of personnel;
- investment feasibility, appraisal and business plan development;
- development of business and innovation strategies;
- locating key sources of new knowledge;

\(^\text{151}\) This World Bank list is compiled in relation to technology transfer relevant to climate change. It has been modified to a small extent by the author to make the list more general in character.
- building linkages with the external sources of information;
- creating and/or operating new dealer and service networks;
- project management and organisational development referrals;
- training and consulting;
- matching potential supplier and recipient firms;
- feasibility, evaluation, and packaging of projects for public or private financing; and
- translating, compiling, vetting, and endorsing information.

Table 8.3 identifies UK universities that have outsourced some or all of their TT&C functions to an intermediary.

<table>
<thead>
<tr>
<th>University</th>
<th>IP Intermediary Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>King’s College London</td>
<td>IP Group Plc</td>
</tr>
<tr>
<td>Queen Mary, University of London</td>
<td>IP Group Plc</td>
</tr>
<tr>
<td>University of Bristol</td>
<td>IP Group Plc</td>
</tr>
<tr>
<td>University of Bath</td>
<td>IP Group Plc</td>
</tr>
<tr>
<td>University of Glasgow</td>
<td>IP Group Plc</td>
</tr>
<tr>
<td>University of Leeds</td>
<td>IP Group Plc</td>
</tr>
<tr>
<td>University of Oxford (Chemistry only)</td>
<td>IP Group Plc</td>
</tr>
<tr>
<td>University of Southampton</td>
<td>IP Group Plc</td>
</tr>
<tr>
<td>University of Surrey</td>
<td>IP Group Plc</td>
</tr>
<tr>
<td>University of York</td>
<td>IP Group Plc</td>
</tr>
<tr>
<td>University of Reading</td>
<td>Angle Plc</td>
</tr>
<tr>
<td>University of Sheffield (Medical only)</td>
<td>Biofusion Plc</td>
</tr>
<tr>
<td>University of Cardiff</td>
<td>Biofusion Plc</td>
</tr>
<tr>
<td>University of Loughborough</td>
<td>IPSO Ventures</td>
</tr>
<tr>
<td>University of Oxford (Biomedical Eng)</td>
<td>Technikos (Sloan Robinson)</td>
</tr>
</tbody>
</table>

Table 8.3 – UK Universities using Intermediaries Source: Library House (2007, p.12)
In a similar vein, Scottish Enterprise has established entities it calls *Intermediary Technology Institutes* which assist in commercialisation without apparently having the outsourcing element. It has established these in three fields: life sciences, energy, and techmedia, and they have the objectives of\(^\text{152}\):

- increasing and sustaining the birth rate of high value added technology based companies;
- increasing the level of exchange between the research and corporate sectors in Scotland, helping in the transfer of skills and increasing levels of Corporate R&D;
- further establishing and connecting Scotland into key overseas markets, promoting Scotland as an important centre for specific technologies;
- creating a sustainable flow of market-relevant technology companies; and
- significantly increasing the retention of graduate and professional skills in Scotland.

There are some potential issues that could arise from the use of third party companies to commercialise university research. The most obvious is that these companies exist to make a profit, so they are likely to take-on and pursue only the technology most likely to succeed. If a university outsources the TT&C function entirely it runs the risk of having many ideas languish for want of a champion to take them to industry, particularly in unconventional areas where there may be public benefit in ideas being taken to market. It also suggests that universities that adopt this approach may be rather more interested in achieving financial results from TT&C than contributing to the greater public good.

Nonetheless, several UK universities, many of them eminent, appear to have embraced the use of intermediaries by outsourcing some or all of the TT&C functions. While it is yet too early to understand the full implications of this development, it clearly meets the needs of a number of universities, and is a topic worthy of further analysis.

### 8.4 New Zealand

#### 8.4.1 General Environment

New Zealand has eight universities\(^\text{153}\) serving a population of about four million people. One New Zealand university stands out with exceptional performance in TT&C: NZ Uni. NZ Uni is a small university of approximately 10,000 EFTSU, located in a regional area, with a small annual research budget of around $20 million in the period of interest. This combination of

\(^{152}\) Referred to at: [http://www.scottish-enterprise.com/sedotcom_home/services-to-business/ideas-and-innovation/iti.htm](http://www.scottish-enterprise.com/sedotcom_home/services-to-business/ideas-and-innovation/iti.htm)

\(^{153}\) University of Auckland, Auckland University of Technology, the University of Waikato, Massey University, Victoria University Wellington, Canterbury University, Lincoln University and the University of Otago
characteristics makes it an interesting case study in order to identify the qualities that permit it to succeed so evidently at TT&C in its environment of a small regional university with a small research budget in a small economy. Its performance suggests that there are factors at work here that overcome the apparent barriers that otherwise exist. This case study examines the university’s TT&C environment and TTO in order to identify the factors that allow this university to excel in commercialisation against the odds.

New Zealand has a reasonably high standard of living achieved through an economy based on a mix of agricultural production, manufacturing and a strong service sector, combined with a stable and robust democracy. Much of this success can be ascribed to the population having access to a high standard of education. There are pockets of global excellence in some fields, in particular agriculture, electronics and entertainment.

### 8.4.2 Regulatory Environment

New Zealand has one of the most open and liberal economies in the world. One consequence of this is that there is little government subsidy or assistance available for commercial activities however worthy they may be. This means that commercial activity and industry in New Zealand are required to perform at or close to world’s best practice if they are to survive competition.

There are no particular rules governing university commercial activities and intellectual property is governed by the general law. There is no guidance given to universities in relation to intellectual property rules and practice.

### 8.4.3 Character of the University

NZ Uni is relatively young, having been established in the 1960s. According to the TTO Director at NZ Uni, “Our university is the top in New Zealand in computer science and in most areas of science, but not so strong in the humanities”. It boasts the top business school in the country, and is prominent in veterinary science, notwithstanding that it does not have a school of veterinary science, as a result of having a leading researcher in the field at the university (NZ Uni Interview 2007).

The university has aspirations to become research-orientated: “We want to be a research-led university, [and] building up teams around very good academics is the way to do that, and the best way to build teams is to get your post-grads” (NZ Uni Interview 2007). By 2009 it plans to have 10% of its student body undertaking higher degrees by research.
8.4.4 Commercialisation Structure

The TTO is a wholly-owned company of the university. It was started in 2002 with the present Director at the helm and has grown since inception to employ eleven staff by 2007. In the opinion of the Director:

“…I think this is one of the big challenges for anybody doing this business, that you need a critical mass… if you’ve got less than four people [you will not succeed], and… to have any chance you need to have a really experienced deal-maker [and preferably more], and at least one commercial manager” (NZ Uni Interview 2007).

The first person the Director employed in the company was a lawyer because of the need for this expertise and to reduce the costs incurred by using external legal advisers.

The university management was fortunate in locating and attracting a Director with extensive entrepreneurial expertise and the ability to adapt his knowledge to the university environment. As he said:

“I've come in, [after] having created a series of companies and I’m applying all of those disciplines you learn [in business], and all those fears and trepidations you get from watching your bank balance every day; I've applied all that to it, and just the hunger for making a buck. At the end of the day I come to work every day because I want to make a dollar. And I think that's quite different, and I've been very careful in building that culture in [the TTO]…“, although “…I didn't even know how universities worked when I took this job…” (NZ Uni Interview 2007).

The university has never provided any significant capital to the company which has relied for growth on internally-generated funds. The TTO is involved only in spin-off companies and licensing – it has no involvement in consulting or contract research. However, the Director would like to change this because he believes that the TTO could increase contract research in particular because of the cultural fit between the company and industry: “…we have a business culture, the university hasn’t”.

The TTO is structured as a central office, with TT&C business managers meant to spend about 30% of their time walking the corridors of the university and keeping in touch with academic faculty.

8.4.5 Commercialisation Process

From the time the TTO started it was on the hunt for commercial opportunities. This was made somewhat easier because, in a smaller university, staff can readily circulate and become familiar with academic faculty and their fields of research. It is a slightly less formal atmosphere. Within two weeks of starting, the Director had identified thirty projects with commercial potential and found he had to slow down looking for opportunities.

While the university has a formal process for identifying projects:
“...the reality is that most of it comes from the relationships that my staff have with the academics, and just casual conversations, keeping up to date with what they are doing, talking about their research, and just throwing ideas around. It’s the academics that we’ve built the relationships with... that we get the most [projects] from... To be honest, I’ve been quite amazed at just how important those relationship are” (NZ Uni Interview 2007).

8.4.6 Commercialisation Performance

While the TTO had to concentrate on “low-hanging fruit” when it began in order to get cashflow going, it made a profit of $500,000 in the first six months of operation and $2 million in its first full year. It has been profitable every year since inception. This result has been achieved principally by the development and sale of spin-off companies rather than licensing.

The TTO does not book any profit on spin-out companies until they are sold, and said that “profit would be a lot higher than that [disclosed] because we are very conservative in our accounting treatment. If we were a private business there would be quite significantly more...” (NZ Uni Interview 2007). Because the university has relied largely on spin-out companies rather than licensing, income has tended to be lumpy and the TTO faces the challenge of needing to keep up a strong deal flow. It is intended that this will be relieved by increasing licence income: “…my goal is that in five years time all the company’s overhead will be supported by royalty payments, but to do that we need about $100 million worth of products to be sold”, partly because there is usually a time-lag of at least a couple of years before royalties from licences normally flow (NZ Uni Interview 2007).

The university strategic plan envisages compound growth of 10% per year from commercialisation activity over the next three years.

The TTO claimed that over the past four years it has created one new start-up company for each US$12 million in research funding, which places it way ahead of figures in other jurisdictions154.

8.4.7 Commercialisation Office Performance

The TTO does not and is not required by the university to forecast next year’s revenue or earnings, although it sets internal targets. Since it has been profitable since its inception, it has always paid its way, and has done so through internally-generated funds.

8.4.8 Knowledge and Awareness

The university does not conduct any commercialisation or entrepreneurial bootcamps or training for academic faculty. This is largely because the small size of the university permits

154 Compared to Canada: one start-up per US$27 million; Australia: one start-up per US$62 million; and US: one start-up per US$71 million.
TTO staff to keep in close touch with researchers. In fact, even in the short time it has been established, the TTO has clearly impressed many researchers because “...the reality is that they are all flooded with projects as well... We’re quite lucky, most of it is academics coming to us” (NZ Uni Interview 2007).

While the university operates the country’s leading business school, it has not had any significant interaction with the TTO.

**8.4.9 Incentives for Commercialisation**

Researchers are entitled to retain one-third of the net revenue after costs from commercialisation. The balance goes: one-third to the researcher’s department and one-third to the TTO.

The TTO made the observation that the one-third of profit it retains from commercial activities constitutes its funding and its income, from which it has to run the company and invest in future technologies, a sum which it believes is too small to give it the financial flexibility it needs. The government provides some small amounts for pre-seed work and up to one-third of some development work, but these amounts are very small and do not meet the needs of the enterprise.

**8.4.10 Linkages with Industry**

Despite its clear success and its ability to interest industry in its technologies, the Director of the TTO said this “…is the hardest thing to do...”. While the staff bring their own networks, and local contacts are important in assisting local industry and building-up reliable cashflow, the university recognises that it is playing in a global pool, despite the challenges it faces in being so far from principal markets, because: “… all the technologies we push are global. It is very hard for the economics that we’re faced with to put a big-time commitment into something that’s not going to be on the global stage. So we’re looking at global-scale technologies” (NZ Uni Interview 2007).

**8.4.11 Technology Parks and Incubators**

The TTO said it incubates companies “… just because we’ve found we have to”. It does this by co-locating young companies with it because the university has no organic incubator. While there is a government (Council) sponsored incubator adjacent to the university campus, the space is largely used for commercial purposes and is not incubating any new companies from the university.

The Director also observed, based on his experience, that he would like to see new enterprises start-off in spartan, non-premium locations in order to keep costs low and to
emphasise to new businesses that they have to work hard at managing cash (NZ Uni Interview 2007).

8.4.12 Intellectual Property

Academic researchers at the university are obliged to disclose discoveries, and the university claims all resulting intellectual property by operation of the university’s Intellectual Property Rights Policy. The university transfers its intellectual property rights to the TTO company upon request.

As usual, students own their intellectual property unless the university has made alternative arrangements under contract or has supplied benefit or value, in which cases the intellectual property is claimed by the university.

The TTO has had no problems with the operation of the policy, but has suffered from what it terms “leakage”, where intellectual property is used by industry without rendering adequate compensation to the university. This usually happens where industry believes it has a right to use the intellectual property that it, as a taxpayer, has helped to fund.

8.4.13 Early Stage Financing and Venture Capital

Early-stage development work is done using two resources. First, at any one time the TTO usually has about twenty students working on projects associated with the development of ideas and, second, it provides pre-seed funding out of its retained profits. There is also a small amount of government pre-seed funding available. Because the TTO has to find its operating costs as well as fund most early-stage development out of its profits, this financial constraint limits the ability of the company to support all the meritorious research that it finds.

Venture capital through angel investors and formal funds is readily available once an idea has progressed beyond the early stages because “...Basically venture capitalists want to finance market growth, [but] they don’t want to finance technology risk”. At the same time, access to venture capital is not usually vital to the success of a technology development because:

“Only some of our deals will go to venture capitalists anyway because most technologies will probably get licensed to existing players. Why build a distribution network if someone’s already got one? …very few will go to spin-outs, so when you go through the number of new technologies we get in here, and the number that… survive our process, there’s not that many, and if you divide that by about ten for the ones that are actually eligible for venture capital investment, you’d be lucky if maybe there is one a year” (NZ Uni Interview 2007).

8.4.14 Entrepreneurship and Culture

The TTO is eminently practical in its approach to commercialisation and encouraging entrepreneurship. It knows that an academic researcher should not become CEO of a spin-
off company; indeed, investors will rarely invest in a business where an academic is the CEO. The most precious resource in the university is world-class researchers, and they should be kept in research, but with a pathway provided between the company and the academic in order to allow access to the researcher’s expertise. As the TTO Director said:

“…I want entrepreneurial academics, but I am using the word entrepreneurial differently. What I like to see is academics that operate within their space just like a business entrepreneur acts within the business space. What I want to encourage is academics that take a very visionary approach to their area of science, and are always trying to push the boundaries and extend it, [to] grow their research team just like an entrepreneur wants to grow their business, [so] we want academics that want to grow their reputation, grow their research unit [and] their research unit’s reputation” (NZ Uni Interview 2007).

9 Australian University Case Study Analysis

9.1 Introduction

Whether concerning teaching, research or commercialisation, each Australian university possesses its own distinctive characteristics. This means that, in order to understand them in their own right, they must be examined in detail and, while there are lessons to be learnt from the experience of universities in other jurisdictions, these lessons are not always capable of uncritical adaptation to the Australian environment. As Johnston, et al. (1999, p.8) expressed it, when discussing the compatibility of US commercialisation models to Australian universities:

“This structural difference between US and Australian universities must be borne in mind when discussing international best practice in technology transfer and research commercialisation. It is not appropriate to recommend that Australian universities emulate the policies and procedures supporting research commercialisation used in the elite US universities (many of which are private) without considering the impact of these different structural circumstances on these policies and procedures”. [italics in the original]

This Chapter undertakes a multiple-case analysis of eight case-study Australian universities, and compares Australian universities’ practices with world’s best practice identified earlier in comparable jurisdictions in order to answer Research Questions 2 and 3.

The analysis used in this Chapter follows closely the structure implied in the development of the propositions. Thus, the relationship between the principal headings in this chapter and the propositions developed earlier is shown in Table 9.1.
<table>
<thead>
<tr>
<th>Issue No</th>
<th>Issue</th>
<th>Proposition</th>
<th>Location in Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Structure of the TTO</td>
<td>The structure of the TTO and the processes used within the university influence success in TT&amp;C</td>
<td>9.3.2, 9.3.3, 9.3.5</td>
</tr>
<tr>
<td>2</td>
<td>Incentives to engage in TT&amp;C</td>
<td>Research staff are motivated by incentives to undertake TT&amp;C activity</td>
<td>9.3.3, 9.3.7</td>
</tr>
<tr>
<td>3</td>
<td>Entrepreneurship and culture</td>
<td>A culture of entrepreneurship and support is vital if a university is to succeed at TT&amp;C</td>
<td>9.3.5, 9.3.12</td>
</tr>
<tr>
<td>4</td>
<td>Access to early-stage capital</td>
<td>In order to succeed at TT&amp;C universities must have access to early-stage capital to provide funding for proof-of-concept development and to undertake detailed market evaluation</td>
<td>9.3.11</td>
</tr>
<tr>
<td>5</td>
<td>Industry linkages</td>
<td>Linkages between universities and industry are the vital element in successful TT&amp;C</td>
<td>9.3.3, 9.3.8</td>
</tr>
<tr>
<td>6</td>
<td>Intellectual property</td>
<td>A workable intellectual property regime is a necessary pre-requisite to successful university TT&amp;C</td>
<td>9.3.10</td>
</tr>
<tr>
<td>7</td>
<td>Co-operative Research Centres</td>
<td>Co-operative Research Centres improve TT&amp; performance</td>
<td>9.3.8</td>
</tr>
<tr>
<td>8</td>
<td>Characteristics of local industry</td>
<td>Local industry has to be capable of absorbing university research outputs if university TT&amp;C is to flourish</td>
<td>9.3.8</td>
</tr>
<tr>
<td>9</td>
<td>Industry clusters</td>
<td>Industry clusters aid universities and industry in TT&amp;C performance</td>
<td>9.3.8, 9.3.12</td>
</tr>
<tr>
<td>10</td>
<td>Role of intermediaries</td>
<td>Intermediaries operating between universities and industry improve TT&amp;C performance</td>
<td>9.3.13</td>
</tr>
<tr>
<td>11</td>
<td>Technology parks and incubators</td>
<td>The presence of technology incubators and technology parks stimulate better TT&amp;C performance</td>
<td>9.3.9</td>
</tr>
<tr>
<td>12</td>
<td>Regional and smaller universities</td>
<td>Regional and smaller universities must satisfy different criteria to other universities if they are to succeed at TT&amp;C</td>
<td>9.3.14</td>
</tr>
<tr>
<td>13</td>
<td>The role of government</td>
<td>The role of government in stimulating TT&amp;C is to establish an environment that encourages parties to participate</td>
<td>9.3.8, 9.3.9, 9.3.11</td>
</tr>
</tbody>
</table>

Table 9.1 – Links between Propositions and University Case Study Analysis

9.2 Selection of the Case Studies

The four major groupings of Australian universities: Group of 8, ATN, IRU and new generation universities was described above in Section 7.3. In addition to these formal groupings, universities may be classified according to whether they are “regional” or “metropolitan” universities, and whether they are “smaller” universities. The definition of regional and smaller universities was covered in Section 4.7.11.

The characteristics and affiliations of the eight case study Australian universities are shown in Table 9.2.
<table>
<thead>
<tr>
<th>University</th>
<th>Regional/Metropolitan</th>
<th>Smaller</th>
<th>Group of 8</th>
<th>ATN</th>
<th>IRU</th>
<th>Non-aligned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aust Go8 Uni1</td>
<td>M</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aust Go8 Uni2</td>
<td>M</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aust ATN Uni1</td>
<td>M</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aust ATN Uni2</td>
<td>M</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aust IRU Uni</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Aust Small Uni</td>
<td>M</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aust Regional Uni1</td>
<td>R</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aust Regional Uni2</td>
<td>R</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9.2 – Case Study Universities and Characteristics *Source: Author*

Table 9.3 sets out some key information in relation to each of the case study universities using the latest available data. These data have been set out in a way intended to obscure the identity of individual case study universities. The Group of 8 universities have much greater research expenditure than any of the other universities and concomitant greater commercialisation activity. The smaller universities have significantly less research expenditure and, apart from licence income accruing to Aust Regional Uni1, relatively little reported commercialisation activity.
<table>
<thead>
<tr>
<th>University</th>
<th>No of Students</th>
<th>No of HDR Students</th>
<th>No of Staff</th>
<th>Research Expenditure</th>
<th>TTO Staff FTE</th>
<th>Disclosures</th>
<th>Patents</th>
<th>Licence Income</th>
<th>Start-up Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aust G8 Unit 1</td>
<td>30,000</td>
<td>2,000</td>
<td>2,500</td>
<td>&gt;$300m</td>
<td>&lt;10</td>
<td>&gt;5</td>
<td>25-50</td>
<td>&lt;$5m</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Aust G8 Unit 2</td>
<td>30,000</td>
<td>2,000</td>
<td>2,500</td>
<td>&gt;$300m</td>
<td>&gt;10</td>
<td>&gt;100</td>
<td>25-50</td>
<td>&gt;$10m</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Aust ATN Unit 1</td>
<td>25,000</td>
<td>1,000</td>
<td>1,000</td>
<td>&gt;$50m</td>
<td>&lt;5</td>
<td>&gt;10</td>
<td>25-50</td>
<td>&lt;$1m</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Aust ATN Unit 2</td>
<td>25,000</td>
<td>1,000</td>
<td>1,000</td>
<td>&gt;$25m</td>
<td>&lt;5</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;$1m</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Aust IRU Uni</td>
<td>25,000</td>
<td>1,000</td>
<td>1,000</td>
<td>&gt;$100m</td>
<td>&lt;10</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&lt;1m</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Aust Small Uni</td>
<td>10,000</td>
<td>N/A</td>
<td>500</td>
<td>&gt;$20m</td>
<td>&lt;5</td>
<td>&lt;20</td>
<td>&lt;5</td>
<td>&lt;1m</td>
<td>&gt;5</td>
</tr>
<tr>
<td>Aust Regional Unit 1</td>
<td>10,000</td>
<td>500</td>
<td>500</td>
<td>&gt;$40m</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&gt;$5m</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Aust Regional Unit 2</td>
<td>5,000</td>
<td>100</td>
<td>200</td>
<td>&lt;$10m</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&lt;1m</td>
<td>&lt;5</td>
</tr>
</tbody>
</table>

Table 9.3 – Principal characteristics of Case Study Universities

Sources: university Annual Reports, AVCC Australian University Handbook 2006, DEST (2007)

9.3 Analysis of the Case Studies

9.3.1 Commentary

The research commercialisation results achieved by universities examined here as case studies are influenced by their environment (national intellectual property policies, size of research budget, support of university management) and by the processes they use (how the ideas are found, and how they are brought to market). Some of these factors are within the control of the university, and some are not.

Assessing the merit of one approach to research commercialisation as opposed to another requires the use of some form of metric. The metric could be based on inputs, outputs or financial results, or some combination of several of these, or it could be assessed on some form of engagement with the world outside the university. Some metrics can be measured in numbers, but some, such as the public benefit arising from ideas flowing from the university to the community cannot conveniently be measured, although the benefits may still be real. Metrics and numbers from many sources help to illustrate the performance of one environment or process over another, but they alone cannot provide a complete picture capable of explaining adequately the differences between universities.

There remains, also, the difference in concept between technology transfer and research commercialisation. Technology transfer offers a public benefit and can be done in multiple
ways (publications, intellectual property licensing, disclosures). Research commercialisation, on the other hand, suggests that ideas are transferred beyond the university only when they produce some tangible financial benefit (income, research funding) for the university. In some cases the difference between technology transfer and research commercialisation is semantic – US universities have historically had technology transfer offices (TTO), but most do much of what Australian university research commercialisation offices do. But there is an apparent fundamental difference in philosophy: in technology transfer the generation of some return to the university is, at least in theory, incidental to the principal role; while in research commercialisation it appears to be a necessary ingredient.

Vignette #9.1
According to the TTO Director at Aust ATN Uni2 the reasons to undertake commercialisation are to:-
- Foster economic development
- Maintain university status
- R&D income
- Attract industrial research funding
- Motivate and reward staff
- Generate income

However, the metrics collected by AUTM and DEST are substantially directed towards establishing the tangible financial value of the various types of transaction to the university. There is not yet a clear understanding or agreement on what all universities are expected to do and this uncertainty is reflected, to some extent, in the significantly different ways in which universities have created and operate their research commercialisation structures.

This uncertainty is further observable in the fact that universities are expected by funding agencies and the government to have a research commercialisation office, but are not provided with funding for either the establishment or operation of such an office. This means that universities are obliged to take one of two paths to funding the office (which is reflected in the staffing and resourcing of the office): make it self-funding, or divert university funds from some other source to pay for the office.

Vignette #9.2
The Director of the TTO at Aust Small Uni observed that:-
“Under present arrangements universities are not funded to undertake commercialisation. They are funded for teaching, and they are partially funded for research, but they receive no funding for commercialisation while, at the same time, there are increasing expectations that they will engage in commercialisation.”
The further sections of this analysis examine the case study universities according to the structure developed earlier. This approach permits the propositions to be tested while allowing a multiple-case analysis amongst the case studies.

9.3.2 Structure of the Research Commercialisation Entity

(a) Comments on Structure

University commercialisation entities go by many names. In North America it is often generically called the Technology Transfer Office (TTO), while examples of specific names include the Office of Technology Development; the Office of Intellectual Property and Industrial Research Alliances; the Innovations Group; and the University-Industry Liaison Office. In Australia commercialisation entities go by names that include UniQuest; Melbourne Ventures; Bluebox; Research Partnerships Team; Swinburne Knowledge; the Office for Commercialisation; and the Consulting and Industry Liaison Officer. This difference in nomenclature partly reflects the different roles each office has and its place in the university. For simplicity the entity that undertakes the principal commercialisation role at any university is called here the TTO.

The case studies indicated that there are six structural elements that distinguish between TTOs:

- Whether the TTO is incorporated or remains a unit within the university structure;
- To whom the TTO reports;
- How long the TTO has been established;
- How the TTO is internally organised;
- Whether the TTO acts as principal in transactions;
- The scope of the tasks undertaken by the TTO; and
- The number and skills of the TTO staff.

The structure of the TTO, whether it is part of the university structure or separate, is an important factor in managing matters of intellectual property and conflicts (Fisher and Atkinson-Grosjean 2002). Each of these aspects in relation to Australian case study universities is discussed in this section and compared with the benchmark universities.

(b) Whether a TTO is Incorporated or Part of the University Structure

There are two principal structural models used by universities to undertake research commercialisation: a commercialisation office organic to the university; or a commercialisation company usually wholly-owned by the university.
North American case studies uniformly had the TTO as a unit of the university although, in the case of Canadian Uni2 this was brought about because it had had to close down its non-performing commercialisation company in order, effectively, to re-start parts of the function. One other partial exception identified was Canadian Uni1 which uses a company to hold the intellectual property and to apply for certain government funding that required a company structure. On the other hand, NZ Uni has used a company structure since its formation. The flexibility available in paying TT&C staff through a commercialisation company was the subject of favourable comment by several of the case study universities which expressed a wish to be free of university restrictions on remuneration. As stated by the TTO Director at Canadian Uni2 (the TTO is not a company):

“... [our environment] could probably be better managed with the flexibility to provide incentive instead of putting people on a salary grading, ...as long as we have commercialisation and tech transfer responsibilities internalised within the university, we will have a lot of churn and we will be in a constant training mode with people who come in, learn the business and then spin-out to be part of the opportunities”

The Australian cases show diversity in structure with the larger universities generally preferring a company structure for their TTO.

Both the Aust Go8 Universities use a commercialisation company, although each company has a different remit and structure, and in the case of Aust Go8 Uni1, commercialisation activity is shared with the Research Office, while at Aust Go8 Uni2 there are several entities in addition to the TTO undertaking commercialisation in specific fields. Half the remaining case study universities, namely Aust ATN Uni1, Aust Small Uni and Aust Regional Uni1 had a company involved in commercialisation activity.

The TTO company at one of the ATN case study universities commenced operation only in 2006 and so has not yet established a track record. This TTO company undertakes commercialisation only through intellectual property licensing and spin-offs. At the same time, this university continues to maintain a separate office for consulting and contract research.

Aust Small Uni has two entities involved in commercialisation: one, a unit of the university, to undertake the functions of a TTO; and the other to own the university’s intellectual property and enter into commercial deals on behalf of the university.

Aust Regional Uni1 uses a wholly-owned company to promote and license software that has become a major product in its own right, however this company does not deal in routine commercialisation activity. For this reason, Aust Regional Uni1 is properly treated as having a commercialisation office that is part of the university structure rather than a commercialisation company.
Each of the remaining universities: Aust ATN Uni2, Aust IRU Uni and Aust Regional Uni2 conduct TTO functions through an office that is part of the university structure. Prior to 2001, Aust ATN Uni2 conducted commercialisation through companies which have since ceased trading.

In each case where a company has been established as the commercialisation entity, the management reported that a significant factor for doing so is to pay staff commercial salaries without the constraints of university salary levels. Another important benefit of incorporation is maintaining separate accounting which permits the commercialisation company to retain profit and cash and avoid the need to seek annual funding from the university administration which, in turn, releases the company from short-term goals of the university administration and allows it to concentrate on the long-term goals of commercialisation. In addition, incorporation can allow the commercialisation company to own relevant intellectual property which can be convenient where the Office negotiates licences and assignments, and also for the purpose of seeking certain government funding which is often only available to commercial companies and not universities, as such. There are direct costs in establishing and maintaining a company for commercialisation, and there is some risk associated with the potential loss of control of the function by the university, but these concerns are often outweighed by the convenience of having a company.

Nonetheless, not all universities are convinced of the efficacy of having a commercialisation company. Aust IRU Uni believes that it is inappropriate and unnecessary, and sends the wrong message to academic faculty who, at that university, are believed to be more concerned with developing their research profile than commercialisation. Aust IRU Uni is of the view that the desirability or otherwise of having a TTO company depends on the culture of the university, which is different at different universities. It is also concerned that TTO companies can consume considerable capital.

As separate legal entities, TTO companies need sufficient capital to survive and prosper. In the absence of any other source this capital has to be found by the university itself. In the case of Canadian Uni2 $10 million was consumed by its TTO company before the university management opted to change course; while in Australia, the TTO of Aust Go8 Uni2 has been capitalised over its life with several million dollars (although it now generates significant profit), while the newer TTO at Go8 Uni1 receives recurrent funding from the university on a fee for service basis to provide it with working capital.
Vignette #9.3
On the matter of having a TTO company, the TTO Director at Aust Go8 Uni1 said:-

“The ability to pay market salaries is part of the motivation for having a company separate from the university. [Our TTO] believes that it is important to have people working for the university who are as capable as those working for industry on the other side of negotiations, so market-linked salaries are essential.

(c) Reporting up the Chain

North American experience demonstrates that commercialisation is successful only if it has the support of the university’s senior executives. The New Zealand case study reinforces this observation. Continuing support for commercialisation is demonstrated in part by having the TTO report to the university President or another senior executive.

With the exceptions of Aust Go8 Uni2 and Aust Regional Uni2, all TTOs, whether an office or company, report through a senior executive of the university, at Deputy or Pro-Vice-Chancellor level, who has research as part of their brief. The TTO at Aust Go8 Uni2 has an independent board that reports through a university holding company to the university governing council while Aust Regional Uni2 does not have a separate entity established to undertake commercialisation.

Until 2006 the TTO at Aust Small Uni reported to the university President, the Vice-Chancellor, but now reports to the Pro-Vice-Chancellor (Research) in order to reduce the number of direct reports to the Vice-Chancellor. Because this takes its reporting down two levels, it could also be seen as a reduction in the relative status of the TTO.

Vignette #9.4
On how essential supportive university management is to the success of its TTO, the Director at NZ Uni said:-

In 2005 “...we got the new Vice-Chancellor we also got a new Deputy Vice-Chancellor and a new head of Corporate Services, which are the next two most [relevant to commercialisation] in the university, so the whole senior management team came in and were all very supportive of commercialisation.”

(d) How Long the TTO has been Established

International experience as to the importance of having a long-established TTO is equivocal. WARF in the US started in 1925, and Stanford has been commercialising for over four decades, while US Public University was a rather later entrant (in the 1980s) and other successful TTOs are also quite young: for example, Imperial Innovations commenced in 1986 and NZ Uni around 2000. This suggests that the age of a TTO may not be a vital factor
for success, although clearly any successful business that has been in existence for some time should have developed efficient processes and a market profile. It is also true that, despite a long existence, most TTOs have undergone several changes of structure and objectives, so that age, alone, is not a reliable predictor of current status.

At the same time, there is strong agreement among all case study universities that TTOs will rarely achieve self-sufficiency (paying for themselves after all real costs) until some years after starting. Canadian Uni2 originally expected its commercialisation company to be self-sufficient after five years, but this proved too optimistic, leading to the university re-structuring its TTO. The general rule-of-thumb is that a TTO needs to exist and be supported by the university for not less than ten years before it will achieve the sorts of results that university management desires. Among the case studies the obvious exception to this is the TTO at NZ Uni which proved profitable within its first year for a few special reasons.

Vignette #9.5

On how long it takes for a TTO to become self-funding: the TTO at US Public University said:-

“If one were just to be starting up a new office at a university that didn’t have one, or had a very weak one, I think you would have to expect at least five years, and maybe ten years before you could have an expectation that the office would be generating an income equal to its expenses...”.

While at US Private University, the TTO said:-

“...your office needs to have been around for at least...fifteen years” for institutions to make money from commercialisation.

Of the Australian case studies, only the TTO at Aust Go8 Uni2 has been long-established (1983), while the two other TTO companies are comparatively recent: Aust Go8 Uni1 in 2003, and Aust ATN Uni1 in 2006, although both Aust Go8 Uni1 and Aust ATN Uni1 had predecessors at their respective universities in the traditional TTO mould. With the exception of Aust Regional Uni2 (which does not have a TTO), the other commercialisation offices or their respective predecessors have been established generally for less than two decades in their current form. For example, in their current structure, Aust IRU Uni was established in 1993, Aust Regional Uni1 in 1997, Aust Smaller Uni in 1999, and Aust ATN Uni2 2001.

(e) Internal Organisation of the TTO

There are, essentially, four structural models for commercialisation entities: the central office model, the hub-and-spoke model (sometimes also called the de-centralised or satellite office model), the front-office/back-office (FOBO) model, and the outsourced model.
The central office model envisions having all the commercialisation resources located in one office with staff from that office making regular visits to researchers to educate them in commercialisation and assist in locating discoveries for disclosure. This model can function with as few as one part-time staff member. This is the most common model used by North American universities largely as a consequence of the small size of most TTOs. It is the model used by NZ Uni, although technical/business managers are expected to spend around 30% of their time working directly with researchers, a task made somewhat easier because the university is relatively small.

The hub-and-spoke model still requires a central office in order to provide a body of common resources such as contract and intellectual property specialists, but diverges from the central office model by having specialist staff embedded throughout the university to work close by researchers in the researchers’ environment on a permanent basis. Clearly, this model is only practical if the university is sufficiently large and diverse and the commercialisation entity has a sufficient number of staff. North American universities generally appear to eschew this model on the basis that it takes the TTO staff out of the orbit of the office thus fragmenting the resource and reducing the effectiveness of individual commercialisation officers.

The FOBO model is similar to the hub and spoke model in that there is a common pool of centrally-accessible skills supplemented with separate pools of technical/business specialists, but the FOBO model differs in that it does not embed the technical/business specialists with researchers, but keeps them in clusters of skills within ready access of the researchers. For example, life science TTO specialists will be located together within a life science research unit accessible to life science researchers, rather than dispersed within individual research clusters. Having experimented with the hub and spoke model, the FOBO model is favoured by the very successful TTO at Canadian Uni1.

Outsourcing is in its infancy but has been adopted by a number of UK universities in particular. It involves granting to an intermediary, a specialist commercialisation company, the right to identify and exploit intellectual property created within the university in one or more fields. For example, the University of Oxford uses this approach, but only in relation to intellectual property developed in biomedical engineering and chemistry. In this way the university benefits by having another entity assume both the technical and market risk associated with a new development while still sharing in the financial profits, albeit potentially to a lesser degree.

UniQuest uses the hub and spoke model and, since 2004, has been responsible for commercialisation at an interstate regional university. In doing so, it added another two
“spokes” to its model to accommodate the needs of this university. By 2007 this TTO employed over seventy staff.

Both Aust Go8 Uni1 and Aust Go8 Uni2 employ a hub-and-spoke model within the constraints of their respective resources.

All remaining universities (except Aust Regional Uni2, which has no central commercialisation entity) employ a central office model, largely because of the limited number of staff employed. The next largest office amongst the case study universities, Aust IRU Uni, employed seven professional-level and four general staff, not all of whom work full-time. The remaining universities employ either one (two universities), two (one university) or about three (one university) professional level staff dedicated to commercialisation (2007 figures). It is not clear whether all the TTOs require staff to spend time actively with researchers – with only a few staff it would not be feasible. In cases where staff spend little, if any, time “walking the floors”, they rely on disclosures made to the office by researchers.

There is a clear division among Australian case study universities on the choice of model. Of the Australian case studies, it is principally only Group of 8 universities that employ a sufficient number of commercialisation staff to operate a hub-and-spoke model effectively.

Despite its apparent success, the TTO at Aust Go8 Uni2 believed that it had not yet exploited the depth of intellectual property and commercialisation opportunities that exist within the university. The TTO Director said “More resources would produce more outcomes”. On the same issue, the TTO at US Public University said that, potentially, a doubling of staff in the TTO could lead to a doubling of income. Thus, even universities with already substantial TTO staff and commercialisation income believe that there are more commercialisation opportunities that could be garnered from their respective universities in the event that more resources could be deployed to find and manage them. This is strongly suggestive that universities that are not yet achieving significant outcomes in commercialisation could do so with the employment of the right number of TTO staff with appropriate qualifications and experience.

(f) Whether the TTO Acts as Principal in Transactions

This issue mainly arises when university commercialisation companies are involved because, in the case of TTOs that are not companies, the university will normally claim all right, title and interest in relevant intellectual property.

The TTO at Aust Go8 Uni2 is assigned title in intellectual property that it wishes to exploit commercially by the university. This means that the TTO may negotiate as principal and enter into agreements on its own behalf with industry. This appears to provide the TTO with
considerable leverage in relation to negotiations, allowing it to develop the skills needed to negotiate effectively, and having revenue flow to it directly as a result of contracts it enters.

The TTO at Aust Go8 Uni1, on the other hand, acts as what it calls a “broker” for the university, in which it manages the intellectual property (in conjunction with the university Research Office) and negotiates licences and assignment of intellectual property with industry, but is not entitled or empowered to enter into a contractual relationship with industry in relation to intellectual property. Because this TTO is still quite a young company it is not possible to draw conclusions on the efficacy of this approach, although it largely replicates the procedures that would exist if it were an office within the university rather than a company. The business risk in this approach is that it continues to make the commercialisation company dependent on university funding rather than developing its own income sources and nurturing the associated skills.

(g) Scope of the Tasks Undertaken by the TTO

North American practice generally, also followed by NZ Uni, is to have TTOs commercialise their universities’ research only through intellectual property licensing (and assignment, where permitted) and spin-off company creation. This means that potential income from consulting (which is a private arrangement for faculty members in North America) and contract research does not generally accrue to these TTOs. As a general rule, in North America and Australia, applications to funding/granting agencies are undertaken by a university unit other than the TTO, although there is often an historical linkage between the functions, and a need for them to work together effectively.

Australian TTOs vary in the commercialisation tasks they undertake. Aust Go8 Uni2, undertakes all four commercialisation activities: consulting, contract research, licensing, and spin-off company formation. From this it achieves a turnover of approximately $40 million per year and has returned over $100 million during its lifetime to the university and faculty members. Aust Go8 Uni2 TTO actively promotes consulting as a commercialisation activity because it believes that it provides researchers and academics with opportunities that enhance their commercialisation skills and potential while operating as a strong lever to other opportunities, with the added benefits of contributing to community engagement and TTO revenue.

Of the remaining Australian TTOs, all undertake licensing and spin-off company formation, the only differences being whether they also do consulting and contract research. The TTOs at Aust ATN Uni2, Aust Small Uni and Aust Regional Uni1 undertake all four commercialisation tasks although, because they are small offices, often largely as facilitators rather than active participants; Aust IRU Uni does all except consulting; Aust Go8 Uni1 does
all except contract research; while Aust ATN Uni1 is involved only in licensing and spin-off company formation. At others like Aust Go8 Uni1, the Research Office (not the TTO) manages contract research, while Aust ATN Uni1 maintains a separate office to manage consulting and contract research.

Each university also maintains an office, usually styled a Research Office, that interacts with the commercialisation entity but which has responsibility for research-related matters such as preparing research proposals and maintaining documentation relevant to research such as policies. The presence of the Research Office is a source of potential overlapping duties that has created tensions in some cases and takes finesse to manage. In the case of Aust Go8 Uni1, the Research Office is the repository for intellectual property disclosures, and is also responsible for contract research, so that both the TTO and the Research Office undertake the protection and management of university intellectual property with commercial potential.

Vignette #9.6
On the matter of interaction with the university Research Office, The TTO Director at Aust Go8 Uni1 said:-

“One of the keys to our success, in my view, is the very close and integrated working relationship with the Research Office. I’ve always said that it won’t work if we don’t work very closely with the Research Office, and I’m glad to say that thus far we have had a very, very good relationship with them. The personalities are very important, there is no doubt about that, and the individuals concerned happen to get along well..., but even so the university knows that [previously], the commercialisation office and the research office didn’t get along very well and didn’t work together and it hurt the university badly”

(h) Staff of the TTO

Staffing TTOs is an area of great diversity amongst universities in North America. There are some clearly successful TTOs in North America that have a large complement of highly qualified staff, but most have small offices with an average of six employees among reporting universities. Universities generally believe that there is a threshold size below which TTOs are unlikely to be viable, although there is no agreement on the number of employees, being variously four (NZ Uni), to ten (Aust Go8 Uni2) and as high as twenty (US Private University). TTOs with fewer than a threshold number of staff are unlikely to be viable over the long term through being unable to provide a suite of services sufficiently diverse and useful to faculty members.

At the same time, the quality of the staff of the TTO and, in particular, the qualities of the Director are vital ingredients in performance. Successful North American TTOs have staff
with outstanding qualifications: most life science business managers possess PhDs or MDs, while business managers in the other principal fields – physical sciences and IT – usually possess technical qualifications at masters level, with many having MBAs. Having staff able to relate to researchers and understand the technology is vital (Harman and Stone 2006). But there is a comment made by some TTO managers that business managers with experience in industry are hard to locate.

Vignette #9.7
On the matter of industry experience amongst TTO staff, the TTO Director at Canadian Uni said:-

“I think an area where we would be light in terms of qualifications is in deep industry experience”

Acknowledging both the importance of industry experience and the difficulty of getting it, the TTO at Canadian Uni took the innovative step in 2005 of engaging an entrepreneur-in-residence to take a fresh view of how things are being done and to identify new opportunities and ways of operating. The entrepreneur-in-residence was an experienced businessman who had had proven industry success and was willing to work for a period of time with the university to assist researchers in commercialisation, to transfer some of his skill, to provide a bridge with local industry, and to identify new sources of seed funding. The experiment has been so successful it is being extended and expanded.

The other, and probably most important, ingredient in making a TTO successful in commercialisation is the quality of the Director. A successful TTO Director needs a mix of skills that are rare: the ability to meld a team of highly intelligent individuals; the ability to work within the arcane structure of a university; the ability to work with a range of technologies that usually have vastly different profiles \(^{155}\), and the inspiration to identify real commercial deals and the tenacity to see them through to completion. To this must be added obligations that include training researchers in commercialisation, and managing and growing a complex business in an environment that is immature and changing with amazing rapidity. Among the case studies this is nowhere better illustrated than at NZ Uni which procured as Director a serial entrepreneur and businessman who started the TTO at NZ Uni and has made a profit every year since inception.

\(^{155}\) This is best illustrated by the fact that most TTOs have a mix of two principal types of technology: life sciences (typically around 50%); and physical sciences and IT (most of the balance). The profile of these two technology types could not be more different in terms of temperament of the industry, time to market, regulatory constraints and researcher attitudes. To successfully manage a business combining these two disparate elements would be a challenge to most managers.
Vignette #9.8

What makes a good CEO for a TTO? The TTO Director at NZ Uni said:-

“I’ve been a lot more aggressive than your average university employee would be... I’ve come from my own businesses where cash is king – you’ve got to get cash in the door – you’ve got to do the deals, and when you’re doing the deals you’re thinking about next year and the year after’s profit and loss statement” and

“I’ve come in, having created a series of companies and I’m applying all of those disciplines you learn [in business], and all those fears and trepidations you get from watching your bank balance every day; I’ve applied all that to it, and just the hunger for making a buck. At the end of the day I come to work every day because I want to make a dollar...” and

“I don’t think most people [in university commercialisation offices are bold]. I think most universities are deal-takers, whereas we are deal-makers.”

But it is possible for a successful Director to come from the other direction – from the university rather than from industry – and to grow into the role of deal-maker. This is well illustrated by the TTO at Canadian Uni1 where the Director is respected as among the best in North America and probably the best in Canada, after having been with the TTO for twenty years, almost half as Director.

In Australia there is a small group of highly-regarded TTO Directors that demonstrate the positive impact of effective leadership. Of Aust Go8 Uni2, Aust VC1 said:

“...in the sweet spot you have [the TTO at Aust Go8 Uni2]... They are very easy to deal with, [The university] invests a lot of money in these people, they’ve got good quality people, they have a lot of transaction experience. They’re not perfect, but they are so far in front of everyone else, it’s not funny” (Aust VC1 Interview 2006).

Similarly, of Curtin University of Technology:

“Here, you’ve got one guy, [the TTO Director], and he’s more productive than ten of these guys [at another Group of 8 university]. So, one industrious guy can make a great difference; he’s very commercial and he’s very active and they like him there because he’s doing the best for the university, he’s commercially reasonable. I would put [Curtin University in the sweet spot]” (Aust VC1 Interview 2006).

All business managers at Aust Go8 Uni1 TTO (the technical experts embedded with the researchers) possess a relevant technical degree, while 65% have a PhD, 31% have a MBA or business qualification, 52% have experience at CEO level, and 72% have international experience. The staff of this TTO are exceptionally well qualified and highly sought-after156. The TTO Director, who has more than 20 years’ experience in technology transfer with

156 This is amply demonstrated by the fact that all three of the senior executives of QUT’s new Brisbane-based commercialisation company, Bluebox, were hired directly from the TTO at Aust Go8 Uni2.
international consulting firms and industry, has been with the company for over ten years and CEO for over five years.

Aust Go8 Uni1 TTO employs both full-time and part-time professional staff, and relies on annual funding from the university in the order of $2 million. The Director of the TTO possesses a technical first degree supplemented by experience in consulting and new ventures, and has been at the commercialisation company helm around five years. At this TTO all life sciences staff possess a PhD, the investment manager MB, BS and MBA, while the physical and other sciences staff possess either technical or business qualifications.

The TTO at Aust ATN Uni1 is somewhat smaller, employing a Director, two general managers (in life sciences and physical sciences, respectively), and four other professionals. All three life sciences professionals hold PhDs and all other staff various technical and postgraduate degrees. Consulting and contract research are handled at the university by a team of three within another office.

Aust IRU Uni is the next largest cased study TTO employing six professionals. Legal staff who used to work in the TTO were moved to the office of the university solicitor. The TTO does not have domain technical experts, but relies on generalist skills. This arises because the staff numbers are relatively small, the university has a diverse research base and because the university cannot afford, within the constraints of being an office within the university structure, to pay what specialists command.

Aust Small Uni employs two commercialisation professionals, both with PhDs, while Aust ATN Uni2 and Aust Regional Uni1 each employ one specialist in commercialisation. Aust Regional Uni2 has no dedicated commercialisation staff.

It is usual for all professional staff in larger TTOs to have technical qualifications, with those in life sciences almost always possessing PhDs, and those in physical sciences and IT usually engineers, while among the group as a whole there is generally a smattering of MBAs and business qualifications.

Common threads among successful TTO Directors appear to be a preparedness to be innovative and try new ideas and to be deal-makers rather than deal-takers. Longevity in their position and the ability to flourish in an environment that combines skills in technology, business, innovation, imagination, people-management and the arcane structure of a university are also indicators of likely success.
9.3.3 Commercialisation Process

This heading deals with processes relevant to intellectual property rights capable of registration, not processes relevant to consulting or contract research.

While it can be misleading to describe any commercial process, particularly one involving new technology, in linear terms, the fact is that most universities use a substantially similar approach to TT&C. The actual process adopted by a university will depend to some extent on whether the discovery is in the life sciences or other fields, and whether the discovery has been made under the terms of sponsored research.

Where research has been sponsored by industry there is usually an existing agreement that prescribes the way in which development and exploitation of the discovery will proceed. Many industry partners seek to own relevant intellectual property arising from their sponsorship, and universities have established processes to permit them to comply with such agreements.

Where life sciences are involved, patents are usually important and often they will be sought as a matter of course in most sophisticated universities. Patents provide long-term protection for the discovery while the idea works its way through clinical trials, approval processes and market entry. Physical sciences and IT, on the other hand, are generally (but not always) less concerned with patent protection and more inclined to seek TTO assistance in market identification, negotiation and contract formation and management.

Allowing that there are two major areas most likely to commercialise (life sciences, and physical sciences/ICT), in general terms both progress through the following steps after a discovery has been made:

- The discovery is disclosed to the TTO;
- The TTO will apply for a provisional patent;
- The TTO assesses whether the discovery has reasonable probability of being marketable;
- A patent is sought; and
- The discovery is taken to market either through a licence agreement or a spin-off company.

A simple but elegant process used by the University of British Columbia is shown in Figure 9.4. Extensive descriptions of models are available from many North American universities, the University of Virginia Patent Foundation being among the more comprehensive\textsuperscript{157}.

\textsuperscript{157} The process can be located at: \url{http://www.uvapf.org/}, but there are many other comprehensive processes.
There are often many other activities undertaken in the interval between a discovery being made and an application for a patent, including further development of the discovery (and the funding needed for that), patent searches, market assessment, negotiations with prospective industry users of the discovery and risk assessment.

One thing that successful US universities have in common is the ability to access the complete suite of capabilities needed to take an idea from nascent form through to industry. Some, like US Private University, offer the complete suite using internal structures (from Corporate Business Development that forms the partnership, through to intellectual property management, early-stage funding, venture funding, business planning, and contract negotiation and, where appropriate, spin-out company formation). Others, like US Public University, which is located near the largest venture capital pool in the world, supply the suite of capabilities except for funding, which is available privately, although the university maintains close links with both industry and capital.

(a) **Obligation to Disclose**

Generally North American academic faculty are obliged to make disclosure of their discoveries and inventions to their university but, as US Public University said: “…in fact, there are no consequences if they don’t”. This is subject to the limitation that disclosure must be made if it is an obligation under the terms of sponsored research. But, even in the US, “many technology transfer office directors believe that substantially less than half of the inventions with commercial potential are disclosed to their office” (Jensen, *et al.* 2003, p.272).

The TTO at Canadian Uni2 speculated whether it may be necessary to allow its several affiliated hospitals to retain their own individual disclosure and intellectual property management regimes as a matter of practice. While this may require increased management resources and vigilance, it may be a practical necessity where institutions affiliated to universities have significant influence and already workable processes.
There are two aspects to disclosure: the written policies of the universities, and their operation in fact. The desirability for disclosure clearly requires universities to balance commercial imperatives against academic freedom and a culture that is not generally attuned to needs of commerce. Of the eight Australian case study universities, the intellectual property policy of six universities places an explicit obligation on creators of intellectual property to make disclosure to the university, while one suggests that creators “should notify” the university, and one, Aust ATN2 Uni, places no explicit obligation to disclose on a creator, although its various policies contain an implication that disclosure is expected.

Practice, however, is noticeably different to documented policy. TTO Directors recognise that attempts to enforce a policy of obligatory disclosure would be unlikely to succeed and, like the NZ Uni TTO Director, adopt a practice of co-operation. In practical terms, if researchers choose not to disclose, the TTO may never be aware in any event, and there is little merit in requiring a researcher to disclose in the absence of free will because commercialisation relies upon the goodwill and support of the researcher in any event if commercialisation is to be effected.

Vignette #9.9

According to the intellectual property policy at Aust IRU Uni, researchers are obliged to make disclosure to the university but, in fact, “they tell you if they want to”. If researchers choose not to make disclosure “how would you know?”. Indeed, the view of the TTO, which is typical of its peers, is that researchers have to want to make disclosure because, if the idea is to be commercialised, you need their support in any event, and you cannot require academic staff to support commercialisation.

Nonetheless, as Aust IRU Uni University noted, there can be good reasons to encourage researchers, particularly junior researchers, to disclose discoveries in order to provide some level of protection to them as disclosing academics against the appropriation or suppression of ideas by other, usually more senior, academic faculty members.

It is notable that two smaller universities, Aust Small Uni and Aust Regional Uni1, comment on the importance of the personal relationship with researchers in identifying research with commercial potential, and the fact that the smaller university stimulates the development of the personal relationship. As the Aust Regional Uni1TTO Director said:

“… I do sometimes walk the corridors, too, which is something we can do here being a small university; you basically know all the staff and you build a relationship of trust and confidence..., so it becomes a bit easier to pick up on things that might otherwise be hidden...”.
(b) Provisional Patenting

Where patenting is the most satisfactory way of proceeding, North American benchmark universities will usually seek a provisional patent in order to buy time to examine the prospects of a discovery in more depth. A provisional patent lasts twelve months, by which time a full patent specification has to be filed, or the patent lapses. In this way universities are given twelve months to decide whether they wish to proceed with the cost and complexity of applying for letters patent.

Information about the discovery has to be kept secret in the interval between a discovery being made and the filing of the provisional patent in order that the right to patent is not compromised (which can happen if premature publication, disclosure or use of a discovery occurs). There is one existing difference between US patents and those of the rest of the world: the US presently grants a patent to the “first-to-invent”, while the rest of the world grants a patent to the “first-to-register”. It is, therefore, vital that secrecy is maintained until the application for a provisional patent is filed. At the time of writing there is a Bill before the US Congress to make the US system the same as that elsewhere in the world in regard to this point.

A description of this part of the process, along with its rationale and some of its quirks is described by US Private University:

“What we do is we generally file as a provisional patent application [to] buy ourselves a year. Typically, when the filing is done, we say good-bye to the professor and leave him alone for eight months or so, [when] we re-connect and say ‘what has happened since? How was the paper received? Have there been...other professors at...other universities coming up with [similar ideas]? Where do you think this will go commercially?’...and we’ve got additional data, and we put all that together and then we get the professor together with the patent attorney and have a brain-storming session as to: ‘where do we think the technology’s going? What do we think the commercial implementation is going to be, and are we going to get the appropriate protection for that, and so forth?’ And so, by the time you come to spend the big bucks, you and the professor will have a [common] view. Does that always happen? No”.

Among other reasons, it doesn’t always happen this way because there are so many routes to market. For example, a professor in electrical engineering may have an established relationship with a telecommunications company and will use this route to get an invention into the fast-moving telecommunications market before even a provisional patent would expire.

There appear to be two principal routes to taking a provisional patent: as an early step in the process before a commercial assessment is made; or following some initial assessment of the commercial potential of the disclosure. Because of the cost involved, there can be an understandable reluctance to file even a provisional patent too early in the process. The decision may also be influenced by the propensity of the university to license intellectual
property or spin-off a company and, as US Private University said, the documented process is often not followed with rigour. Of the six Australian case study universities where information on provisional patenting practice is available, two (Aust ATN Uni1 and Aust Regional Uni1) have a policy that appears to encourage a provisional patent early in the process, while four (Aust Go8 Uni1, Aust IRU Uni, Aust ATN Uni 2 and Aust Smaller Uni) appear to undertake some level of commercial assessment of a disclosure prior to filing a provisional patent.

At the same time, there are strategies other than patents (provisional or otherwise) used by universities to protect intellectual property and the value of ideas in fields other than life sciences: see Vignette 9.10.

Vignette #9.10
On the matter of patenting, the TTO Director at Aust Go8 Uni1 suggested that for creations and discoveries in fields other than medicine and life sciences, protection strategies other than patents may be adopted out of convenience or necessity. For example:
“... it may be copyright... in software you might just keep the source code a secret..., but you still need a mechanism by which someone can be... motivated to invest in the technology to get it market ready, and if you put something into the market [before it is ready] you are really relying on, [for example] in the IT world, open-source developers to pick it up and run with it”.

(c) Making the Decision to Commercialise

Most North American universities go through a generally similar process to decide whether a disclosure should be commercialised. All benchmark universities use internal resources (sometimes aided by a patent expert) to make this assessment.

The fact is, though, that most university disclosures appear early in the process, generally in inchoate form, making commercial prospects difficult to judge. This problem, and its variant in life sciences, is described by Aust IRU Uni:

“Scientific area is the most obvious [area for disclosures], but the problem is the perennial problem, they are too early... Biomedical area has proven the biggest area. The good thing about biomedical and the life sciences area is that it’s highly structured so, compared to all the others, it’s relatively easy to work out what pathway you get onto...

And from Aust Go8 Uni1: “… a lot of the technologies coming out of the university are not yet ready to be deployed in industry, they require further investment…”.

Where a nascent idea needs development before a decision can be made on its commercial prospects, the university has to make a decision whether to invest money in further research or preliminary development in order to get an idea to the proof-of-technology or proof-of-
principle stage. This further research or development almost always requires funding over
and above that provided for the initial research, funding that may come from the TTO, the
university itself, the government, foundations or investors. This topic is complex and
addressed below under the heading Early Stage Financing and Venture Capital.

Where a discovery is sufficiently advanced for the university to make an assessment of its
commercial potential, this is done either by an individual person, a committee involving
principally university resources, or a committee involving university and external resources.
At US Public University this is “pretty much done [by] the individual licensing officer. [He]
makes the original decisions in term of: ‘does this look like it’s worth pursuing and trying
some patenting and marketing?’”. Australian case study universities generally appear to
make the decision on commercial potential within the TTO. For example, Aust Go8 Uni1, in
conjunction with the university Research Office, assesses commercial potential and prepares
a business case as the basis for a decision by the university. Aust IRU Uni makes the
decision in the TTO, sometimes in consultation with industry and other academics. Aust
ATN1 Uni, on the other hand, will apply for a provisional patent if there is peer support for the
discovery, allow the researcher a year to work on the idea, and then support
commercialisation if an industry partner has been found. Essentially, their philosophy is “if
there is an industry partner interested then we will pursue it”.

In all universities the essential test to be satisfied before proceeding with commercialisation
involves assessing the commercial potential of the discovery. Given the wide range of
discoveries potentially involved this decision is part art, part science, and a great deal of
experience. The support of an industry partner is often sufficient evidence of commercial
potential. However, few ideas are actually accepted for commercialisation. As the TTO at
Canadian Uni2 said:

“We have a fairly rigorous assessment process internally. We have been accepting, over the
past few years, only 10% of the invention disclosures that we see. So our screening process
has a fairly fine grid, and when we accept them, we think they have a fairly good chance for
commercialisation - it is only these that are going to go to the review panels”.

Several Australian universities noted the fact that the presence of Co-operative Research
Centres has had an adverse effect on the university obtaining a full understanding of the
intellectual property being produced within the university orbit, and commented on the
challenges this has created in developing an understanding of the intellectual property being
developed throughout the university. It was described by one university as the balkanisation
of university research. Concern was also expressed over the limited resources available in
CRCs to identify, protect and exploit intellectual property.
(d) Commercialisation Route

The two principal routes for commercialisation of university research are either to license the intellectual property involved or to form a spin-off company to exploit the idea. United States universities usually prefer licensing because it is relatively simple, lower risk, can be executed speedily, and fits readily within the rules of the *Bayh-Dole Act*. US Public Uni said that the Act doesn’t impose any unreasonable burden on their ability to undertake commercial activity, but “as a policy, we just don’t assign rights to technologies, we only license”. Spin-offs, however, add a layer of complexity and risk that make them less attractive in many cases, although they may be a necessity where a market does not presently exist in the product or service involved, or where an invention may have the potential to generate larger financial returns to the university. This is explained by the TTO Director at Canadian Uni1:

“A spin-off is going to take to close to ten times the amount of work and effort [while], in terms of the return, we’re not doing this based on financial return as our sole indicator, so the spin-off has economic return, it has political return and, in fact, it does have, in many cases, a very strong financial return” (Canadian Uni1 Interview 2007).

An agreement to license intellectual property can be negotiated as long as an existing market and distribution chains exist. Where these do not exist, or where they do not suit the objectives of the university, the option of forming a spin-off company remains. But a spin-off company requires the university to acquire skills in a number of areas where it may have limited experience, such as raising capital, identifying and enlisting suitable commercial board members and managers, and new modes of reporting and valuing assets. Many universities also require permission from boards of governors or governments in order to create new companies. Spin-off companies also pose the risk of losing one of the most precious resources in the university: skilled and experienced researchers who may be lost to the university if they dedicate time to a new enterprise. Some of the risks associated with spin-offs are stated by the TTO Director of NZ Uni who said:

“I have very strong views on [spin-offs]. Coming from two angles, the university has two scarce resources: the obvious one’s money, and the second one, which is probably the most important, is world-class researchers. So, every time we do a spin-out, if we take a world-class researcher out of the university, we are going to be real unpopular, real quick… it is much harder to get a world-class researcher than it is to get a million [dollars], so my approach has always been to keep the academic in the university, but to create [access which] is as good as possible for the company to the academic. And that way, if the company contracts research back to the university, the university gets to build its research base, [while] if we take the academic out, we weaken it”.

The objective at NZ Uni, therefore, is to allow a spin-off company access to the researcher, but to try, as much as possible, to keep the researcher undertaking research in the university. Another reason to adopt this approach is because, “…at the end of the day the academic world is quite different, it’s very rare to find an academic that actually has genuine business skills and the people skills to run a business…”.
While the complexities involved in spin-offs may suggest that this route is likely to be favoured by larger universities or those that have been engaged in commercialisation for some time, the evidence does not support this. By 2007 the TTO at NZ Uni had been involved in several spin-offs including selling some of them at a substantial profit. In the Australian context some of the smaller universities have favoured the spin-off route over the licensing route. In particular, Aust Small Uni believes that, for smaller universities, the spin-off route delivers better results because it encourages entrepreneurship and the development of entrepreneurs, which is consistent with the general philosophy of the university. The view of the TTO at Aust Small Uni was that:

“Setting up spin-off companies actually might generate employment for our graduates, generate some research funding for the university... and adds value to the intellectual property so that you might actually get it licensed by a real player”.

However, this view is not shared by some other university executives who are “dead against” spin-off companies because they represent a cost with only some prospect of returning cash to the university.

There is a diversity of views amongst Australian case study universities on this issue. Aust ATN Uni2 prefers licensing intellectual property to the spin-off route, which it believes is more complex and risky. This preference is evidenced by the fact that the university had only two spin-off companies in a decade. Aust ATN Uni1 reported that it has no particular preference but noted that academic entrepreneurs prefer the spin-off route, although licences produce more immediate cashflow for the university. Aust Regional Uni1 has not produced any spin-off companies (except through a CRC) possibly because it has a large and continuing source of licensing income. Aust Go8 Uni1 reported that it has no preferred commercialisation route, although it noted that the university’s former intellectual property policy (which vested intellectual property ownership in the creator rather than the university) often inspired spin-off companies in preference to licensing arrangements. Aust Go8 Uni2 appears to have no preference and opts to choose the route which is likely to provide the best return. It has clearly had success with spin-offs, reporting a portfolio value in excess of $30 million.

There is no consistency of view amongst the case study universities as to the better or preferred route for commercialisation, although there may be a greater inclination to commercialise using spin-off companies among larger universities and those universities where TTO management has broad entrepreneurial experience.

### 9.3.4 Commercialisation Performance

There is no agreed set of parameters by which to judge the commercialisation performance of universities. This makes a comparison between universities potentially difficult, although experts in the field are capable of nominating universities that excel in commercialisation.
This is exactly the technique Tornatzky, et al. (2002) used in their study of US universities to enable them to identify universities with excellent commercialisation performance – they asked a panel of experts to nominate outstanding universities and then compiled a league table based on the results. But there are several tangible standards that are used to evaluate performance, and some of these are examined below before an assessment of universities’ performance is undertaken.

(a) Metrics

Pressure on US TTOs and the metrics by which they are assessed is being driven in part by the progressively greater use of open-source innovation, and the failure of patenting arising from delays and the increasing occurrence of defensive patenting and litigation. US Strategist’s expectation was that this will drive a new type of TTO to develop, with different mandates and metrics, as well as a new style of intermediary, in particular driven by philanthropists. This theme of a new approach to commercialisation is evident in a number of developments including the rise of large philanthropic institutions backing open-source developments and in the rise of for-profit intermediaries such as Imperial Innovations and others in the UK.

Nonetheless, numerical assessment has become the proxy for measuring performance (for example the reports on the economic impacts of publicly-funded research for the Australian Government by Allen (2003a; 2003c), but even then it becomes sometimes a matter of measuring what is available rather than what may be desirable in the circumstances. This concentration on numbers has resulted in many stakeholders finding the results unsatisfactory as evidenced by the declining number of respondents among US universities to the annual AUTM surveys – only about 150 out of more than 400 universities respond to the survey. Other limitations of the present systems of metrics include that they are expensive to collect and tend to be strongly lagging indicators. For example Australian figures for 2003 and 2004 compiled in the latest survey published in late 2007 are already at least 3 years old. It is also clear that the responses by universities are not always measuring the same thing and some level of subjectivity in answers has occurred. To be fair, AUTM has embarked on a comprehensive information gathering enterprise by compiling case studies of technology transfer (AUTM 2007a), with a similar exercise being undertaken in Australia by KCA and the AIC (KCA 2006), but even this fails to provide a measure of the performance of individual universities or the sector overall by providing a comprehensive picture, nor can it capture adequately the role of the university in economic development nor of their performance in the US Strategist’s “grand challenges”.

The 2005 recommendations of the Australian Government concerning appropriate metrics (DEST 2005a) may prove a useful change – one set of data (DEST 2007) has been
published since its publication. It is instructive to compare the metrics proposed to DEST by the Co-ordinating Committee on Science and Technology (CCST) (DEST 2005a) with those used by the Australian Government in two surveys into university research commercialisation: its 2004 survey of university commercialisation for the years 2000 and 2002 (DEST 2004b); and the metrics in the later survey on the 2003 and 2004 years (DEST 2007). These are compared in Table 9.5. The 2004 survey correlates with only five of the metrics proposed by the CCST, while the 2007 report shows much better correlation (10 of 14 metrics). Most of the remaining metrics can be obtained from other data prepared by universities, although metric 4, pilots, prototypes, clinical trials, etc, appears to remain uncollected.
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<td>14. LOAs by Research Area</td>
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<td>4. Pilots, prototypes, clinical trials, etc</td>
<td>11. Licence Income</td>
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<td>5. Gross Revenue from licensed technology</td>
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<td>6. New products, services or business processes created</td>
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<td>15. Start-up Companies Formed</td>
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<td>16. Value of Equity Holdings</td>
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<td>8. Research contracts and consultancies – number and gross revenue; sectors &amp; company size</td>
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<td>9. Peer-reviewed publications and reports – number and type</td>
<td>19. Value of Equity Holdings</td>
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<td>10. Repeat and flow-on business (% of contracts with previous clients)</td>
<td>20. Start-up Companies</td>
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<td>11. Commercialisation &amp; entrepreneurial training for researchers</td>
<td>21. Start-up Companies – equity held</td>
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<td>12. Research graduates employed in industry</td>
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<td>22. List of Start-up Companies Formed</td>
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<td>13. Research post-graduate income</td>
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<td>14. Research post-graduates employed in spin-outs</td>
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Table 9.5 – Comparison of Metrics Used and Proposed by DEST Sources: DEST, per above
(b) University Performance

There is something of a dichotomy in the way universities perceive TT&C performance. On one hand it is done as a community benefit, while on the other it is usually expected to turn a profit. The two objectives need not be incompatible, but they are not the same thing.

Generally, North American universities are expected to engage in technology transfer principally for the betterment of the community and to make a return to the community for the support provided to the universities. Public-good sentiments permeate the philosophy of North American benchmark universities. For example, according to the US Private University OTT Director:

“Income to the university should be low on the priority list...If a university gets a 5% royalty, or finishes up owning 5% of a start-up company when it goes public and they can sell, they are doing a pretty good job. But what that means is, 95% of the economic impact is outside the university” (US Private University Interview 2007).

This emphasis on public good is reflected, also, in the fact that the North American benchmark universities are not bound by fixed commercial targets set by the university. If they were bound to reach particular targets this is likely to suggest that their purpose is more mercenary than public spirited. NZ Uni, similarly, does not impose specific objectives on its TTO.

This is not to say that results are unimportant, but they may be measured more to reflect the needs of granting agencies and government, which need some apparently objective numbers on which to base decisions, than for any need generated by university management.

North American benchmark universities and NZ Uni are all successful in financial and public benefit terms, as set out in their case descriptions (although Canadian Uni2 is still in the process of bedding-down its new commercialisation structure). How do Australian universities perform in TT&C?

The two systems of metrics most relevant to this research are those produced by AUTM, covering US and Canadian universities, and those developed by the Australian Department of Education, Science and Training (DEST) for Australian universities. For purposes of comparison here, even in light of the limitations discussed above in Section 4.7.3, numerical data compiled by AUTM and DEST are used. The tangible results that most closely reflect the financial and economic benefit to the university and the community are: the license revenue; and the value of the equity portfolio. On this basis, using the latest data available (2000-2004 inclusive) (DEST 2007, Tables 54 and 59), the University of Queensland stands

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158 Others such as those developed by Unico and the Association of European Science and Technology Transfer Professionals (ASTP) are also of interest, although they, too, are numerical.
out as the stellar performer on both measures. Australian universities appear to cluster into three groups on each measure, as follows:

- Universities with **licence income** exceeding one million dollars per year each year 2004-2007: Melbourne, New England, Queensland and New South Wales;
- Universities with **licence income** exceeding one million dollars per year on average: those above, plus Flinders, Macquarie, Wollongong and Sydney;
- Universities with **licence income** below one million dollars per year: the remaining 31 universities;
- Universities with **equity holdings** of at least five million dollars per year each year 2004-2007: Sydney, Queensland, Western Australia;
- Universities with **equity holdings** of at least five million dollars in at least one year (to allow for the fact that holdings vary as companies are created and sold): those above, plus New England, Monash, Swinburne, Melbourne, Flinders, Adelaide and South Australia;
- Universities with **equity holdings** of at least one million dollars in at least one year: those above, plus New South Wales and ANU;
- Universities whose **equity holdings** never exceed one million dollars over the reporting period: the remaining 27 universities.

On these data Australia has one clear world-class performer in university commercialisation: UniQuest at the University of Queensland. These data also disclose at least two other interesting facts. The research-intensive Group of 8 universities do not monopolise commercialisation performance – for example, there are three smaller and regional universities in this list, and, rather unexpectedly, only one member of the ATN, the University of South Australia.

There are many other ways of examining university commercialisation performance, but every one of them has limitations. What this brief analysis shows is that, on the basis of the best available data, membership of a particular grouping is not a predictor of superior financial performance in commercialisation. It would not be valid, therefore, to conclude that all Group of 8 research-intensive universities achieve superior financial results (as one may otherwise expect given that they receive the majority of research funding), but that there are other factors at work in addition to research spending that affect an individual university’s commercialisation performance.
9.3.5 Commercialisation Office Performance

According to US Strategist, “...less than 5% of any university in this country [the US] pays its own way for the office of technology transfer” (US Strategist Interview 2007). According to US Private University, in the case where TTOs are attributed only that portion of commercialisation revenue that the university retains, then about one-third of offices make more than they spend, and it has been at this level for many years (US Private University Interview 2007). These views are consistent with results in other countries where most universities’ commercialisation entities run at a loss, such as in the UK (HES 2006). If no more than one-third of US universities that respond to the AUTM survey (and these may be presumed to be the better-performing universities) make sufficient money to pay the costs of the TTO, two questions arise: why do universities maintain the TTO, and what characteristics are possessed by those TTOs that more than pay their way?

One of the most striking characteristics about US university TTOs is their size. The median number of employees is three (AUTM 2007b). This means that a considerable majority of TTOs are one or two-person operations and likely to be sub-optimal in having to undertake an array of tasks beyond the reasonable ability or experience of such a small group. The figures concerning TTO size are similar in Australia. According to DEST (2004b; 2007), the median number of full-time commercialisation staff in the 32 universities that reported for 2002 was 1.5, and the average number was three159. This shows that, like the US, there are a small number of offices that have a large number of staff while most have none, one or two employees.

On the first question: “why do universities maintain TTOs that do not pay their way?”, this has been discussed earlier, and there is no one simple answer. It may arise, in part, because so many TTOs are relatively new and university management is prepared to wait for some time to see if results improve, while other universities may retain the TTO for more altruistic reasons involving public benefit.

There is evidence from the benchmark universities and Australian case studies that TTOs, certainly TTOs at larger universities, start to break-even financially after at least ten years of operation in a supportive environment. On the other hand, in its first half-year of operation the TTO at NZ Uni made $500,000 profit, followed by $2 million profit in the first full year; and it has increased each year since. That is, it has been profitable since its formation. Profit has

159 For the purposes of this analysis the number of staff attributed to the University of New England was reduced to one (the actual number engaged in the commercialisation office) rather than the 32 reported in the 2004 survey because the larger number of staff reported work in a separate company that sells a particular product. This anomaly in reporting arises because of the difficulty in interpreting questions on some occasions. The net results scarcely changed in the most recent survey (DEST 2007).
been calculated after all costs, which included salaries, commercial rent and all other costs such as patenting, legal costs, travel and the like. “Profit would be a lot higher than that [disclosed] because we are very conservative in our accounting treatment. If we were a private business there would be quite significantly more…” (NZ Uni Interview 2007). This demonstrates that there are circumstances where a university with a modest research budget and a newly established TTO can become profitable rapidly given the right circumstances.

Based on the information supplied by universities to DEST in the National Surveys (DEST 2004b; 2007), during the period 2000-2004, only two of the eight commercialisation entities amongst the case study universities clearly returned more income than they consumed in costs: the two Group of 8 universities. Arguably Aust Regional Uni1 makes a positive return out of a continuing income stream from one product, although their costs appear high and arguably leave little net profit, while Aust Small Uni sold out of an equity position that returned considerable income to the university. Given that Aust Small Uni places greater emphasis on spin-out companies than licensing, the university was profitable on a net basis over the five year reporting period. In summary, at least half of the eight universities appear to have commercialisation entities that cost more to run over the three-year period (2000-2004) than they returned in income\(^\text{160}\).

Both Australian Group of 8 case study universities largely meet the criteria suggested by the North American universities as being required to operate a successful commercialisation office: being established for at least a decade, a large research budget and a threshold number of staff in the office. Arguably, this is a workable test. But it does not explain the presence of successful smaller universities – NZ Uni and Aust Small Uni – that have turned a profit from an early time, a relatively small research base, and a relatively small office. What characterises these universities that make them successful in commercialisation despite not meeting the apparent criteria?

There are two characteristics possessed to a noticeably greater degree by both of these offices than universities generally: an entrepreneurial TTO Director, and supportive university management. In the case of NZ Uni, the presence as TTO Director of a hard-driven serial entrepreneur supported by management at every key level has allowed commercial ventures

\(^{160}\) This has been calculated by the author based on the reported recurrent income and attributing a proportion of reported equity holdings compared to the estimated cost of maintaining the commercialisation office at reported staffing levels. Such calculations will always be contentious because they may not capture all the income or may overstate costs. But, if used as a coarse indicator only, it is as good as can be reasonably achieved in the absence of published accounts. Of the universities examined in detail for this research, only Canadian Uni1 publishes anything in the nature of financial accounts. Aust Go8 Uni2 provides summary profit and loss data in its Annual Reports.
to thrive. At Aust Small Uni, a manager with vast experience in business and entrepreneurial behaviour, again when supported by university management, was able to leverage the entrepreneurialism inherent in the university to create valuable new enterprises. In the case of Aust Small Uni in more recent times, where the university President has expressed less overt interest in commercialisation and shunted the TTO to a lower-level report, performance in commercialisation and apparent enthusiasm for it within the university appears to have declined. It was the presence of both a dynamic and experienced commercialisation manager and university executive support for commercialisation that had stimulated success.

This analysis, of course, has the weakness noted earlier of emphasising numerical results, and financial numerical results at that. It is valuable to reflect on the benefits to the university other than financial that arise from a successful TTO. For example, in addition to the direct financial return that Aust Go8 Uni2 TTO provides the university, it makes: “… a large non-financial contribution to the university through education programs, grants, sponsorships and assistance with external grant applications and initiatives. While not formally accounted for, these activities represent a meaningful contribution to the university community”. According to the Aust Go8 Uni2 TTO Director, another important non-financial benefit that flows from its successful commercialisation activities is that it is: “… helping to attract star researchers to [the university], who want the assurance that their innovations can be successfully commercialised”, and: “… [the university’s] research reputation is benefiting also”. Another of the valuable benefits provided by the TTO to the university is administrative and back-room services to spin-off companies and similar entities at minimal or no charge, including: company secretarial services, office administration, accounting and payroll services, preparation and filing of statutory accounts and returns, board papers, accounts receivable and payable, debt collection and financial statements (Aust Go8 Uni2 Interview 2006).

The TTO at Aust Go8 Uni2 was started with a substantial capital injection from the university (it obtained additional capital later) and a general remit “to make profits” and to generate “a return to the university”. The TTO at Aust Go8 Uni1 has been capitalised by the university and guaranteed a certain income stream for a number of years as it establishes its business. The TTOs at both universities operate as companies owned by the university. Of the remaining Australian case study universities only Aust ATN Uni1 has a company involved in commercialisation, while Aust ATN Uni2 had a company for many years which ceased operation several years ago. All other case study universities operate their commercialisation offices as a unit of the university.

It is interesting to note that not one of the five international benchmark case study TTOs is given specific mandated performance targets by university management. For example, at US Private University the TTO is given a patent budget within which it must manage, and the
manager informs the university how much he expects to make in the coming year. “As long as I make more money than I spend, they seem to be happy” (US Private University Interview 2007). At Canadian Uni1, the TTO Director prepares the annual goals and then negotiates these with the Vice-President Research, and Canadian Uni2 operates somewhat similarly. This degree of operational freedom arose before any of the TTOs had demonstrated superior performance and probably reflects the understanding among senior university management of the difficulty in setting firm targets in such a dynamic and fluid environment. This is not to suggest that TTOs do not internally set goals, each of them does, both for the office and for the professional staff.

9.3.6 Knowledge and Awareness

Awareness among researchers of what commercialisation means and involves is an essential pre-requisite to them becoming involved in TT&C. This can be done through awareness training or less formal activities in which TTO staff interact regularly with researchers. TT&C is also stimulated by recognition through activities such as publicity, recognition of commercialisation successes, and competitions (particularly, but not exclusively, directed to students).

North American universities have generally found that simply offering straight-forward courses for researchers and academic faculty has limited value. US Public University found that commercialisation courses and bootcamps “… haven’t been very successful. And I think the reason, typically, is that the faculty aren’t interested, in general, unless they are specifically involved in something that they need it for, then they want it. But, prior to that, they’re really not interested, and so they tend not to show up” (US Public University Interview 2007). Similarly, US Private University noted a decline in attendances at such courses, although Canadian Uni2 found value in running ad-hoc courses. But all North American case study universities report considerable value in employing a range of activities that encourage entrepreneurial behaviour, as explained in Section 9.3.12, below.

The Australian Government, through DEST introduced in 2007 a novel approach to training academic faculty and researchers in commercialisation: the Commercialisation Training Scheme (CTS)\textsuperscript{161}. The CTS is a 6-month post-graduate certificate for research graduates intended to equip them to understand and participate in research commercialisation. It offers training in three particular areas:

\begin{footnotesize}
\textsuperscript{161} Details are located at: http://www.dest.gov.au/sectors/research_sector/policies_issues_reviews/key_issues/commercialisation/commercialisation.htm
\end{footnotesize}
• Commercialisation know-how (a strategic understanding of commercialisation processes);
• Technical commercialisation skills (e.g. intellectual property management, financial management, project management and market research); and
• Organisational behaviour skills (e.g. leadership, teamwork and presentation skills).

The Australian Institute for Commercialisation (AIC)\(^{162}\) also offers a range of courses in commercialisation directed to publicly-funded research entities and private sector innovators as well as advice and support during the commercialisation process. The AIC is a government-sponsored initiative that helps business, research organisations and governments address market gaps and accelerate the commercialisation of know how and technology by providing advice, solutions and tools, and by assisting people improve their commercialisation skills. Some of the Australian case study universities have sent staff to commercialisation courses conducted by the AIC.

Among the Australian case study universities there is a general view that the most effective means of training researchers in commercialisation arises from developing personal relationships. Apart from this, universities have three broad approaches to commercialisation training: those that offer no specific training through the university (Aust ATN Uni2 and Aust Regional Uni2); those that offer ad-hoc training (Aust Regional Uni1, Aust Go8 Uni1, and Aust IRU Uni); and those that have a structured and regular approach to training: (Aust Small Uni, Aust Go8 Uni2 and Aust ATN Uni1). The most active university in promoting awareness through training is Aust Go8 Uni2 which reports conducting up to twenty seminars relevant to commercialisation annually. Aust Go8 Uni2, observed that: “…we get those who are interested in commercialisation”, and not much interest until that threshold is met. Nonetheless, Aust Go8 Uni2 TTO acknowledged the importance of education, and was of the view that its ability to take the long-term view allows it to invest in activities such as knowledge and awareness programs, “… where the return from that is at least five years up to fifteen years out” (Aust Go8 Uni2 Interview 2006).

**9.3.7 Incentives for Commercialisation**

Irrespective of whether universities or researchers own the intellectual property, all universities offer to share the benefits of TT&C with the creators of the intellectual property or ideas. The benefits offered to researchers and academic faculty come in two principal forms: income from profits derived from TT&C; and promotion based on engagement in commercialisation. A cogent reason to offer academic researchers incentives to engage in

TT&C is because their continuing involvement is usually necessary, although TT&C is not part of their mandated role. It has been reported that “... faculty involvement in further development (even after a license is executed) is necessary for commercial success for 71% of the inventions licensed” (Jensen, et al. 2003, p.1272).

Feldman, et al. (2002, p.105) succinctly stated most of the factors at work in allocating the benefits of TT&C, including the provision of researcher incentives:

“... a search to optimize, or, more pragmatically, to balance the objectives of managing intellectual property rights, developing new revenue sources, and accommodating faculty interests while simultaneously maintaining norms related to the conduct of academic research and the dissemination of research findings”.

Australian research (Yencken and Ralston 2005) suggested that there are three main categories of incentive effective in promoting TT&C at universities: financial incentives to the researchers; business and commercial support; and financial support to assist in further development.

The incentives that motivated researchers to engage in TT&C that emerged repeatedly from the case studies were profit sharing and promotion.

(a) Profit Sharing

Despite the fact that most universities claim ownership of the intellectual property that is commercialised and which forms the basis of income and profit from TT&C, universities invariably offer to share some of the profits arising from commercialisation with the creator of the intellectual property or idea, unlike industry where the profits from intellectual property created by employees will normally accrue to the company. This seemingly anomalous position arises probably for two principal reasons. Most importantly, academic researchers are not obliged to participate in the commercialisation of their research discoveries but may be motivated by profit-sharing to assist the university. Second, not all researchers on a project may be university employees: students and visitors may retain some title or interest in new intellectual property or ideas, and offering a financial incentive may stimulate them to transfer to the university any residual interests they may have.

At the same time, profit sharing may not always be a potent incentive to encourage an individual to participate in commercialisation. In particular, life sciences have commercialisation time frames that are usually much longer than those of physical sciences, with periods between discovery and exploitation sometimes measured in decades. Linked with the uncertainty as to whether a discovery may achieve financial success, researchers may have to be bold to undertake commercialisation where it could otherwise prejudice their academic or research career. Of course, where a breakthrough in life sciences has a major impact, the potential profits can be enormous. Given the clear differences in
commercialisation characteristics between, say, life sciences and physical sciences, it is curious that benchmark universities appeared not to make any distinction between the type of research involved when calculating the share of profit offered to the researcher. The relative importance of financial incentives is illustrated by the reported different perceptions among US university participants, namely that “…71% of TTOs and 69% of central administrations thought royalties were extremely important, but only 41% of inventors did” (Jensen, et al. 2003, p.1273), reinforced by their finding that “…the share of royalty income allotted to inventors is lower for universities with higher quality faculty” (p.1274).

In the United States the Bayh-Dole Act requires that royalties arising from an invention funded by the federal Government be shared with the inventor although it prescribes no amount or proportion. In all benchmark universities investigators are offered between a low of 30% (US Private University) to a high of 50% (Canadian Uni1). The exception is Canadian Uni2 because of its intellectual property ownership structure: the university offers between 25% if the university undertakes exploitation, to 75% if the investigator undertakes exploitation. In all universities the profit share is calculated after the costs associated with commercialisation. The substantial variation in profit sharing suggests that the proportion of profit gained by the investigator is probably not the main factor motivating an investigator to be involved in TT&C.

The most common profit share granted to an investigator at an Australian university is one-third of the profit (that is, the revenue after associated costs). In the case of the Australian case study universities one-third of profit was granted by four universities (Aust Go8 Uni2, Aust ATN Uni1, Aust IRU Uni and Aust Regional Uni2), two universities granted a discoverer 40% of profit (Aust Go8 Uni1 and Aust Small Uni), while Aust ATN Uni2 granted up to 50%. Aust Regional Uni1 did not prescribe a proportion of profit granted to an investigator, merely noting that the amount is subject to negotiation. In many cases universities grant a larger (up to 100%) of profit to investigators where the amount of money involved is relatively low, typically up to around $20,000. There is no obvious reason why there should be differences in the amount of profit share granted to investigators among different Australian universities, but may merely reflect historical practice by individual universities. There is no evidence that a greater or lesser profit share, of itself, affects the willingness of investigators to engage in commercialisation or correlates with university commercialisation performance. Australian universities make no distinction between the profit share granted to different types of research upon commercialisation, which may be further evidence that profit share arrangements are not the principal factor motivating investigators to become involved in TT&C.
It was noted during analysis that all Australian case study universities (and a vast majority of Australian universities) purport to deal with the issue of profit sharing through university policy. Where there are relatively small amounts involved this is unlikely to give rise to contention between the university and investigators. However, there is potential for large sums of money to be involved in some cases, with possible complexity arising where, for example, an external company may have sponsored part or all of the research, where an investigator has brought some of their own intellectual property (the value of which has to be considered), the precedence to be given to individual contracts of employment (which may cover some investigators only), the circumstances in which intellectual property may be taken out-the-door by participating investigators and used in other research or commercial applications, and whether there are varying contributions and input from other investigators. These matters have the potential to give rise to litigation and may distract from the research and commercialisation that can result. Australia has had two recent cases relevant to this issue, the first, Victoria University of Technology -v- Gregory and ors [2004] VSC 33, was resolved in favour of the university having rights over software developed by two contract academic faculty. The second, University of Western Australia -v- Gray (No 20) [2008] FCA 498 decided in 2008, concerned a right to a medical technology discovered by Professor Gray. The Federal Court at first instance held that the relevant technology had been developed either before Professor Gray started at the University of Western Australia (UWA) or otherwise could not be claimed by UWA. The Court also held that, even if wrong in concluding who owned the right to patent, Professor Gray was not employed by UWA to “invent” things, and therefore anything he invented was his to patent and exploit, not the university’s. Because of its significant ramifications this decision is now subject to appeal.

(b) Promotion

Promotion in Australia of university faculty members is based on a number of fairly consistent criteria irrespective of institution, namely: teaching, research, and community service. Within the research and community service criteria recognition of work done in TT&C is often mentioned as relevant to promotion. Because the potential financial rewards from TT&C are usually small and often speculative, it is important that participation in TT&C not hinder academic promotion, even if it is not a major factor in achieving promotion.

Even in North America, academic faculty participation in commercialisation is not usually recognised as an important factor in promotion. Noting that the Bayh-Dole Act requires universities to offer investigators financial reward in order for a university to be entitled to own intellectual property resulting from federally-funded research, US Public University observed that:
“If the faculty get no reward for patenting and commercialisation they’re not going to bother, because it doesn’t help them as much with their career. Their tenure and their status within the community is [determined] primarily on their research [and] their publications; and whether they have a patent doesn’t enter into it nearly as much...”.

Among the Group of 8 universities in Australia seven of the eight universities mention patenting or intellectual property as being among criteria for academic promotion. Every one of the five ATN universities mentions patenting explicitly or by necessary implication among criteria for promotion. Promotion criteria among Australian case study universities where TT&C is mentioned is shown in Table 9.6. It suggests that Australian universities have regard to engagement in commercialisation by academic faculty when assessing individuals for promotion.

<table>
<thead>
<tr>
<th>University</th>
<th>Commercialisation</th>
<th>Patenting</th>
<th>Consultancy</th>
<th>Involvement with industry</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aust Go8 Uni1</td>
<td></td>
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<tr>
<td>Aust Go8 Uni2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Technology transfer activities</td>
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<tr>
<td>Aust ATN Uni1</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Aust ATN Uni2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(a) Spin-off companies (b) application of knowledge to serve a useful social or commercial purpose (c) Problem solving for industry</td>
</tr>
<tr>
<td>Aust IRU Uni</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>involvement in the solution of practical problems experienced by industry</td>
</tr>
<tr>
<td>Aust Small Uni</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>securing, designing and delivering significant commercial projects to industry</td>
</tr>
<tr>
<td>Aust Regional Uni1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aust Regional Uni2</td>
<td>transfer of results of research and development to industry</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 9.6 – Criteria for Promotion

Source: university published promotion criteria (see footnote 163)

Footnote 163: This table was compiled by the author from data on promotion criteria published by the respective universities. The promotion criteria selected were those applicable to promotion between Level C (senior lecturer) and Level D (Associate Professor), although the criteria for promotions between most levels are similar.
While Table 9.6 suggests TT&C may be influential in academic promotion, there is a likelihood that reality does not match policy, and that engagement in TT&C may not be considered favourably. Views among the Australian case study universities on this issue are mixed. At Aust Go8 Uni2 there was the view that while the regulatory side is satisfactory, there could be: “...more on the promotion side. If academics got recognition for their commercial successes this would encourage them” (Aust Go8 Uni2 Interview 2006). At Aust ATN Uni2 the view was that publications are more valuable than research commercialisation for promotion, not the least because it may take five or ten years before commercialisation results are achieved, while Aust ATN Uni1 noted that “Research gives more [credit towards] promotion than consultancy” (Aust ATN Uni1 Interview 2006). Aust Go8 uni1, in its 2005 Operational Plan stated that one strategy to promote research excellence was (author’s italics added):

“To stress the importance of applied research, technology transfer and the development and commercialisation of intellectual property, through the appointments and promotion practices of the University, through recognition of the primary interests of the creators and through access to targeted support available from [the TTO]” (Aust Go8 Uni1 Interview 2006).

Aust Regional Uni1, on the other hand, may already recognise commercialisation as a key criterion for promotion, with three recent promotions (two to senior lecturer and one to associate professor) apparently heavily influenced by the involvement in commercialisation of the academic faculty members involved (Aust Regional Uni1 Interview 2007).

Whether commercialisation will be used as a criterion for promotion in the foreseeable future may be prejudiced by the introduction of the Research Quality Framework (RQF) because, as Aust IRU Uni observed, results obtained through research commercialisation are “... not counted in any fashion... under the RQF”, and this is expected to flow through into the way both the university and the research community view commercialisation (Aust IRU Uni Interview 2007).

While the data here show no consistent view, there is, at least, some recognition among universities that commercialisation plays a potential role in promotion. It is likely, subject to the possible role of the RQF, that it may become more important in those cases where it is emphasised by university executives and carried into policy in the manner of Aust Go8 Uni1, or where an individual demonstrates outstanding ability and results in commercialisation, in the manner of Aust Regional Uni1.
9.3.8 Linkages with Industry

Most comprehensive reports on university commercialisation emphasise the critical importance of having good links with industry if commercialisation is to succeed (Howard 2001; Lambert 2003).

Many universities will only move forward on commercialisation when an industry partner is prepared to become involved. Indeed, unless industry partners are found, there will be no licensing, and the likelihood of creating a successful spin-out is greatly reduced. Before the creation of TTOs, individual academic faculty members often developed personal relationships with industry in order to raise research funds on the understanding that the industry partner would benefit from the research. Individual relationships remain the most potent connection between researchers and industry.

(a) The Importance of Industry Links

Universities understand the importance of links with industry. Aust IRU Uni said:

“... if you are not connected to industry, the chances of success [in commercialisation] are [virtually nil]”, and “if your commercial project isn’t being backed intimately by a relevant commercial partner its chances of success [are significantly diminished]” (Aust IRU Uni Interview 2007).

The view was expressed by experienced TTO Directors that the most important outcome from TT&C is developing better and stronger links with industry. Of course this leads back into the issue of metrics and how TTOs are assessed on their performance, which makes their ability to prove their value to the university sometimes difficult when they do not make an overt profit. Nonetheless, TTO Directors genuinely expressed the view that commercialisation is a lever to better industry relations, while “…if we can get contract research back as an outcome, that is a good outcome. Any sort of royalty or fee is a bonus” (Aust Small Uni Interview 2006).

Sometimes there are strong industry linkages reflected in activities such as consulting and contract research that are not reflected in the figures of North American universities because consulting is conducted by academic faculty independently, while contract research is rarely measured by the TTO. For example, the TTO at the Canadian Uni2 handles about $65 million per annum of contract research which is not reflected in any of its metrics. This can be contrasted with the TTO at Aust Go8 Uni2, for example, which derives about 50% of its revenue from managing contract research and consulting. Managing research contracts is not always a simple task and consumes significant resources of a TTO, as reflected in observations by the TTO at Canadian Uni2, which said: “[the contract research undertaken] reflects much stronger basic industry relationships than people give us credit for. A lot of those contracts are fraught with difficulty because we end up fighting a lot about IP
ownership with industry, who tends to want a lot for very little…” (Canadian Uni2 Interview 2007).

(b) The Market for University Ideas is Global

The most common theme coming from universities is that they are operating in a global market\textsuperscript{164}. They are making linkages with business anywhere in the world capable of exploiting the ideas generated by the university and are not constrained to their regional or national economy. They are obliged to choose the best partner in the world to take ideas to market.

For example, NZ Uni looks at potential markets both nationally and internationally because:

“…all the technologies we push are global. It is very hard for the economics that we’re faced with to put a big-time commitment into something that’s not going to be on the global stage. So we’re looking at global-scale technologies, [while] a lot of the time the companies or people that are going to take them to market are overseas. So we have to maintain foreign networks as well…” (NZ Uni Interview 2007).

The same sentiment as to the importance of the global market was expressed by Canadian Uni2.

Of the eight Australian case study universities, only two made no explicit reference to their market being global. Australian universities, like their counterparts throughout the world, are involved in developments that have international implications. Comments included:

Aust Go8 Uni1: “In thinking about the path for a technology we never confine ourselves to Australian industry, we are always thinking about it as a global opportunity, and that’s because intellectual property is a global commodity and travels around the world very quickly. The notion that if there was no Australian company that could take it, therefore we wouldn’t license it out, we would certainly look at US, European [and] Asian licensees as well…”.

Aust Go8 Uni2: In many cases a new idea needs to address a global marketplace, “…and if there isn’t one here already, can we create one? And this is where the venture capital industry comes in… In a lot of cases we can [call on venture capital], and when we do create [a new company], we create them with the intention, right from the start, of going after global markets”

Aust ATN Uni1: “…if we’ve got some technology, we will try and license it to somebody and, if it means licensing offshore, we will do it offshore; it is a global game. We will make the first contacts with Australian companies, and if it happens to be the subsidiary of a foreign

\textsuperscript{164} This same important point is made about Australian companies, large and small, having a positive outlook to globalisation: Johnston (2004).
company we will continue that discussion either through them or directly with the foreign firm.

Aust IRU Uni: “People are finally working out that the academic enterprise is a global enterprise, not local…, so if you truly want industry-changing [outcomes] you’ve got to think in terms of global markets”

Aust Small Uni: The TTO expressed the view that Australian industry does not have the capability to absorb the output potentially available from Australian universities. An example at the university involved a new medical product. There was no company in Australia that could take this product and the obvious market was the USA. The university is presently seeking funding to perform clinical trials to prove the efficacy of the device compared with an existing product before offering it to US companies who may have an interest in manufacturing and distributing the product.

Aust Regional Uni1: “…we are in a global industry, we are looking at global markets – you’ve got to find the best partner in the world, not in Australia, and that’s what we are doing…”

While Aust ATN Uni2 didn’t explicitly refer to its activity in global markets, a few years ago it sold its premier spin-off company to a US business in order to allow the global exploitation of the world-leading ICT technology that had been developed from research undertaken at the university.  

Aust VC2 made the same point with clarity:

“… the Australian economy is 2% of the world economy, so you can’t build an attractive venture-type investment in a company that only targets that size market. We will look at things where we can start in Australia, and build a base in Australia, but really to address markets overseas as well” (Aust VC2 Interview 2006).

The data indicate strongly that university TTOs are concerned with a global market. Certainly this is a clear view among university TTOs in smaller markets (Australia and New Zealand). The fact that universities are in a global market is likely to have a profound effect on their ability to influence regional or even national economic activity. For example, if a university develops new technology and the company with the best ability to produce and market the product happens to be in the United States, an Australian university either licenses the new technology to that company or faces the prospect of competing against the best in the world, which would scarcely be logical.

(c) Personal Connections

The literature clearly identifies the importance of personal relationships in developing the links with industry vital to TT&C, and the international benchmark case studies offer similar

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165 Further details about spin-off companies is contained in Zhao (2004c)
views. For example, while the TTO at US Public University manages its Industrial Affiliates program (described below), it noted that other links with industry tend to be ad-hoc and rely on individual department attitudes and, therefore, individual faculty members.

The TTO at Canadian Uni2 noted that its linkage with industry “is something that we have done on an ad-hoc basis for many years. We’re trying to formalise a little more now”. It saw its formalisation of linkages as being a complement to the personal connections developed at an occupational level (Canadian Uni2 Interview 2007).

Australian universities acknowledge the importance of the personal connection. Aust Go8 Uni1 said that the most important links between the university and industry are the ones that are forged between individuals:

“The interaction starts at a person-to-person level and is sustained at the person-to-person level... All of the most valuable relationships that the university has revolve around particular academics [who] have strong relationships with counterparts in industry, and to me that is the most important way that universities build linkages” (Aust Go8 Uni1 Interview 2006).

Aust ATN Uni1 said: “…the relationship is between the academic staff and industry… that’s the critical element… the university can impose something over the top of that but, unless those relationships are solid, it’s just not going to happen” (Aust ATN Uni1 Interview 2006).

The same sentiment was expressed by the Aust Small Uni TTO Director – the best outcomes rely on relationships with industry and trusted intermediaries.

Conversely, Aust ATN Uni2 TTO noted that allowing academic faculty to deal with industry directly can sometimes lead to sub-optimal results. There are cases where academics have negotiated to provide university services in-kind that exceed the actual cash contributed by industry as part of a research activity. From the researcher’s perspective this achieves the desired result (research cash), but can produce a poor result for the university (Aust ATN Uni2 Interview 2006).

(d) Proximity and Regional Engagement

While the market for university ideas is global, universities do not neglect their local industry. It appears that connections with Australian regional or national industry may be particularly important when it comes to offering contract research and consulting.

NZ Uni is well-connected locally: “…we do a lot of small research contracts [but] I think we could do a lot more, but we have to grow our research capability as well”. While the TTO mandate does not include contract research, the TTO Director said that it would be advantageous if this were part of the company’s remit. Probably the best reason for the
commercialisation company to do this is the cultural fit with industry: “...we have a business
culture, the university hasn't” (NZ Uni Interview 2007).

While Aust Regional Uni2 has not engaged in intellectual property licensing or company spin-
outs, the support it has supplied to industry and local business through consulting and contract research, particularly in regional and rural areas, makes it a vital adjunct to business in half the State.

(e) The Role of SMEs

Under the Bayh-Dole Act United States universities are obliged to offer the first opportunity to
commercialise new ideas to small business where it is feasible to do so after reasonable
inquiry. This provision is given added support by the US Small Business Innovation
Research Program which was established in 1982 and has been called (Connell 2006, p.2):

“... the world’s largest seed capital programme for science and technology businesses. Each year it makes over 4,000 awards to US small businesses, totalling over $2 billion in value. It has helped thousands of US academics become entrepreneurs, and converted billions of dollars of US taxpayer-funded research into
highly valuable goods and services, benefiting both society and the economy”.

The importance of SMEs in the US is evident from comments by US Private University TTO:

“I think small companies tend to be the natural partners of universities; certainly, look at the
AUTM data and, say, sixty-five percent of the deals we do are with little companies...Bayh-
Dole requires us to give preference to small companies, but it's never been tested [as] to
what that means” (US Private University Interview 2007).

California makes available Discovery Grants designed for small and start-up businesses
which are allocated on the basis of 50/50 matching grants in the range $100,000 to a few
million dollars (US Public University Interview 2007).

The Canadian view of SMEs is positive despite a lack of encouraging results. The TTO at
Canadian Uni2 noted that:

“SMEs are often more agile - they're quicker on their feet to adopt a new technology, if you
 can find someone to fund it. If they can find some source of government funding..., they
 would be happy to do it. They are not ready acceptors of early-stage new technology that
takes a lot of development, which is typically what comes out of the university... The SMEs
are good people to talk to, but they don’t have any money. We have not licensed
successfully to an SME” (Canadian Uni2 Interview 2007).

In Canada interaction between universities and SMEs has been encouraged through
Provincial developments such as the Ontario Centres for Excellence.

But the view of Australian universities to SMEs generally appears anything but positive.

According to Aust Go8 uni1, SMEs have not and are unlikely to constitute any significant
partnership opportunities for the university (Aust Go8 Uni1 Interview 2006).
Aust Go8 Uni2 said:

“There are very few SME’s in Australia that have the financial [ability] or the time or the management resources to take a technology coming out of a university and turn it into a product. In terms of SME’s there is a much greater need for engagement via consultancies and knowledge and skills transfers because that is where you can have more marginal but incremental gain” (Aust Go8 Uni2 Interview 2006).

Aust ATN Uni1 has found it difficult to work with SMEs:

“…we find it very difficult to engage with SMEs; …timelines are different, universities are huge bureaucratic organisations that they don’t know how to deal with; we would if we could, but we don’t tend to. I should qualify that: we do have corporate programs that are run through the university in terms of student programs, and we do deal with a lot of SMEs on that, but that has been a ‘bite-size’ thing they can do, a six-month project that they can fund for $8,000 or so”. This included licensing IP to SMEs, although: “we haven’t done a lot of licensing to them” (Aust ATN Uni1 Interview 2006).

Aust ATN Uni2: “SMEs are really tough: short term, no money, don’t know what they’re doing”. The experience of the commercialisation management is that SMEs are highly localised, and they have no time, momentum or interest to be involved in research, although they are, themselves, highly inventive and innovative. SMEs are great adapters, but this is not the role of universities; universities are about inventing new ideas rather than adapting existing ones (Aust ATN Uni2 Interview 2006).

In the view of Aust Small Uni, SMEs are not and never will be a very good vehicle for the commercialisation of university intellectual property, because they do not have sufficient resources to undertake the necessary work properly (Aust Small Uni Interview 2006).

Aust Regional Uni2 did not see SMEs generally as suitable commercialisation partners. While SMEs are nimble, the university believed they generally lack the capital needed for development. To the extent that the university deals with SMEs, they are usually directed to its associated technology park.

Some relief from this prevailing view came from Aust IRU Uni, which recognised the attitude of some to SMEs: “…academics look to get big companies in to try to get big research money out of them, because academics are about research… They don’t necessarily like anything to do with SMEs because they haven’t got any money to do research …”, but has developed a strategy called work-integrated learning. This strategy works by integrating the university course into the local business community in which, for example, the final year of engineering requires a major industry project over at least half the year and, in many cases, the full year. “And whole companies are now founded on these graduates” in the local area (Aust IRU Uni Interview 2007).

There is a clear mismatch between the views of Australian university TTOs and SMEs. While SMEs could be receptors for university technology, as they are in the US, they tend to be
seen more as a distraction with little ability to add to the university research enterprise. If SMEs could bring more substance to a relationship, such as funding through programs similar to the US SBIR, they may be more likely to be recognised by TTOs as a legitimate partner.

(f) Techniques to Link with Industry

Even premier universities acknowledge that more needs to be done to link with industry. For example, US Public University has created a number of consortia:

“... particularly in the physical sciences. There are a couple of consortia that have twenty, thirty companies that come together, they pay some small annual fee to be part of this consortium, and then they get an option on any technology that gets developed [from the funding of the consortium], and that is quite useful in terms of interaction with industry”.

Companies pay in the order $20,000 to $50,000 per year to participate in a consortium. No consortia have yet been established in the life sciences.

Canadian Uni2 has two schemes to improve commercialisation performance. The first is a program of showcases directed to bring researchers and industry together on a regular basis to encourage dialogue, and “... to have industry hear what researchers are doing, have researchers hear what’s of interest to industry, and try to establish the idea that, for industry, [the TTO] is the place to come to get access to the bigger university”. The second involves the TTO and the university Development Office working to establish, under the aegis of the university President, an alumni council involving a group of successful alumni who are seeking to do more for the university - one area being commercialisation (Canadian Uni2 Interview 2007).

US Private University has a philosophy of working closely with industry. Two particular developments are significant. The university is the principal partner in establishing a European-style manufacturing intermediary in the US to provide development assistance to industry. The centre “conducts applied research for local and international industry. Its mission as a non-profit institute is to develop next generation manufacturing technologies for industry based on emerging US and European research”. The other development is an Office of Corporate Business Development within the TTO, which seeks to build mutually beneficial relationships with industry partners by strategically aligning internal research initiatives and capabilities with synergistic industrial partners that are committed to accelerating the development and commercialization of academic technologies (US Private University Interview 2007).

Canadian Uni1 has developed a suite of very sophisticated activities to enhance industry linkages. The philosophy is predicated on flexibility in dealing with industry. This is because: “We’ve found that, particularly in the high-tech sector IP became a barrier to working with
companies”. It became the case that a lot of work was being put in to protect intellectual property for a future revenue stream that most often never materialised, so it was found that a better way to operate was to concentrate on getting funding for sponsored research and be more flexible in respect of protecting intellectual property and sharing it with industry. This philosophy is captured in the university’s New Ventures Program, which includes “…workshops, courses, networking events, company in a box (which was just access to common legal documents and those sorts of things), mentorship (sitting on boards), [and] early-stage access to capital…” (Canadian Uni1 Interview 2007). Two of these initiatives are mentioned here, although the New Ventures Program has a number of interlocking activities that make the whole structure powerful. The first, involves open access to most of the university’s captured commercial intellectual property for a small or no fee. It is described in more detail below under the heading “Electronic Links”. The second is an Entrepreneur-in-Residence program, the first in Canada, which has achieved outstanding results.

It is clear that North American universities are undertaking activities in which they engage with industry at a number of levels: leveraging the success of alumni; developing communities of interest through which to direct research into areas of value to industry; establishing leading institutes to interface as intermediaries between the needs of industry and the capabilities of university; developing innovative and flexible arrangements to provide low-cost and quick access to university research; and employing entrepreneurs as the bridge between the university research enterprise and industry.

Many Australian universities have or are in the process of implementing some programs similar to those in North America, but few have yet developed quite the visionary approach evident in the likes of Canadian Uni1. Aust Go8 Uni1 acknowledged that it has a history of weak linkages with industry and is establishing a Commercialisation Working Group in order to create an improvement (Aust Go8 Uni1 Interview 2006).

Aust Go8 Uni2 takes an almost contrarian approach with its view that most collaborations are opportunity-driven and rely rather less on long-term relationships. Australia is a world-scale player in mining and agriculture and, to some extent, ICT, but apart from these sectors: “…there are very few companies that are continually getting a stream of innovation from universities”. The TTO Director expressed a pragmatic view of the purpose of relationships, when he said:

“None of them [people in industry] is interested in building a long-term relationship just for the sake of supporting research, they all want outcomes to specific problems; it is more problem-solving and more opportunity-based rather than a long-term collaborative relationship type thing” (Aust Go8 Uni2 Interview 2006).
Australian universities that are implementing programs similar to those of the benchmark universities include Aust IRU Uni, which is proposing:

a “strategic commercial partners program” which aims to get “medium to large companies coming to campus… at least once a year for five years… The process starts with each company giving a general seminar about the company, what it is doing, how it interacts with researchers and research organisations. Up to six companies per year could be accommodated in the biotech area, some multinational, some local, and every company approached has seized the opportunity to be involved. One multinational has proposed to use this model with other universities in Australia” (Aust IRU Uni Interview 2007).

Aust IRU Uni recognised the potential of developing a research enterprise and is encouraging this through its “strategic commercial partners program”, although it acknowledged there is a cultural journey to get this accepted throughout all areas of research in the university (Aust IRU Uni Interview 2007).

Aust Small Uni reflected the Canadian Uni1 view that the relationship with industry is the important outcome from TT&C rather than any licence income. It said that getting university intellectual property into industry is the lever to develop greater relations, and reported that a lot of the research done in its associated industry institute arises from the numerous industry representatives that it has on its course advisory committees (Aust Small Uni Interview 2006).

Universities with a particular field of strength, such as Aust Regional Uni1 in agriculture, have a close relationship with their natural constituency. Aust Regional Uni1 found that:

“…[consulting and contract research] is a good link, because when you are dealing with contracts that might contain research you have an industry partner already at the other end of the scheme; you can usually flow that on into commercialisation deals if that happens to be the right technology” (Aust Regional Uni1 Interview 2006).

Aust Regional Uni1 also reported placing academic faculty into industry for twelve months. No other Australian university reported doing this, although it is common practice among better performing US universities.

Most Australian universities which possess only limited TTO resources do not appear to undertake any systematic linkages with industry.

(g) Electronic Links

The US operates a number of databases that consolidate information arising from publicly-funded research, for example Interagency Edison166 (a database of inventions derived from federally-sponsored research sponsored by the NIH), Radius167 (a database of federally-funded research and development sponsored by RAND), the Federal Laboratory

166 Which can be found at: https://s-edison.info.nih.gov/iEdison/
167 At: https://radius.rand.org/radius/index.html
Consortium\textsuperscript{168} (a forum to link federal laboratory expertise with the marketplace), Knowledge Express\textsuperscript{169} (a commercial database of available technologies) and Birch-Bob\textsuperscript{170} (a commercial database of technology opportunities) which create a marketplace for ideas and intellectual property arising from a number of sources of which universities are one part. For all their power, databases like these do not allow differentiation to be developed between institutions, while they repose control in a gatekeeper that is not the university. While university ideas and intellectual property may be on these databases they do not seem to be a significant mode of technology transfer from US universities.

One particular electronic linkage with industry and other researchers developed in Canada is open access to smaller fragments of knowledge.

“The idea behind [this linkage] is that there are a lot of...research artefacts: biological material, small pieces of software code, digital works... that don't have a high intrinsic value, but they may be very valuable to somebody for use, and that may be half-a-dozen people in the world, maybe that's five hundred people in the world. And how can we make them available to a broader range of actors for whom they may have a small value or no value, but you still want to do it in a controlled mechanism and you don't want to burden the tech transfer office with this. So that way you can allow a lot of this transactional things to happen and, in the case of [the university], I think we have three hundred or three hundred and fifty licence agreements a year off [this linkage while] we do thirty-five licence agreements a year in the traditional form”.

This mechanism services a research community that would otherwise have found great difficulty in reaching its potential market, assisting both the researcher and industry efficiently. “It's not meant to make money…”, but forms almost a part of the intellectual commons. It has been so successful that Canadian Uni1 is looking at commercialising the idea itself through a spin-off, given that it is now used in sixty institutions across Canada in two languages, and is going into Denmark and, possibly, the US. The difference between this idea and the central intellectual property databases more commonly used elsewhere is that this software allows localised control of the data by institutions. The software has published over 1,000 research projects and issued over 4,600 licences since it began in 2001 (Canadian Uni1 Interview 2007). This approach may represent one way to promote the open-access ideas advocated by US Strategist.

Several searchable research databases have been established in Australia. One of the earliest, Research Finder, was developed about 1997 by the CSIRO to trawl for information on any nominated research topic, but the project foundered for want of funding and lapsed. Electronic databases presently operating include: InnovationXchange\textsuperscript{171} (a commercially

\textsuperscript{168} At: \url{http://www.federallabs.org/}
\textsuperscript{169} At: \url{http://www.knowledgeexpress.com/}
\textsuperscript{170} At: \url{http://www.birchbob.com/}
\textsuperscript{171} Located at: \url{http://www.ixc.com.au/home.html}
neutral, global knowledge network operated as an independent not-for-profit); Aussie Opportunities\textsuperscript{172} (a web-enabled database to link inventors with investors and partners); and TechFast\textsuperscript{173} (designed to identify, assess and deliver collaborative innovation projects, sponsored by the Australian Institute for Commercialisation).

Case study universities' experience with automated networks and databases has not been positive to date. Such databases are said to require significant resources to maintain currency, be rather inflexible and to have rarely resulted in any successful linkage.

Although Aust Go8 Uni1 operates an on-line showcase of its technology, the presence or absence of web-sites and other formal mechanisms is seen as nowhere near as important or significant in making industry links as personal contact by individuals (Aust Go8 Uni1 Interview 2006).

Aust ATN Uni1 subscribes to InnovationXchange, but noted that it is not mandatory for academic faculty to post research on the service and, for this reason, it is unlikely that either a significant amount of the university’s research is posted on it or that the researchers peruse the service (Aust ATN Uni1 Interview 2006).

Aust ATN Uni2 believed that static databases have proven of very limited use. The university is a member of InnovationXchange, but noted that “it takes considerable resource just to present information in the formats required”. The university has considered other databases such as AsiaConnect but, after enquiry, concluded that these would provide no real benefit (Aust ATN Uni2 Interview 2006).

Aust Small Uni reported that it participated in InnovationXchange for many years, but it is not now used by the university. After an earlier commercialisation exhibition the university placed five pieces of research with commercialisation potential on the AussieOpportunities website but has never had any inquiry arising from it. There is no belief that these services provide any benefit to university commercialisation results. It said that the best outcomes rely on relationships and trusted intermediaries (Aust Small Uni Interview 2006).

These data indicate that Australian universities from across the spectrum have not found static networks and databases useful in TT&C. The results achieved by Canadian Uni1 with its innovative software and approach may have some attraction for Australian universities with a large portfolio of small-scale ideas and intellectual property or who may wish to pursue the open-access philosophy for their research enterprise.

\textsuperscript{172} \textit{At:} \url{http://www.aussieopportunities.com.au/}
\textsuperscript{173} \textit{At:} \url{http://www.ausicom.com.au/01_cms/details.asp?ID=82}
(h) Co-operative Research Centres

The Co-operative Research Centres (CRCs) program commenced in 1990 as an important feature of Australia’s innovation system intended to improve the effectiveness of the nation’s research and development effort. It represents the Government’s major program for promoting collaborative research links between industry, research organisations, education institutions and government agencies. Various reports have found them to be effective in this objective (Howard 2003; Insight Economics 2006). Of the seventy-one CRCs funded in 2004, only two did not involve a university (DEST 2004a). CRCs, therefore, involve a large number of universities and, in many cases, several universities in one CRC.

There are differences in the way CRCs are viewed by university TTOs and venture capitalists. Aust VC2 said:

“We have a better investment rate out of CRCs than out of universities... because they’ve actually got prototypes in some instances and they’ve got potential end-users who are saying this is valuable. They always have some more level of market validation when we speak to them than universities”.

CRCs are generally more able to identify potential technology users. “They have users in mind [and they] have the CRC participant as a partner inputting [information during development]” (Aust VC2 Interview 2006). And from Aust VC1:

“...we’ve had more success with CRCs [than universities] because they are a little more accountable, they know they need to demonstrate that they’ve actually [achieved results from research], whereas universities have no accountability whatsoever. [Universities take the view that] ‘we don’t have to demonstrate our value to anybody’, so CRCs have a motivation to show that they can successfully develop commercialisable outputs” (Aust VC1 Interview 2006).

Vignette #9.11

Noting that universities have learnt that CRC’s represent threats and risks as well as some rewards Aust Go8 UniI noted that, in terms of CRCs:

“... the value proposition, I think, for the university is looking less and less enticing, and we have certainly noticed that at [our university]... the risk-return profile looks less and less appetising for us as the program evolves”.

Universities clearly commit a great deal of resources to CRCs and, on their face, they would seem to be vehicles designed to stimulate the commercialisation of research. The evidence from the Australian case study universities, however, suggests that they are only moderately good at commercialising their research and are generally irrelevant to the commercialisation of university research (as distinct from CRC research) while, in some cases, they constitute more of a hindrance.
For example, Aust Go8 Uni2 was of the view that CRCs have not produced much result for universities in Australia. With some exceptions they have done little more than raise some research funding while achieving few commercial outcomes.

While acknowledging CRCs “as a mechanism for commercialisation, when done well, do have quite a powerful impact in terms of changing the culture of researchers and changing their mind-set about how to do commercially relevant research…”, Aust Go8 Uni1 said:

“… that the tangible outcomes that you can [identify] and say that that is a clear outcome from CRCs, probably have disappointed over time for such reasons” as being sub-scale and existing over a seven-year lifetime, which is quite short. "It is time for a bit of a re-think of the CRC program… the experience of the Australian Photonics CRC\(^{174}\), the break-up of that, was very sobering for universities and focused them very much on the risk side of the equation rather than the rewards" (Aust Go8 Uni1 Interview 2006).

“In terms of effectiveness to [our university], in terms of return on our investment in CRCs, I think the jury’s out on some of them; CRCs are time consuming; like any company, once you spawn them, they tend to take on a life of their own”. CRCs have no relationship with the TTO, and seek no assistance from it concerning contracts and commercial matters (Aust ATN Uni1 Interview 2006).

Aust ATN Uni2 said that CRCs are an ineffective commercialisation vehicle from a university’s perspective. A university contributes cash, in-kind resources and expertise to the CRCs and yet fails to own the intellectual property, does not control the entity, receives little cash return and assumes a large proportion of the risk. Also, CRCs essentially add another layer of management in the commercialisation chain. Four of the twelve CRCs of which Aust ATN Uni2 was a member ceased operation in 2006 due to them not being re-funded by the federal Government (Aust ATN Uni2 Interview 2006).

Aust IRU Uni TTO believes that CRCs represent a sub-optimal investment of the university’s research resources and that much better results could have been achieved without compromising any worthwhile industry relationships had the funds and resources committed to CRCs been invested in university-directed research (Aust IRU Uni Interview 2007).

CRCs enabled Aust Small Uni to build its research profile quickly and obtain an industry-sponsored prototype manufacturing facility, but the university now believes that they are falling out of favour. They are now producing little for the university with the exception of one centre which has produced twenty-five PhDs and two post-doctoral students over its seven year funding life but could not build a solid base for ongoing work. In the view of Aust Small Uni, “… industry sees [CRCs] as a means of getting government money to leverage into

\(^{174}\) The Photonics CRC was placed into administration in 2006 owing approximately $10 million after spending some $100 million over ten years.
research at universities, and universities see it as research funding” (Aust Small Uni Interview 2006).

Aust Regional Uni1 noted that CRCs are not profitable for the university, but “… they are actually set up to be the link between the research and industry, and in that sense they actually perform a very good function because they do bring research out into the field where it is being utilised”. This technology transfer, along with some PhD students and some small amount of publicity, is the extent of the return that the university has generally achieved from its involvement in CRCs.

Despite some positive outcomes, CRCs raised issues of concern to TTOs. For example, when a CRC comes up for re-funding after its initial seven-year term, it sometimes ends up with one or more new industry partners in which case the intellectual property that remains in the CRC itself, and the royalties payable are diluted because of the new part-owners, and the university has no control over this. Another concern relates to the independent management of CRCs which make decisions about the filing and renewal of patents without necessarily consulting the university. In addition, profits made by CRCs are typically retained within the CRC and used for re-investment in research rather than distributed to the partners as profits, so that investment in CRCs provides little or no financial return to universities.

From a national point of view there may be a case to continue with the CRC program or something like it because of the benefits achieved. There is, however, an arguable position that they may be reaching the end of their usefulness, at least as it concerns university research commercialisation, and at least in their current form.

9.3.9 Technology Parks and Incubators

Commercialisation managers and people experienced in commercialisation generally appear to have scant regard for the value of technology parks and incubators. It is often the case that where a new university enterprise needs incubation it is done on-campus until it can survive on its own. The view was often expressed that providing well-appointed accommodation for new companies can send the wrong signals and such companies would be better prepared for real-world markets if they were located in modest circumstances. The Director of the TTO at NZ Uni said that he would like to see new enterprises start-off in spartan, non-premium locations in order to keep costs low and to emphasise to new businesses that they have to work hard at managing cash (NZ Uni Interview 2007). The US VC was similarly scathing of incubators.

Canadian Uni2 operated an incubator through its TTO company (before it was wound-up), but found it was not successful because it was neither properly funded nor fully occupied:
“We were trying to do it out of our existing budget, which included this line of credit and it consumed an enormous part of this line of credit, which was really not core business for us and consumed a lot of resources. I suspect it consumed more than anybody ever thought”.

While the university now operates a form of incubator, a technology park is no part of the university’s plan (Canadian Uni2 Interview 2007).

Neither US Public University nor Canadian Uni1 operate a technology park or incubator. In the case of US Public University it is probably not needed given its proximity to some of the world’s leading high-technology resources, while in the case of Canadian Uni1 it has not proven necessary. US Private University operates “...some of the finest on-campus incubation facilities in the United States...” and a research park. Nonetheless, US Private University TTO observed that:

“... universities have very high cost structures. We have a couple of incubators. I think we’re now [of the view] that they’re nice to have for our own spin-outs for a period, but the President said to us: ‘Why...do you bring external companies onto campus? We’re never going to make money from them. The only reason to bring them on-campus is if they’re going to become part of the intellectual climate of the university - [for example], take students and give them internships, talk about their business plans in the School of Management and stuff like that’, so that’s what we’re doing” (US Private University Interview 2007).

Over the years there have been many reports written about the perceived importance of technology parks and incubators, yet the international case study universities made no significant case for universities to possess such facilities. While incubators appeared to offer some value during the early life of some high-technology companies, there is a time beyond which all new companies should be subject to the disciplines of the market and financial reality. Incubators may be of benefit in industries that require specialised laboratory conditions, most likely to arise in certain life sciences, but should be treated as a loss-making activity sponsored by a non-profit organisation or the state.

International experience is mirrored in Australia. Aust Go8 Uni2 echoed the views of the US Private University President when it said of incubators:

“... they are a huge cost - [you have] got to provide a building, got to manage it, run it, and these companies are strapped for cash and they haven’t got the funds to pay top rents... generally incubators are a huge sink of funds and, unless someone is prepared to fund it, you wouldn’t go into it” (Aust Go8 Uni2 Interview 2006).

Aust Regional Uni1 was highly critical of technology parks and incubators. It used to have a technology park,

“... but it was a major disaster. It was only partially filled – there is just not enough here in [our regional city] to fill buildings with small and medium-sized enterprises... It fell by the wayside and it is now just a piece of real estate that is being rented out for any company. Incubators just don’t seem to work very well”. Incubators seem to be a trend that comes and goes, and they provide space for emerging technology-driven enterprises that, “...are not going anywhere because they are not being driven by the people who actually have the knowledge, who probably haven’t run any small businesses themselves and don’t know the
ins and outs of it, and… a lot of these small businesses are too concentrated on one little thing only and haven’t got the right management…” (Aust Regional Uni1 Interview 2007).

Apart from Aust Regional Uni2, none of the other Australian case study universities has or plans to have a technology park or incubator. The prevailing approach is to permit a spin-off company to reside for a short time in a university department. Where a new business needs to go to an incubator, universities direct them to State or federal Government owned and operated facilities or, in the case of Aust Small Uni, to a university-owned commercial company which interfaces with industry. Aust Regional Uni2, curiously the university with the least present activity in commercialisation, operates a technology park, although the park forms no part of the university’s enunciated research plan and has not developed strong research links with the university.

From the venture capitalists’ point of view technology parks and incubators are largely unimportant in developing university ideas. According to Aust VC1:

“… they are a third-order issue … From a venture [capital] point of view, we don’t really get deals coming from incubators… We put a lot of effort into that but it didn’t prove a discriminated source of deal flow for us. I don’t see it as a particularly important model…” (Aust VC1 Interview 2006).

From the point of view of Aust VC2:

“Incubators, I think, help educate start-ups about some things. Some help them pull together a business plan, some give them office accommodation – any help they can get is good” (Aust VC2 Interview 2006).

As far as Aust VC2 was concerned the involvement of a start-up with an incubator does not increase the value of the business and they have not been an important issue for them when it comes to a decision to investing in a start-up (Aust VC2 Interview 2006).

The data are quite compelling nationally and internationally: universities should not operate technology parks or incubators. There is, however, a case that incubators can assist new companies in life sciences (in particular) but, to the extent that they are needed, they should be treated as either a commercial enterprise (best run by industry) or as a loss-making enterprise for the public benefit financed by industry, not-for-profit foundations, or the government.

9.3.10 Intellectual Property

(a) Ownership of Intellectual Property

There are two major issues relating to intellectual property ownership. The first is the extent to which the creators of the intellectual property, the researchers, retain any rights to the intellectual property, while the second concerns which entity owns the intellectual property within the university.
The general rule applicable in North American universities is stated by US Private University:

“Basically, professors, when they join universities, and I would say this is universal throughout America, they have to sign an agreement that they will assign any intellectual property they generate to the university… [Professors at the university] are supposed to disclose everything…” (US Private University Interview 2007).

This is efficient in North America because a disclosure statement usually contains a term under which intellectual property rights are assigned to the university at the time of disclosure. In this way students and visitors to the university, as well as faculty members, assign their individual rights to the university. This may be contrasted with the Canadian position, where universities have complete autonomy in developing intellectual property ownership rules and the implementation by Canadian Uni2, for example, prescribes:

“… joint ownership upon invention, and then, upon disclosure, [the university goes] through an assignment process where the IP can be assigned by the principal investigator or investigators either to the university, or they can assert their right to the invention, in which case the university will assign ownership to the principal investigators…” (Canadian Uni2 Interview 2007).

The importance of common principles or policy is clearly evident in the views of Canadian Uni1, where the Canadian lack of a common position among universities\textsuperscript{175} is said to be causing opportunities for commercialisation to be lost, to power imbalances amongst faculty members and students when it comes to decisions on commercialisation, and to complexities when multiple investigators or institutions are involved.

It has become the common rule in Australia that a university claims the intellectual property developed by researchers within the university. This situation is qualified by a miscellany of rules dealing with the status of the researcher involved (employee, student, visitor) and the circumstances under which the intellectual property was created (under contract with industry, as part of the normal duties of the employee, or using university facilities and expertise). The situation has been complicated by the 2008 decision of the Federal Court of Australia in the case of University of Western Australia -v- Gray (No 20) [2008] FCA 498, which suggested that the usual rule (which can be altered, for example, by a term in an employment contract) is that individual university researchers, rather than universities, own the rights to intellectual property they develop. Co-operative Research Centres, on the other hand, as separate legal entities, most probably own the intellectual property developed within them unless other relationships (such as sponsored research) intervene. Research involving more than one institution presents a further challenge. If, for example, research involves two universities, there are at least six categories of individual involved (employees of each university, students of each university, and visitors to each university) all of whom may be governed by different rules under university policies. This has the potential to create

\textsuperscript{175} This is despite many recommendations to the contrary, for example by Reimers (1999) to the ACST.
uncertainty as a result of different university rules and, where relevant, different terms in employment contracts.

Industry noted that intellectual property title quality is of much greater concern in life sciences than industries with shorter economic lifetimes such as ICT. As an indication of the concern that Australian venture capitalists have in relation to university intellectual property title, Aust VC1 said:

“... when we invest in something, we like to take control of the patenting”. Aust VC1 is particular in ensuring that the quality of the title they take is beyond challenge, to the extent that it is possible to do so. “We’re quite careful about that in our legal documentation of a deal. When we invest in a deal we get assignments – we really go through the history on it and find anybody who ever [had any involvement at all], and get them to assign everything over to the company” (Aust VC1 Interview 2006).

Aust VC2 noted that this need for assurance on university intellectual property can slow down deals significantly, with negotiations taking one year or more not uncommon.

The entity within a university that owns the intellectual property to be commercialised varies between universities. Where the TTO is simply a unit within the university structure the university itself normally owns the intellectual property. Where the TTO is a separate company, intellectual property can be owned by the university or the company. Aust Go8 Uni2 obtains title to intellectual property from the university prior to exploitation, while Aust Go8 Uni1, although a company, does not take title from the university but acts as a broker in any deal.

(b) Reversion of Intellectual Property

In the event that a university elects not to proceed with commercialisation of an idea, North American universities will normally allow intellectual property to revert to the researcher, subject to processes and limitations of the Bayh-Dole Act. This Act also contains use-it-or-lose-it provisions requiring universities to take effective steps to achieve practical application of the subject intellectual property within a reasonable time.

Under their various rules dealing with intellectual property thirty-one of Australia’s thirty-eight public universities make specific provision for the reversion of intellectual property to the creators in the event that the university elects not to commercialise or fails to commercialise within a nominated period. In some cases the reversion is automatic, while in others it occurs upon application by the creator. The periods allowed to the universities to make the election to commercialise are different in almost every case. In summary, almost every university in Australia has a different rule concerning reversion of intellectual property rights, another

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176 These conclusions were drawn by the author after assessment of the intellectual property rules that apply in every Australian university.
potential source of confusion confronting industry when dealing with universities. The seven universities that do not make provision for reversion of intellectual property are silent on the issue but may, as a matter of practice, grant reversion. Of the Australian case study universities only Aust ATN Uni2 is silent on the issue of reversion.

One aspect of the US legislation that Aust VC1 believed would be usefully replicated in Australia is the use-it-or-lose-it provision, requiring universities to do something with their intellectual property or, otherwise, lose the right to exploit it to any person willing to use it. In this regard, Aust VC1 believed that universities “…need to be accountable, and then things will happen” (Aust VC1 Interview 2006). In this way intellectual property would not be permitted to moulder in the event that it had value and its existence was known outside the university.

(c) Differences between Research Fields

There is a difference in the intellectual property needs and demands of life sciences when compared with those of physical sciences and ICT, largely arising from the difference in the market and regulatory demands of the two. Life science regulatory approvals can take many years so that time to market is almost always measured in years and sometimes decades, while physical sciences and ICT have market cycles generally in months or a few years. This means that patents are usually less important in physical sciences and ICT (where time to market is often the crucial issue) than they are in life sciences.

“I think that the IT, engineering technology tends to be incremental rather than revolutionary – it is rarely patented or protected in any meaningful way by patent. It is always tied to the individual and so you can’t just transfer it and let somebody else deal with it, it almost always has to go with the individual. And the speed with which it works is pretty big, as well… And there is also a bit of a culture there that shouldn’t be underestimated, and the culture of those individuals is one of administrative distrust and non-compliance, and so if you’re from the central administration here-to-help, you can imagine the response that you get. Regardless of whether you’re providing good services or not, it’s just not something which is easily accepted by that community” (Canadian Uni1 Interview 2007).

9.3.11 Early Stage Financing and Venture Capital

There is usually a distinction drawn between early-stage financing and venture capital. Early-stage financing is provided for activities such as early bench-testing, proof-of-principle, pilot and working models in order to prove the idea or principle involved – to ameliorate the technology risk. After the technology has been proven and a market identified, large amounts of money become needed for development (which typically consumes 90-95% of the research and development expenditure), which may be supplied by venture capital, which takes what is sometimes called the market risk. While there is something of a continuum in this funding, the fact is that only a fraction of the ideas developed by research ever get early-
stage funding\textsuperscript{177}, and only a small fraction of these are ever funded by venture capital\textsuperscript{178}. Early-stage funding is much higher risk, with money invested more likely to be lost. In Canada, Australia and New Zealand, early-stage financing is most commonly supplied by government or not-for-profit enterprises while venture capital is almost exclusively arranged by private organisations. It doesn’t have to be this way.

US VC said that government should not provide funding at any level. The high-risk capital needed for early-stage proof-of-principle should be filled by private investment. He said:

“The way that government should fill that gap [early-stage funding] is to create incentives for private investment. A bureaucracy cannot manage and work with successful, growing, high-technology companies...”. What government can do is “create incentives for private investment, and that’s something that’s extremely important” (US VC Interview 2007).

The different expectations of early-stage funding and venture capital have to be understood, as they have quite different profiles. Early-stage money is very high risk. Venture capital is at risk, but it’s not at such very high risk. “Venture capital is not incubation money. Venture capital in [the US] is not interested in giving you money to prove the concept, it is interested in you going into a serious round that eventually will take the company public [so] I can get my cash out pretty quick” (US Strategist Interview 2007).

From the point of view of universities there are arguably three principal components of financing: small amounts of very early stage university funding to extend or prove research (usually not exceeding around $100,000), early-stage or proof-of-principle funding (generally between $500,000 and $2 million), and full-blown venture capital which provides whatever funding is needed to bring an idea to market.

The other important thing to recognise is the distinctive profile of life sciences vis-à-vis other technologies. As Canadian Uni1 reported: “Life science projects often have much higher research and development costs than those in the physical sciences” (Canadian Uni1 Interview 2007), again reinforcing a distinction that needs to be made between the costs involved in life science research and commercialisation, and all other.

The structure of early-stage funding is well illustrated by the approach at Canadian Uni1. It has three sources of early-stage funding: a prototype development program; proof of principle funds; and idea-to-innovation funds.

\textsuperscript{177} Canadian Uni1 reports that between 1 January 1988 and 31 March 2005 there were 1,835 invention disclosures made at the university, of which 138, or 7.5\% received any funding under their early-stage funding scheme. (Canadian Uni1 Interview 2007)

\textsuperscript{178} While the fact that few creations ever receive venture capital funding is well known, a concrete example is provided by Aust VC1, which said: “... we have identified and looked at about one thousand discrete opportunities across public sector research and we have invested in about 1.3\% of those – between eleven and thirteen deals”, across universities, CSIRO, DSTO and CRCs. “The 1-1.5\% yield rate is the early-stage norm, and that is what you should be doing” (Aust VC1 Interview 2006).
Under prototype development funds the university makes grants of between $5,000 and $25,000 in up to twelve individual projects per year to a maximum of $150,000. The other two funds are funded by the Provincial and federal Governments and are typically $50,000 to $150,000 per year for two years. Venture capital funds usually come from private sources, but because of the difficulty of getting early-stage life sciences funding, the university is aiming to raise $140 million from the Canada Foundation for Innovation (CFI), industry and government to back ideas. As a variation on this theme, Canadian Uni2 is obtaining funding from the Ontario Government for two funds: physical sciences and life sciences, to allocate up to $120,000 per idea in three tranches: $10,000 in the first round followed by two successive rounds of about $50,000 each.

The two benchmark US universities provide an interesting contrast. US Public University provides no funding for early-stage development of ideas or venture capital, probably because it is near the largest and most sophisticated venture finance pool in the world and, as a public university, feels that its funds should not be used in financing idea development. US Private University, although also close to major venture financing, offers a range of funding from internal sources from early-stage through to venture capital. US Private University has funds at three levels: Ignition Awards to generate commercially relevant data, reach key milestones or develop a prototype; Launch Awards to assist in starting new companies based on technology developed at the university; and venture capital up to around $5 million as general partner or co-investor. The funding for all the awards is largely self-perpetuating with profits from successful investments being re-invested in new ideas and enterprises.

The problem of funding in a small economy like New Zealand is quite acute. As the TTO Director at NZ Uni said: “Basically venture capitalists want to finance market growth, [but] they don’t want to finance technology risk”. So they operate in a specific market segment. “Government in New Zealand is trying to stimulate the angel investor base, but again, angel investors really want to invest in just a smaller version of what the venture capitalists want to invest in. They don’t really want to come back and carry any more risk” (NZ Uni Interview 2007). This TTO has had to direct a great deal of its profit into early-stage investment.

Aust Go8 Uni2 has comprehensive early-stage funding arrangements: early stage (up to $50,000); next stage ($100,000-$750,000) and, for life sciences ($500,000-$2 million). Most universities acknowledge that there are always venture capital funds available for proven ideas. While the university would like more funds, especially at the early stage, it is able to support a number of ideas each year.
Three Group of 8 universities are shareholders in UniSeed\textsuperscript{179}, a common early-stage capital fund, and have access to these funds. What this program lacks, however, is key early-stage funding at levels up to $50,000. It has no such funds presently available and it is left to individual researchers to find that funding.

Aust ATN Uni1 has established an early stage fund along the lines of a program at the University of Western Australia to grant researchers up to $40,000 to undertake proof-of-principle development. Aust ATN Uni2, on the other hand, has no organic funding to support early-stage development, although it has a small amount of funding to undertake some market research and patent searches. Neither of these ATN universities appears to have any relationship with venture capitalists.

Aust IRU Uni is similar to Aust ATN2 Uni in that it has no specific funds available for early-stage development, although “if... the university had half-a-million dollars to put in to some of these projects, the value that we would get from [the intellectual property], compared to what we are getting, would be [very significant]” (Aust IRU Uni Interview 2007).

Of the smaller universities, Aust Regional Uni1 has a small discretionary fund of about $100,000 financed from royalties which it grants in tranches of $20,000-$30,000. To take an idea beyond proof-of-concept stage the university would normally require the involvement of an industry partner. Aust Small Uni provides small grants of up to $20,000 to build relations with industry, and has developed an idea-financing arrangement in entrepreneurship and innovation. This fund has $500,000 available for commercialisation only (not research), but the university has been very cautious in its investments and has only invested in one idea up to 2007. Aust Small Uni said that it believes that government pre-seed and seed funds have proven unsuccessful and something like the UK University Challenge Funds would be a preferable model. Aust Regional Uni2 can access funds up to about $50,000 per idea for early-stage development from an affiliated company as well as Head of School delegations.

These data suggest that there is no common approach to early-stage funding, the consequence of which, in some universities, may lead to the inability to commercialise some worthy ideas. Where university management supports TT&C, with Aust Go8 Uni2 being the obvious model, they ensure that funds are available for early-stage development. The potential loss of ideas because of the clear lack of early-stage capital in some universities is an area that requires attention. Whether it is along the lines of a co-operative scheme among all universities like UniSeed, along the lines of the UK University Challenge Funds as recommended by Aust Small Uni, or whether private funds should be encouraged as

\textsuperscript{179} The Universities of Melbourne, Queensland and New South Wales. See: \url{http://www.uniseed.com/index.htm}
recommended by US VC, Australia appears to be losing the benefit of some ideas under the current disparate arrangements.

9.3.12 Entrepreneurship and Culture

The example of North American universities showed there to be at least three major aspects to this issue: the views and attitudes of the university management, the freedom given to academic faculty to undertake independent commercialisation activities, and the close engagement of TTO staff in academic life.

(a) University Culture

Commercialisation within a university will only thrive if it is supported institutionally, and this starts with support from the chief executive or President (in Australia, the Vice-Chancellor) through the key executive ranks. Each of the successful benchmark universities is supported institutionally and by a supporting culture. As Owen-Smith and Powell (2001, p.104) put it: “The key step in successful tech transfer is creating an entrepreneurial culture among the faculty”.

The strong theme among the North American benchmark universities was that commercialisation is part of the return to the community for the investment it makes in research. In practical terms, with government supplying some 70% of research funding in the US (US Private University Interview 2007), the government also expects to see public good arising from the research it funds which, in turn, provides universities with a stimulus to ensure that this is done. For these principal reasons TT&C is generally supported by university management, and has been among case study universities for many years.

At the small NZ Uni, the importance of commercialisation was recognised by the university’s chief executive (the Vice-Chancellor) when he stated in his overview in the university’s 2005 annual report: “The nurturing and sale of intellectual property is becoming ever more important to the financial well-being of the University, and is a key part of our mission to contribute to wealth creation in our region, and in New Zealand as a whole”. As the Director of the university TTO said: “Our Vice-Chancellor is very [supportive of] commercialisation. He is very pleased with the performance of the TTO and he takes every opportunity to tell everybody how important [commercialisation] is to the university” (NZ Uni Interview 2007).

Aust Go8 Uni2 TTO has existed in substantially the same form within the university for almost a quarter of a century and has been supported financially during its start-up phase and by management throughout this time. Sentiments on the importance of commercialisation are found throughout the university’s plans.
Aust Go8 Uni1 re-formed its commercialisation unit over the last five years. Components of commercialisation remain split between the TTO and the Research Office (which handles disclosures, for example). The university is attempting to develop a corporate understanding of TT&C and how it should be effected, with the risk that, particularly during other restructuring presently occurring at the university, commercialisation may remain for a while yet, a “side-show”.

Vignette #9.12

The propensity to commercialise is a function of a university’s culture. On the commercialisation culture at Aust Go8 Uni1, the TTO Director said:-

“Historically a very small number of academics pushed and tried to run with [commercialisation] and I think that proportion is growing... but I don’t think it will ever reach 100 percent. That, I think, is largely driven by the culture of an institution, and I don’t think that we, at [our university], have as strong a culture, certainly compared with UniQuest [the University of Queensland],... but it’s still not bad”

“...I think that the process of change of culture [and] changing of knowledge has to proceed at a pace that the institution can handle”. While things could be pushed faster, it may not be the highest priority facing the university... One of the other reasons that progress has to be measured is because: “…to match the training that you give people, they have to have a chance to put it into practice and have some experience of doing it; ...we need to actually lead by doing, we have to get out there and do deals, demonstrate that it can be done,... and there is only a finite pace at which that can happen”

The two ATN case study universities represent another contrast in approach. Aust ATN Uni1 is expanding its support for commercialisation and, in the last few years, has created a new commercialisation company and is on a path of expansion. Aust ATN Uni2, on the other hand, has a very small commercialisation unit (effectively one person), and ceased trading through its commercialisation company some years ago with no present intent of re-establishing a company. The TTO Director at Aust ATN Uni1 expressed the view that his university is like most others: some researchers are active in research and commercialisation and some are not. “…what we’ve got to try and do is to change the culture across the whole university to say that, as an outcome of research there is... a transfer of knowledge [for the public good]” (Aust ATN Uni1 Interview 2006).

Aust IRU Uni commercialisation appears to be driven largely by the energy of the employees of the TTO rather than senior university management which appears to have no strategic view of TT&C. The university itself has a culture that, while not averse to commercialisation, is not universally welcoming.
Among the smaller universities commercialisation does not generally appear to be viewed by management as a core activity of great significance. Aust Small Uni, which has had some significant success in entrepreneurship and spin-off companies has demoted the TTO in terms of its line of reporting, while at Aust Regional Uni1 the TTO employs only one person.

Among the Australian case study universities only Aust Go8 Uni2 has provided significant executive support for commercialisation over a long period of time. The recent changes at Aust ATN Uni1 presage greater support for commercialisation but will have to be continued in forthcoming years if commercialisation is to make a significant impact at the university. Among the other case study universities there appears not so much antipathy or even indifference to commercialisation as much as a lack of understanding among university senior management as to what it actually means. It may be that many of these universities have yet to pass the infancy stage of commercialisation as described by the Canadian Uni1 TTO Director when he said that when they started, commercialisation was:

“... in its infancy, and so the very first thing we were trying to do was get inventions through the door... and then a few years later we started to count patents, and a few years later we started to count licence agreements, and then many years after that we started to count royalties. It’s because of that that the evolution of practices have changed over time and, with that is one of the things which I think is a success factor for us is that we try new things” (Canadian Uni1 Interview 2007).

It may be that Australian university executives have not yet developed a thorough understanding of commercialisation and its place in the life of the university and the community. The contrast with the management of the small NZ Uni is very telling in this regard.

There is also a link between high-performing academic faculty and commercialisation success. The officer responsible for commercialisation at Aust Go8 Uni1 observed that:

“... a lot of the time we see the most successful commercialising academics are also the most successful at research, the traditional research academics. High performing academics tend to be high performing across a lot differing areas... [There is no necessary distinction between] either doing commercialisation or ... focusing on research excellence, most of the time we see academics are able to combine both” (Aust Go8 Uni1 Interview 2006).

The principal caveat on this observation is that many in universities and industry commented on a distinct generational difference whereby academic faculty younger than about forty years are much more inclined to embrace commercialisation. It may be that the combination of younger researchers and high-performance is a key to culture change in this regard.

This intangible aspect, called university culture, and the importance of its impact on an individual university’s performance in TT&C was succinctly stated by Owen-Smith and Powell (2001, p.111) when describing their research results:
“The catch-all phrase ‘entrepreneurial culture’ is central in informants’ explanations of [the elite private university’s] commercial success. Discussions of a broad campus culture supportive of patenting are almost entirely lacking at [the state university]. Entrepreneurial culture has been used to explain the success of high-technology regional economies and has been adopted by faculty and administrators to explain the success of highly commercial universities. A strong culture of patenting attracts faculty interested in pursuing commercial endeavors and socializes new university members into that pursuit. In this kind of environment, status becomes attached to commercial outcomes and technology transfer endeavors come to reinforce traditional academic status hierarchies, linking tangible and intangible patent benefits together with ongoing academic pursuits by blurring the boundaries between commercial and academic science”.

The culture evident at Aust Go8 Uni2 reinforces this observation: over time, the university has invested commercial outcomes from research with the cachet of respectability and desirability. Their success has become self-perpetuating and continues to grow.

(b) Commercial Freedom for Academic Faculty

A number of universities in the United States have embraced commercialisation enthusiastically and one of the features that distinguishes them is their willingness to grant academic faculty the ability to pursue their commercial interests. The desirability of granting academic faculty freedom to pursue commercial interests was emphasised by US VC. But even at the universities that don’t grant the extensive freedom of the likes of MIT and Stanford, academic faculty still have their one day a week to undertake commercial interests.

The importance of freedom to pursue personal commercial interests was also mentioned by US Private University:

“I think that [giving professors a day a week to pursue business interests such as consulting and spin-off companies] is a critical part of the US success, and I only really learnt that when I had someone come and teach in my class about federal labs. Now the federal labs don’t give their employees a day a week. And if their employees want to take a year off to start a company, they won’t let them come back. [So] I think letting faculty take leave of absence, [start a company], and then come back [is critical to success]” (US Private University Interview 2007).

Canadian universities do not appear to be quite as liberal in granting such freedom to academic faculty although they can buy-out up to 20% of their teaching obligations using, for example, research funds.

Australian universities generally grant their academic faculty a degree of freedom to undertake commercialisation, such as allowing academic faculty generally up to 20% of their paid time to pursue individual commercial interests\(^{180}\). The relative freedom to pursue

\(^{180}\) By way of example, at the University of Queensland, “As a general principle, the University supports members of its academic staff engaging in paid outside work with industry and government that enables them to stay at the forefront of their area of expertise and advances the wider interests of the University”. The university grants up to 200 hours each 6 months to undertake university-related outside work, and places no particular restriction on private non-university related work provided it does not interfere with the performance of University duties, or adversely affect work efficiency or availability, does not present a conflict of interest, and does not compromise
individual commercial interests by Australian academic faculty members appears quite liberal. However, data on the amount of time Australian academic faculty at research-intensive universities spend on commercialisation indicates that senior academics, those one would expect to be more in demand for consulting and similar assignments, report spending and average of only 2.9 hours per week on “consulting and industry-related activities” (Harman 2002, p.145). This suggests that the liberal policies extant in universities are not resulting in the close co-operation with industry that they may be expected to inspire. Further, as a general rule, if an Australian academic faculty member wishes to leave a university to pursue a commercial opportunity they would rarely, if ever, be re-engaged by their former institution on the same terms as they left, yet this is granted by many US universities. Aust Regional Uni1 reported that an academic was granted a year away to work with a US company, but this was noteworthy because of its rarity.

While there appears to be quite a degree of commercial freedom granted to Australian academic faculty members, it is not clear how many use this freedom for the intended purpose, and further research into this may provide some useful insights.

(c) Engagement of TTO Staff in Academic Life

There is some evidence among the benchmark universities of integration between the TTO and teaching that does not appear in Australia. That is, some universities make adjunct appointments of TTO staff to teach as part of broader courses, or otherwise routinely invite TTO staff to lecture in courses such as EMBA. For example, at US Private University the Manager of Technology Licensing has a two-day-a-week faculty appointment in the School of Management.

There is no evidence that anything like this has been tried among the Australian case study universities. While not a matter of primary importance, when combined with other factors, there may be a case for Australian universities to consider some level of integration to allow leverage between the teaching, research and TT&C (outreach) functions of the university.

9.3.13 Intermediaries

Much of industry is of the view that the role of university TTOs is to act as a convenient conduit between the researchers and industry. This view is captured in the comments of Aust VC1, which said that a good TTO is really there to get an opportunity:

“… to the ‘loading dock’, but that’s kind of where they really should leave it. And they all kind of very much depend on investors like us to carry the can for them – they are not really

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the university. See: University of Queensland Policy No. 1.50.2. Other Australian universities make similar provision.
there to add value to the investment, they are kind of there to watch the deal" (Aust VC1 Interview 2006).

If this sentiment reflects the view of industry, the obvious issue becomes whether university TTOs represent the best intermediary or whether there are other models that should be examined.

There is support in Australia for outsourcing commercialisation in some form for a number of reasons. Aust VC1 identified the difficulty in finding sufficient suitably skilled staff to operate university TTOs. It said that understanding the interaction involving a business and the attendant risks is largely art, and Aust VC1 sees developing an appreciation of this art as involving “...an apprenticeship, to really [develop] an empathy for how these risks can play out, and how to gauge them requires experience over a number of fields over time”. To do this consistently well requires universities to employ very experienced and skilled staff in commercialisation:

“... but why would someone do it unless there were big rewards – [you need] incentives, and the type of people that would do this very well would not be the kind of people who would fit into the university model, so it is ripe for outsourcing, I think... The kind of people that could do this really well probably wouldn’t work within [university] infrastructure very well. So I’ve always looked at this and said: ‘there’s probably an outsourcing model there that someone might [develop]” (Aust VC1 Interview 2006).

Aust Go8 Uni2 said that as long as researchers have access to well-run university commercialisation operations there is little need in Australia for intermediaries such as Battelle Corporation in the US, where intermediaries tend to “cherry pick” – that is, to pick the best technologies and try to commercialise them. Also, Aust Go8 Uni2 is, “... reluctant to put more layers in the process. Every layer adds another transaction cost and another layer of complexity”. Australia would be better off putting money into current structures that work rather than create another layer (Aust Go8 Uni2 Interview 2006).

Australia does not presently have any large entity like Battelle or the National Technology Transfer Center in the US, Fraunhofer or Steinbeis in Germany, or Imperial Innovations or IP Group in the UK available to provide intermediary services to assist in the commercialisation of research. There are some smaller entities that provide assistance in particular areas (Milton-Smith 2001)\(^1\), most commonly in accessing government funding, but no large intermediaries have emerged. While the likelihood of cherry-picking individual ideas in order to increase the likelihood of commercial success and maximise profit is real, this may not necessarily be a bad thing where the alternative is the loss or delay in ideas becoming available to the community. There may be a middle ground where intermediaries have a role

\(^1\) As of 2001 Milton-Smith identified just two firms practising specifically as intermediaries in Australia: Zernike Australia; and Foursight Associates. This does not appear to have changed significantly in the meantime.
to play in commercialising Australian university research that is complementary to the role of university TTOs. There is always the possibility, although it remains nothing more than that, of a successful TTO like UniQuest metamorphosing into a separate company providing services to a broader range of research entities than merely the Universities of Queensland and Wollongong, particularly in view of the Aust Go8 Uni2 comment that: “… there is a market opportunity for [university] experts to assist [Australian] industry with product development and commercialisation” as a result of its market analysis of Australian industry’s skills and ability to take a novel idea to market (Aust Go8 Uni2 Interview 2006).

9.3.14 Smaller and Regional Universities

Published reports do not provide compelling evidence of regional Australian universities being active in TT&C (Garlick 2000; DEST 2003a, 2003b). DEST (2003a, p.342) reported that:

“… overall commercialisation activity in regional universities is relatively weak…. Regional universities account for 21% of the full-time and fractional full-time university staff; however, they hold only 8.3% of Australian patents, 10% of international patents, 6.5% of Australian patents owned by universities granted in 2001, and 3.4% of total patents granted to Australian universities in 2001. Only in spin-off companies (15.6%) did regional universities perform in proportion to their percentage of staff employed”.

The relative performance of regional universities in TT&C is illustrated in Figure 9.7.
While the reported Australian situation appears rather grim on these data, they emphasise the usual TT&C criteria of patent counts while neglecting other important aspects of TT&C where regional universities are likely to be of greater assistance to industry: consulting and advice, and contract research. There are no comparable data for smaller universities, as such, although most regional universities are also in the smaller category as defined earlier.

These results should also be compared with those reported by the benchmark NZ Uni, which has achieved impressive results despite being a smaller regional university with a small research budget. The experience of this university alone suggests that regional and smaller universities can achieve excellent TT&C results if the right conditions exist. It is suggested that the conditions necessary for superior TT&C performance are the same for all universities regardless of size, location, status, age or other factor: institutional and management support for the function; sufficient world-class research outcomes; and superior TTO management.

Turning to the experience of the Australian case study universities, three are in the category of smaller or regional: Aust Small Uni; Aust Regional Uni1; and Aust Regional Uni2. Aust Small Uni has achieved some sound commercialisation results but appears recently to have had diminishing institutional support. The two regional universities each have no more than one person each working in TT&C specifically with both having apparently lukewarm...
institutional support, yet Aust Regional Uni1 has the legacy of an excellent existing business based on a commercialised product, while Aust Regional Uni2 is important to its local community and beyond in those metrics that are largely invisible: consulting and contract research. Yet each of these universities could improve their performance in TT&C, in the manner of NZ Uni, if the key criteria for success in TT&C were satisfied.

9.4 Conclusions

Each Australian case study university exists in an environment that offers the same common infrastructure, yet there are some universities that perform well at TT&C, while others do not. The essential question is: why? What factors permit some universities to succeed at TT&C, while others flounder?

Clearly the first requirement for universities to succeed at TT&C is a common infrastructure that provides an adequate environment for TT&C to exist. There is no such thing as a perfect environment due, at least in part, to the rapid changes occurring in technology and universities’ role in it. However, the case studies show that, as long as the common infrastructure is at least benign, and if universities can satisfy the criteria mentioned below, they can achieve world-class TT&C results.

The first conclusion from this analysis is that the data show there are three essential criteria upon which university TT&C success is built: institutional and senior executive support for TT&C; superior TTO management; and sufficient world-class research being conducted. First, the university government and senior executives must demonstrate genuine support for TT&C over a period of years, supply the resources needed for success, and permit TTO management to develop and undertake long-term plans capable of maturation. Second, the leadership of the TTO provides the vital element in a successful enterprise. The Director has to have that unique combination of attributes that permits him or her to work in this most unusual enterprise: the ability to meld a team of highly intelligent individuals; the ability to work within the arcane structure of a university; the ability to work with a range of technologies that usually have vastly different profiles; and the inspiration to identify real commercial deals and the tenacity to see them through to completion. To this must be added obligations that include training researchers in commercialisation, and managing and growing a complex business in an environment that is immature and changing with amazing rapidity. The third factor needed for TT&C success is the existence of world-class research at the university; it is not necessarily the quantum of research that is important, because universities can create a body of TT&C success by exploiting whatever world-class research they are undertaking.
The second conclusion is that the same key criteria for success in TT&C appear to apply across the board, whether a university is smaller, regional, technical, new or old, research-intensive or otherwise. There may be more challenges facing smaller and regional universities, but if the essential conditions for TT&C success are in place these challenges can be overcome, as the data show.

If the essential criteria for success are met, the balance of the challenges facing universities: industry linkages; structure of the TTO and staff remuneration; university policies and processes; incentives and remuneration for researchers, entrepreneurship and university culture, resources to assist spin-off companies, and even early-stage funding, can be overcome as they have among the benchmark universities and better-performing Australian case study universities.
Part V – ANALYSIS - INDUSTRY TECHNOLOGY UPTAKE

Part V deals with Research Question 4: How could the uptake by industry of Australian university research outcomes be improved? Sections 10.1 to 10.5 describe in some detail how the question is framed and the process by which it is answered. Section 10.6 answers the research question by analysing primary data from case study companies, while Section 10.7 analyses secondary data using narrative review and triangulating the results from the two methods. This approach is used in order to provide a rigorous result and to demonstrate the use and combination of alternative methodologies to derive the result.

10  The Performance of Industry in Absorbing University Output

10.1 The Research Question

There are a number of mechanisms by which industry, Australian or otherwise, takes up Australian university research: by licensing technology; by starting new enterprises; contract research, consulting; and other modes of co-operation. The general view of interaction between Australian universities and industry is summarised in the report on best practices in university research commercialisation for DEST (2002, p.vii):

“... Australian industry, with its fragmentation, small size and low R&D investment in general has a relatively poor capacity to absorb university-generated technology. For this reason, many linkages have to be established with overseas firms”.

Consistent with this view, it was noted earlier that most TTOs see the market for their technology as satisfying a global need – it is rare that research at the cutting edge will produce results relevant only to a domestic market. The research question therefore has two potential limbs. The first involves the strategies that universities should use to promote the uptake of their research by industry generally (not limited to Australian industry) recognising that the market is likely to be global rather than local. The second limb is: what can or may be done to ensure that Australian industry, or at least the Australian economy, takes most benefit from the research?

In relation to the second matter, a perceptive article by Cebon (2006) summarised ten case studies dealing with innovative Australian companies and drew two conclusions (pp.65-66):

“The first is that it is probably much harder for these firms to be successful than it would be if they were located in another country. Second, there is no obvious single cause which, if solved would make the problems go away. Rather, it appears that the managers of these ventures are relatively poorly equipped for the task, on one hand, and that the environment they face as a source of labour, capital, and other inputs is significantly more problematic than in other countries. Furthermore, as a general rule, Australia is a more difficult domestic market for high technology products than other countries, and it is more difficult to export from Australia than from other countries. That is, these companies face a complex suite of
barriers to success, and not just one or two obvious barriers which, if fixed, would make the problems all go away."

These conclusions describe the same difficulties facing university-industry interaction in Australia.

10.2 Analysis Process

The first step in the analysis process requires the identification of the issues under which to analyse the research question. The issues were identified based on the headings used above in analysing universities, as well as being derived from the propositions and topics raised in preliminary discussions with industry participants, and using some issues that emerged from the literature. Case studies and the narrative review were then developed using these headings. Case studies were prepared from interviews with companies using the script shown in Exhibit C of Appendix 1 supplemented with information about the case study companies available from public sources.

The research question is examined from two directions for the purpose of permitting conclusions to be drawn. This is done by using methodological triangulation: first, by compiling case studies based on the industry interviews (Section 10.6); and, second, by reviewing the literature on the topic using narrative review (Section 10.7). The same headings are used, to the extent possible, in both analyses to permit comparison of the two results. The relationship between the later headings in this chapter and the propositions developed earlier is shown in Table 10.1.
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<td>9</td>
<td>Industry clusters</td>
<td>Industry clusters aid universities and industry in TT&amp;C</td>
<td>10.6.13 10.7.13</td>
</tr>
<tr>
<td>10</td>
<td>Role of intermediaries</td>
<td>Intermediaries operating between universities and industry improve TT&amp;C</td>
<td>10.6.14 10.7.14</td>
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<tr>
<td></td>
<td></td>
<td>performance</td>
<td></td>
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<tr>
<td>11</td>
<td>Technology parks and incubators</td>
<td>The presence of technology incubators and technology parks stimulate better</td>
<td>10.6.8 10.7.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TT&amp;C performance</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Regional and smaller universities</td>
<td>Regional and smaller universities must satisfy different criteria to other</td>
<td>10.7.15 10.7.15</td>
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<tr>
<td></td>
<td></td>
<td>universities if they are to succeed at TT&amp;C</td>
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<tr>
<td>13</td>
<td>The role of government</td>
<td>The role of government in stimulating TT&amp;C is to establish an environment</td>
<td>10.6.12 10.7.12</td>
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<tr>
<td></td>
<td></td>
<td>that encourages parties to participate</td>
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</tbody>
</table>

**Table 10.1 – Links between Propositions and Industry Case Study Analysis**

**10.3 Selection of the Case Studies**

Case studies of manufacturing companies were selected from a group that had the following characteristics: in the electronics or related high-technology industry; in the Brisbane area (for ease of logistics); and in the small to medium business category. Seven companies were approached to participate as case studies, of which six had had dealings with universities. Of these six, five were able to participate in the relevant time frame. Companies were not approached on the basis of any *a priori* knowledge about their actual or likely dealings with universities, and the extent and depth of the companies’ dealings with universities came as a surprise to the researcher. Summary background information on the case study companies is shown in Table 10.2.
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Year Established</th>
<th>Approx. Turnover</th>
<th>Approx. Employees</th>
<th>PIFRO Dinealge</th>
<th>Universities Dealt With</th>
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<tr>
<td>Company A</td>
<td>1998</td>
<td>$5m</td>
<td>25</td>
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<td>Griffith</td>
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<td>James Cook</td>
<td>Queenland</td>
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<td></td>
<td>UTS</td>
</tr>
<tr>
<td>Company B</td>
<td>2003</td>
<td>N/A</td>
<td>112</td>
<td>CSIRO</td>
<td>Griffith</td>
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<td></td>
<td></td>
<td></td>
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<td>ANSTO</td>
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<td>Adelaide</td>
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<td>South Australia</td>
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<td>Western Australia</td>
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<td>Camborne School of Mines</td>
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<td>Colorado School of Mines</td>
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<tr>
<td>Company C</td>
<td>2002</td>
<td>&gt;$8m</td>
<td>30</td>
<td>DSTO</td>
<td>Queensland</td>
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<td></td>
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<td></td>
<td></td>
<td>Griffith</td>
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<td>QUT</td>
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<td>RMIT</td>
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<tr>
<td>Company D</td>
<td>2003</td>
<td>N/A</td>
<td>12</td>
<td>CSIRO</td>
<td>Queensland</td>
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<td>Wollongong</td>
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<td>RMIT</td>
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<td>Monash</td>
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<td>ANU</td>
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<td>Barcelona</td>
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<tr>
<td>Company E</td>
<td>1996</td>
<td>$10-$15m</td>
<td>50</td>
<td></td>
<td>CQU</td>
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</tbody>
</table>

Table 10.2 – Characteristics of Case Study Companies Source: Case Studies

The views of the three venture capital company case studies listed on page 10, two from Australia and one from the US, plus that of US Strategist are relevant also to this analysis.

The fact that all the case study companies are located in one city, Brisbane, should not compromise results because there is unlikely to be any significant difference between the results obtained among SMEs in different large Australian cities. However, there are some caveats on the results from these case studies. First, the sample size of five companies is relatively small, so that there may be some concern over the general applicability of the results. Second, the manufacturing companies were selected from one industry group, electronics, which may limit the applicability of results outside this industry group, or to industry groups that are less open to innovation (Laursen and Salter 2003). Third, the manufacturing companies are SMEs, so that the results may not be applicable to larger enterprises. Even allowing for these caveats, the results of the case studies are illuminating and suggest that some generalisations are possible, while giving guidance on where further research may be useful in verifying and expanding on these results.

10.4 Transferring University Knowledge to Industry

Knowledge transfer activities between universities and industry can take many forms, as described by the Science and Technology Policy Research Unit at the University of Sussex shown in Table 10.3, but there are many ways in which the activities can be identified and characterised (Howard 2001, 2005a).
From the perspective of the university TTO, TT&C activities were considered earlier as having four main components: consulting, contract research, intellectual property licensing, and spin-off companies. However these four components do not cover the richer range of dealings identified between the university (as distinct from the TTO) and the case study companies examined here.

If the opinions of Australian university TTOs reported earlier are taken at face value it would appear that SMEs and universities have little interaction and universities have little to offer SMEs. However, this does not represent the case at all – evidence from the industry case studies shows that universities and SMEs are frequent partners. When seeking to locate SMEs in the electronics industry to analyse for this project it was found that six of the seven companies approached reported recent dealings with universities. Quite clearly universities are a potent source of ideas for SMEs (or at least some SMEs), so how could there be such a disconnect between the importance to universities of SMEs reported by TTOs on the one hand, and the fact that SMEs frequently engage with universities on the other? As the analysis below demonstrates, it arises from a number of factors including: scale (TTOs need to deal in global technology generally with larger companies rather than local companies); the depth of personal relationships established between SMEs and university faculty members; and the fact that SMEs are much less interested in intellectual property licensing than in direct personal interactions such as staff transfer and using graduate students within companies.

Consistent with this view, Cohen and Nelson (cited in Colyvas, et al. 2002, p.68), reported that:
“A survey research study done in the early 1990s ... inquired of industry the most effective channels through which firms benefited from university research. In most industries the most cited channels were publications, open scientific communication more generally, and consulting. In very few industries did licensing of university patents come up as an important channel”.

Other evidence suggested that the industries that find patents an effective channel are pharmaceutical and chemical industries (Mansfield 1986) and life science-related industries.

10.5 What Attributes Measure Knowledge Transfer to Industry?

Attempts by scholars to measure the value of knowledge transferred from universities to industry have not yet provided satisfying results. The difficulties in doing so in the US context are described by Geiger and Sá (2005, p.3) (italics by author): “Academic research rarely produces marketable goods, but rather serves as an input to enhance the value of industrial R&D. For this reason, its tangible value cannot be precisely determined. Nevertheless, its contribution can be critical in gaining comparative advantage”.

Mansfield (1986, 1991, 1998) among others has shown the importance of university research to industry, and attempts by the Australian Government (Allen 2003a; 2003c) to quantify the contribution are helpful, but subject to interpretation based on assumptions and data limitations.

10.6 University-Industry Interaction - Case Studies

10.6.1 Knowledge by Industry of Relevant Research

Without industry being aware of research there can be no effective transfer of knowledge and subsequent innovation. Therefore the starting point for commercialisation is industry awareness of research results. Historically the principal means of communicating new ideas developed at universities is through graduates, publications, public lectures and the like. It is estimated that over 90% of ideas go out the university door otherwise than through the TTO (US Strategist Interview 2007). An Australian TTO Director substantially agreed, estimating that “... over 95% of the university’s technology goes out free into the world, and that is at it should be” (Aust Go8 Uni’1 Interview). Whatever the proportion may be, the point is clear: most university technology goes into the community freely.

Protecting university technology, where it is done, is for the purpose of assisting industry because, in some cases, industry will only be able to use technology when it is protected. This necessity is explained by US public university:

“You particularly see this in the pharmaceutical type area; where if something isn’t patented, if it isn’t licensed, it is basically a lot of discoveries that just don’t go anywhere because it has to be exclusive, it has to somehow generate income back to a company that is going to
invest hundreds of millions of dollars to develop this, [and] if they don’t have a strong patent position it just sits there and doesn’t go anywhere” (US Public University Interview 2007).

Similarly, an Australian TTO Director stated, in such cases “…to get interest you have to have it protected. We don’t expect to make a lot of money out of it; the whole process is about facilitating, getting it into the hands of an industry partner or whoever that can use it” (Aust Small Uni Interview 2006).

There is a greater likelihood that ideas and discoveries will be communicated to industry in the future using an open-source approach, often with the involvement of powerful and cash-rich foundations. This is evident in the United States through entities such as the Case, Milken and Gates Foundations which are providing enormous sums for medical research. As US Strategist said: Foundations and the like represent “… new forms of collaboration that did not exist in this country, or around the world. You have some people who are thinking of the higher good …”. In essence, any company that wants to exploit knowledge may do so, “… but what we’re not going to do is [fight] over the research and the research agenda and who [wins] along the way”. Disputes over the ownership of the intellectual property will not be permitted by the foundations (US Strategist Interview 2007).

A somewhat similar theme runs through the development of simplified access to university inventions at Canadian Uni1, one of North America’s leading commercialisation universities, which permits simple access to the university’s ideas – in fact at least 90% of licences issued by the university annually are done through this mechanism – with little intervention required by the university. In leading universities it is likely that the role of the TTO will continue to involve capturing and protecting ideas and negotiating with industry on their use, but the mode of delivery of many of the ideas may well change to a more open format.

None of the industry case study companies reported using databases or the like to locate information about university research – indeed, only one was even aware of them. This is despite the fact that it is usually the company and not the university that initiates business contact. Companies are pragmatic when it comes to seeking information. They don’t search university sites because “… you don’t know where it’s been published. Individuals may not be putting it on the university website …" and they “… are impossible to navigate. You’ve got to know what you’re looking for” (Company E Interview 2007). But they use the internet extensively, generally using Google or similar search engines because, if they are looking for information on a topic, Google will generally locate everything available, including relevant papers.
10.6.2 Cultural Differences

One theme that recurred in the industry case studies was the different imperatives driving universities and industry. These differences in motivation, time frame and general attitudes made it difficult for the two parties to understand fully each other’s view.

Vignette #10.1
On the differences between the philosophies of universities and industry, a Managing Director said:

“There is no way that an entity like [our company] can relate to a university. I don’t think there’s any prospect of it at all. They have totally different time frames involved; they have totally different understandings of market – they don’t even know what a market is, most of them – so we can’t talk with the structure there”.

There are occasions, however, when cultural differences can work to advantage. For example, one company found this when working with the University of Wollongong, “... which is pre-eminent in high temperature superconductivity. They probably have the best facility in Australia for high temperature superconductors”. The facility in Wollongong is operated by materials scientists, so that Company D has “... engineers [that] are systems people [while the university researchers] are phenomenological people, and that’s a happy relationship. That’s the way I always try to work the relationships with any university” (Company D Interview 2007).

While case study companies have benefited from their dealings with universities, among some there remains something of an equivocal view about the appropriateness of universities dealing in commercialisation. This was put succinctly by the Chief Technical Officer (CTO) of Company A when he said:

“... I have iconoclastic views of universities becoming commercial is all madness. Academics are at universities because they are interested in technical issues or in what particular [interests them], not in being commercial; trying to expect them to be both is silly. I think it’s distorted universities” (Company A Interview 2007).

However, the practical necessity of universities having a TTO in the current climate, whatever it may do to the university intellectual commons, is reflected in the views of others such as Company E: “What surprised me was... that not all universities are doing it [running an efficient TTO]. I was really surprised. I can’t understand how a university, in this day and age, cannot possibly have a commercialisation unit working there” (Company E Interview 2007).

10.6.3 Fields of Research

There are two principal areas of investment by Australian venture capitalists: life sciences, and ICT/physical sciences. This break-up mirrors the split observable both among university
TTOs and the number of ventures publicised by AUTM and KCA (roughly 50% in each of life sciences and physical sciences/ICT, broadly defined), and venture capital will follow one or both fields.

It is possible that the ICT sector has peaked in terms of investment following the bursting of the dot-com bubble, but emerging areas such as energy, extractive and environmental sciences may play to Australia’s research strengths. Despite Australia’s obvious strength in agriculture, Aust VC1 was rather pessimistic about the commercialisation prospects arising from universities in this field.

10.6.4 Linkages

There are numerous modes of linkage between industry and universities as shown in Figure 10.4. The five case study companies examined in this project used most of the modes shown in this figure.

![Hierarchy of Linkage Mechanisms](https://example.com/hierarchy.png)

**Figure 10.4 – Hierarchy of Linkage Mechanisms** Source: OECD (2001)

For example, one case study company, Company B, is a 2003 spin-off company from a PFRO. While the company is not descended from a university, it exhibits many of the same characteristics, although it had developed a reasonable degree of maturity before separation. Two other case study companies, Company A and Company E, are descendants of a university spin-off.
Most case study companies used multiple linkage mechanisms. Every one of the case study companies had engaged in contract research with universities, four of the five have or have sought licenses from universities, and a majority engage post-graduate students to assist in development. Case study companies have also used two linkage mechanisms not listed in the figure above: providing adjunct professors, and board membership from universities. While it may be possible to include these in one or other category listed by the SPRU or OECD, they appear sufficiently distinctive to be noteworthy (Howard 2001).

Two companies also observed that they find university libraries and journal collections of considerable assistance in their work but find this source of information closed to them. This would be a form of linkage and interaction that would benefit Australian industry, certainly SMEs who are less likely to have the resources to afford separately the cost of multiple journal subscriptions, in the event that universities could make this service available.

The mere existence of high quality research in a university does not mean that a university represents a suitable commercial partner for industry. More is needed, in particular the willingness to engage with industry in TT&C – and this has to start with the university President and permeate the culture of the institution and be reflected in the university’s rules. US VC said of his experience with universities it has been “bittersweet”, and this statement coming from a venture capitalist that deals only with universities that encourage TT&C while largely neglecting research-intensive universities. In the Australian context the same point is made by Aust VC1, which said that some of the Group of 8 research intensive universities are “empty vessels”, while some universities with the right culture, like Curtin University in Western Australia (a member of the ATN) are successful and well regarded by industry (Aust VC1 Interview 2006). Aust VC2 agreed with US VC: “If the spin-out doesn’t happen, even though the researcher and the university want it to, they’ve still got a day job. But it all gets too hard. It’s not like there is a burning, real, desire to get it out [into industry]” (Aust VC2 Interview 2006). Another difficulty with university researchers is that they cannot be forced to engage in commercialisation activities if they elect not to do so:

“There have been opportunities where the researcher has not been interested in a spin-out... [while] there’s not an issue with that at all, ... it just means that if you see something you are interested in, that doesn’t necessarily mean that you will be able to commercialise it, even if the university wants to commercialise it” (Aust VC2 Interview 2006).

Vignette #10.2

The vital linkage between SMEs and universities is the personal relationship. As one SME Managing Director said about the selection of a partner:

“We didn’t choose the university, we chose the professor because of the expertise – he’s an acknowledged expert in the field”.

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The importance of the personal link between the university and the company is mentioned by each of the case study companies. Without doubt, this is the key link without which TT&C would not exist. This is not always an easy road as Company D identified:

“Relationships are very, very important in this business. We can’t work with people who are too awkward or eccentric or unpleasant, we just can’t do it. It’s so inhibitory in terms of the speed that we want to move at. So we’re quite happy for them to have their peccadilloes, but we can’t deal with it in a commercial sense” (Company D Interview 2007).

Industry is practical. Its wants to make money and it wants to do so efficiently. It does not want to waste time on process for its own sake or pursuing technology that cannot be taken quickly to market. Whether the source of technology is the university itself, a CRC or a research institute is not a material issue; the real concern is getting a practical deal done and, assuming that suitable technology is being created, the most important criterion is the preparedness of the university or other research entity to deal efficiently with industry. Some universities have developed this ability by the selection of the right staff, the development of appropriate processes and the cultivation of a culture supportive of TT&C. These factors are clearly at work in universities achieving superior TT&C results – Canadian Uni1, US Private University and NZ Uni are outstanding models in this regard. In the Australian context venture capitalists appear to find it easier to deal directly with CRCs than universities, which is an interesting contrast with the TTO view of CRCs. At the same time high-technology manufacturing companies, which work on a personal basis with university professors, also find CRCs to be of limited interest or value (see next section).

10.6.5 Co-Operative Research Centres

Universities produce ideas with commercial value through two principal mediums: the universities themselves; and through their connections with other entities, in particular Co-operative Research Centres (CRCs). From the universities’ point of view, described in Section 9.3.8, CRCs do not generally represent a potent linkage with industry – if they did not exist most TTOs would not be concerned. This view is not uniformly the same from industry’s perspective. For example, Aust VC1 believed that CRCs have incentives to act commercially because their funding is renewed every few years:

“…we’ve had more success with CRCs [than universities] because they are a little more accountable, they know they need to demonstrate that they’ve actually [achieved results from research], whereas universities have no accountability whatsoever. [Universities take the view that] ‘we don’t have to demonstrate our value to anybody’, so CRCs have a motivation to show that they can successfully develop commercialisable outputs”. With universities, however, they have found “…there is absolutely no urgency at all. It doesn’t matter [to the university] if a deal gets done; there is no accountability” (Aust VC1 Interview 2006).

Aust VC2 has a similar experience, finding CRCs easier to deal with than universities directly. They said:
“We have a better investment rate out of CRCs than out of universities... because they've actually got prototypes in some instances and they've got potential end-users who are saying this is valuable. They always have some more level of market validation when we speak to them than universities”. CRCs are generally more able to identify the market users. “They have users in mind [and they] have the CRC participant as a partner inputting [information during development]” (Aust VC2 Interview 2006).

While theory may suggest that CRCs are closer than universities to industry, the manufacturing companies interviewed expressed the general view that CRCs had little or nothing to offer them. Unless a company was part of a CRC consortium, and none of the case study companies were, CRCs were seen as dealing with larger companies rather than SMEs and, in any event, one had to be a part of the consortium to be privy to any results. Company A said: “I think CRCs are a mixed bunch. I think we are a little too small [to be of interest to CRCs]” (Company A Interview 2007). Continuing this theme, Company E commented that it had only dealt with them:

“... very indirectly, through other people... I have no experience of them, but I have never experienced any outcomes from them, either. Never seen any outcomes from CRCs. Not in our area... They are all the same thing. They are dealing with the big end of town most of these guys...small guys are never going to see any results” (Company E Interview 2007).

CRCs were not generally of assistance to SMEs because “they are too hard to deal with” (Company D Interview 2007). In addition to the other difficulties, one case study company commented on the fact that CRCs received funding only for specific periods and may not be renewed. This uncertainty meant that “Sometimes when you approach them at year five, it's all too hard. They don't know whether they're going to still survive after two more years” (Company D Interview 2007).

One exception to this view related to a company spun-out of Aust Small Uni to assist industry in the design, fabrication and integration of polymer micro-engineered systems, exploiting bio-, micro- and nano- interfaces, which received favourable comments from one case study company. A second exception was Company B’s experience with the Co-operative Research Centre for Coal in Sustainable Development (CCSD) located in Brisbane. CCSD had Company B perform some work on a paid basis as part of its research on measuring coal attributes, a project that has proven useful in gaining industry acceptance of Company B’s products world-wide.

**10.6.6 Australian Industry Capacity to Absorb University Research**

(a) **Lack of Local Receptor Businesses**

The TTO Director at a Canadian university expressed a view common among universities in smaller economies when he said:

“... we don't have receptor capacity in this country in a number of areas. I think you can see that in life sciences in particular, where Canada has the second largest number of life sciences companies anywhere in the world, but it is undercapitalised with thin IP, so if we
have four hundred companies, two-thirds of them have less than a year’s cash on hand… Licensing can solve the market issues, but there are other factors around the terms of the deal” (Canadian Uni2 Interview 2007).

The university also mentioned that Canada is working in a global economy, which means that it may have to license to international companies, not only Canadian ones. On this issue: “…we’ve got to change our mind frame”. Canadian Uni1, on the other hand, noted that the source of its licensing revenue for 2005-2006 was 71% from the Province, 14% from the USA, 11% from the rest of Canada and only 3% from the rest of the world. This suggested that local receptors in this Province may be quite strong, with some of this, at least, arising from the fact that the Province is such a long distance from the major Canadian population centres, and “…there is a bit of a frontier mentality west of The Rockies, and I think that’s something that has actually helped us more than hindered us” (Canadian Uni1 Interview 2007).

A senior TTO Manager at a US university, an experienced operator with knowledge of Australia, made special comment about the apparent lack of suitable receptor businesses in Australia when he said:

“Certainly, one of my observations…was the limitation on technology transfer from Australian universities was not [with] the universities [because], I thought, by and large the offices of technology transfer seem to know how to do it, but it was on the receptor side that the availability of early-stage risk capital was limiting, and the availability of experienced management who knew how to do start-ups” (US Private University).

Australian universities cite numerous examples where foreign businesses have been the eventual receptor of their technology. Aust ATN Uni2 sold its premier spin-out to a US company in 2005. Aust Small Uni has developed an advanced medical device which no Australian company could take up and it has had to look to the US for potential receptors.

The combination of universities working in a global marketplace and the perceived lack of receptor businesses in the local economy must necessarily limit the potential for university research outcomes to be exploited in the domestic economy. Another logical outcome could be the greater likelihood that universities in smaller economies would chose to commercialise through spin-off companies. Universities in larger economies, such as the US, are generally more inclined to license intellectual property than create spin-off companies.

Case study companies reported that they are operating in a global market in just the same way as Australian case study universities commented, as illustrated by Vignette 10.3.
Vignette #10.3
SMEs are looking to global markets, just like universities. One SME said:
“Forget about [the domestic market alone]. Australia is far too small – you can’t possibly do it. But the big problems for companies in Australia, and even bigger problems in New Zealand, is the size of the local market”. They have to, and do, address a global market for their products.

(b) Lack of Local Management Expertise

In transferring technology to industry through the spin-off company route, a university has to be able to find management and board members that can guide the company to success. Canadian Uni1 said that, until about 2000 it did not assume the responsibility to find and appoint management and boards of spin-off companies, but since then “...it’s been an ongoing challenge trying to find the right people...” (Canadian Uni1 Interview 2007). This sentiment is repeated by most universities, for example, Canadian Uni2: “So, my personal worries about spin-offs are the management team, the capitalisation and the market access ...” (Canadian Uni2 Interview 2007). It is not just a matter of having experienced managers and board members, for example according to Cebon (2006, p.58) in relation to innovative Australian start-up companies: “Starting up a high-technology venture is one of the most difficult managerial tasks in a modern economy, and yet these ventures failed to attract the best managers”.

(c) Risk Aversion

Aust VC1 identified five types of risk in any deal: management risk; technology risk; market risk; model risk; and financing risk (Aust VC1 Interview 2006). Ferris (2001) referred to a culture of risk aversion on the part of companies as one reason for there being a disconnection between invention and commercialisation. Aust VC2 referred to a culture of risk aversion on the part of universities. There is likely to be different ability to accept risk among companies and universities according to a range of factors, most likely influenced by their experience in TT&C.

“Universities are risk-averse, that would be clear to everyone. But sometimes they are too un-commercial in that they want to get things commercialised with no down-side to themselves, which doesn’t work commercially”. For example, a venture capitalist will invest money which, in the event that a venture fails, they lose their money. However, some universities want to keep an option over the value of intellectual property they contribute by “[placing their IP in a company], get the funding [and] get the benefit of the venture if it works but, if it doesn’t, if it fails, they want to call back the IP”. This has been done by
offering, for example, a licence rather than an assignment of intellectual property (Aust VC2 Interview 2006).

An Australian TTO Director identified a commonly-held view when he said that Australian industry is very risk averse (Aust ATN Uni2 Interview 2006).

(d) The Size of the Receptors - SMEs

SMEs appear to be something of an enigma to Australian university TTOs. SMEs are, of necessity, the receptor when technology is placed into a spin-out company, because a spin-out company will necessarily be small – at least at the beginning. But the general reference to SMEs in this context usually involves licensing technology to SMEs other than spin-outs, and the difficulties associated with doing so.

There is generally limited incentive for existing Australian SMEs to undertake the commercialisation of university research because of the significant risks inherent in doing so, and the ponderous (for an SME) university systems involved in licensing technology. The difficulties in dealing with universities expressed by Australian venture capitalists, which have access to all manner of technical, legal and financial expertise, are magnified many fold for SMEs that do not possess the same level of resources. Yet the transfer of technology from university to SME in the United States appears quite vigorous. The two major obstacles: commercialisation risk and university systems, have been overcome to a sufficient extent in the US so as to encourage SME engagement. This is achieved through deliberate federal Government policy expressed in the Small Business Innovation Research (SBIR) Program (Connell 2006) and related policies.

In Australia it may be that SMEs are great adapters, but this is not the role of universities – universities are about inventing new ideas rather than adapting existing ideas (Aust ATN Uni2 Interview 2006).

10.6.7 Making the Connections

Industry can find universities frustrating to deal with. An Australian venture capitalist commented:

“… I think we’ve probably had our phone ring ten times. [Universities complain] all the time: ‘there’s no money to support [development]’, [but] the pre-seed experience is: don’t sit there and wait for them to come to you. We’ve had to drag everything out of those universities and, in fact, [some] have active policies that prohibit you from knowing what’s going on – it’s all about territoriality… It’s very difficult to get [universities] to [disclose information about research] and actually show you what they have got. Further exacerabrating that is the [fact] that some of these departments are somewhat [resource limited], and it’s a lot of time and effort to go out and actually [identify] …the IP from within the university. Many of the universities don’t even know what they, themselves, have. I could probably tell them about things [about which] they have no idea…from [my] dealing directly with the departments” (Aust VC1 Interview 2006).
Australian venture capitalist VC2 expressed the same view, finding universities somewhat difficult to deal with, exhibiting a lot of inertia, and slow to get deals done. “What would help is if there was some way to create a greater sense of urgency in the universities and the researchers...”. Both Australian venture capitalists mentioned that it typically takes at least twelve months and up to eighteen months to get a deal out of a university.

While several Australian universities observed that they do not get business from common-user databases and networks, industry is rather keener on them as a way of finding potential commercialisation opportunities. An Australian venture capitalist cited existing models at Berkeley University and the CSIRO, both of which operate “…a searchable database – everything that they’ve got – a little paragraph on everything…” (Aust VC1 Interview 2006).

Manufacturing case study companies generally expressed less frustration in their dealings with universities, possibly as a result of working quite closely and having several linkages, but they still felt that there was much to learn about what universities are doing that may be relevant to them. For example, Company E noted that it had never been approached by a university and relied on established relationships when working with universities. A similar sentiment was expressed by Company A. Company B said that it has had to approach universities to initiate engagement, and that it would assist if, “…when they have an open day or a session where they invite industry people to come in and talk about what they want to do. I have no idea how to do that, [but] that would be extremely valuable for us”.

Providing information to its market in a readily accessible form is done by leading universities. For example, at Canadian Uni1:

“The Technology Transfer Group markets its technologies to industry, often through direct relationships, but also by distributing a CD-ROM containing a searchable database of available technologies. This database is also mounted on our website and currently contains over 100 technologies available for license and investment” (Canadian Uni1 Interview 2007).

10.6.8 Technology Parks and Incubators

Only one of the case study companies (Company D) started life in an incubator\(^\text{182}\), and found it a worthwhile experience. While most of the other start-ups in the incubator with Company D tended to be involved in software, the value for Company D was in the general support, the opportunity to meet venture capitalists, and the ability to access specialist facilities – in this case a furnace suitable for ceramic work. One case study company noted that a number of its customers evolved from incubators, and said: “My experience of incubators is that they can work” (Company E Interview 2007). The other four case study companies started without

\(^{182}\) Company D started at a State Government-funded incubator, iLab in inner-city Brisbane, Australia.
an incubator, while two (Company C and Company D) are located in Brisbane Technology Park. Company C is there because it obtained a good deal from a former tenant, while Company D took over space from a company with which it shared space but subsequently moved. Company D finds it useful to be located in a technology park because it: “... needed a commercial presence in order to try and get the venture capitalists to take us seriously”. Company A, on the other hand, expressed the view that Brisbane Technology Park was unsuitable for two reasons: “… one was it is too far away from [where the staff live], and the price of it... It was way above what we wanted to pay”.

Venture capitalists expressed the view that the existence or absence of incubators is largely irrelevant to university commercialisation. US VC said that start-up companies need entrepreneurs, not managers, and entrepreneurs don’t fit into incubators. Aust VC2 expressed the view that incubators assist new companies in education and developing a business plan but conceded that “... we’re not going to increase the price [paid for a business] because you are in an incubator”. Aust VC1 viewed them as a “third-order issue”. Indeed, most of industry would like to see the cold winds of financial reality whip around new ventures so that they begin to act commercially sooner rather than come to believe that the warm blanket of state funded real estate and facilities will be there to support them for as long as they need.

10.6.9 Intellectual Property

Much of the industry and university data collected in interviews suggested that registered intellectual property is of diminishing importance in commercialisation dealings for reasons such as excessive time spent in protecting and negotiating on it, the prevalence of defensive patenting, and the rise in importance of open-source technology. US Strategist explained the desire to avoid patenting wherever possible because of the complexities and delays it imposes and the rise in influence of well-endowed public-interest foundations. As Canadian Uni1 said, it has become more flexible in the way it deals with intellectual property and industry in order to make transfer easier and simpler. Certainly in the high-technology sector (life sciences generally excepted) intellectual property was becoming a barrier to working with companies, so the better way to operate is to concentrate on getting funding for sponsored research and be more flexible in respect of protecting intellectual property and sharing it with industry. Life sciences, on the other hand, because of its particular market and regulatory demands which can mean that there may be many years or decades to market, does require intellectual property protection, at least when it emanates from universities, and at least on some matters.
Most case study companies did not report any difficulties in dealing with universities and intellectual property. Largely this arose because intellectual property rarely became a contentious issue for them, indeed it was rarely important to the relationship at all. Company D noted that patents, in particular are rarely vital to the company because of the need to move quickly to market, but: “... they are of great relevance to attract venture capital”. In similar terms, Company A expressed the view that: “What you commercialise from universities, in my view, is the people and ideas rather than actual things”.

Most relationships have proceeded smoothly, with Company D reporting that, while the University of Wollongong granted it a world-wide, exclusive, royalty-free licence to use the intellectual property arising from their work together, other universities have not been so easy to deal with. The company found the starting position of many universities on matters of intellectual property to be a source of aggravation and delay in consummating the relationship, particularly in electronics where the commercial window of opportunity can be relatively short.

Australian industry is aware of the fact that local universities have the freedom to develop their own distinctive intellectual property policies and the added complexity that this means to a deal.

“... With a university, you [have] to go in and secure the IP, which means either, if they haven’t already done it, setting up the vehicle, getting the researchers, all the universities, all the departments, all the students, all of them to actually reach an agreement on the IP before you can go forward”. The necessity to do this “…has slowed deals down significantly... It might take a year to do a deal out of a university, and that’s not uncommon...we’ve had some that have gone eighteen months to two years, but that’s from first contact to getting a deal done, so there were a lot of steps in between” (Aust VC2 Interview 2006).

Valuation of intellectual property can be a contentious issue, but “… as everyone becomes more experienced you get more realistic valuations, and the reality is that if the valuations don’t work, then we won’t invest... There have been deals where we haven’t invested because we haven’t agreed on valuation” (Aust VC2 Interview 2006). Even mature TTOs like that at Canadian Uni’1 believe they can improve their performance at intellectual property valuation. In a 2006 review of its practices, among other matters the TTO was identified as over-estimating the value of intellectual property in negotiations. While this may reflect an element of vigorous self-criticism, it does indicate the continuing difficulty facing TTOs in negotiating with industry the value of intellectual property, particularly when the intellectual property is quite early-stage.

Aust VC1 said it would like to see Australian universities subject to a “use it or lose it” regime in relation to their intellectual property in the style of the Bayh-Dole Act. While on the surface this approach has appeal, there are at least three practical difficulties. The first is that such a
rule could only apply to registered (as distinct from unregistered or unregistrable) intellectual property, so it would apply to a limited set of university intellectual property which would have to be published somewhere so that all interested parties could become aware of its existence. Second, if universities are made subject to such a rule they may become reluctant to register intellectual property for fear that they have limited time in which to use it before they lose control of it. And third, most university intellectual property involves quite early-stage ideas that need further development before technical risks have been sufficiently ameliorated, which means that the continuing involvement of university investigators is usually needed to advance it towards commercial reality – yet there is no means by which universities may compel the continuing involvement of university researchers in commercialisation activities.

10.6.10 University Technical Transfer Offices

While personal relationships between a university academic and a person in an industrial company are the key to TT&C, as noted earlier, there are occasions when companies have to deal with the TTO. The fact that they are SMEs may colour the views of the case study companies, but there was a consistent view among them that TTOs are either irrelevant or, where they have to be dealt with, difficult. Industry’s discontent arose from several causes, such as the costs associated with dealing with TTOs, the delays imposed when dealing with TTOs, and the attitudinal differences between TTOs and industry. These problems were exacerbated by the fact that universities often have only nascent ideas that need much more development before being marketable:

“We always know that when we go into ... an engineering faculty or a physics faculty, we always know, when we’re shown something on the bench, particularly if it needs a bit of student software, it is daggy, and it will not work... This whole thing needs to be re-engineered to even make it work a second time in the lab, let alone in the world... [and] they’ve got no concept of taking it forward” (Company D Interview 2007).

On the disparate culture between TTOs and SMEs Company D said:

“[TTOs] are on a mission. They want to bring the huge intellectual horsepower [of the university] that is sort of almost tangible, but not quite, in this huge enterprise into industry... But no one is addressing the absolute divergent cultural differences between these two groups, because it’s too hard…” (Company D Interview 2007).
Vignette #10.4

SMEs rarely deal with university TTOs. A typical reaction is:

“We dealt directly with the professor, but he did go through some kind of commercialisation process... He organised it all, but the documents we got to sign came from another body within the university”.

While another SME said:

“We deal with the professors. The professors don’t like contractual paperwork”. There has been no instance of the company using a university TTO when the exchange of ideas is involved. “We don’t waste a lot of time signing agreements and all this kind of stuff, it is more of a handshake type of thing”.

And a third, on whether it has dealt with a TTO:

“None at all. Ever...It’s all about personal relationships; it’s got nothing to do with anything other than that. They have to deal with these other entities... but the deals are set up through individuals... that’s what made it happen”.

(a) Costs of Dealing with TTOs

Company D believed that university TTOs do not add value in the chain, rather they add to the cost of dealing with universities. In one contract with a foreign university, the company found that the TTO “cranked on their overheads, just like [Australian universities] crank on their amazing overheads, for no value whatsoever in terms of the process”. The company prefers to negotiate directly with researchers, and “... we are now negotiating a new contract with the people that we were working with which is much more like the old [procedure] that used to exist in universities before the [TTOs] came along, which was a contract relationship”, such as a specified fee for a specified task. “… very simple and hygienic…” (Company D Interview 2007).

(b) Delays when Dealing with TTOs

While not always the fault of the TTO, delays in dealing with universities are a common concern to industry and can be very frustrating. Company C put this clearly when it said:

“That’s my number one complaint with universities in general ...They just have got no concept of the urgency of getting the job done and getting the return on investment, and getting the goods out and the money in. They’ve just got no concept of that. They can afford to sit back and their salaries will still get paid…” (Company C Interview 2007).

In the experience of Company D, TTOs impose delays due to their need to impose a formal process on something that could be dealt with informally:

“... industry will say: ‘Great. We’re in a bit of a hurry’. Pressures of the marketplace. We’ve got speed to the marketplace as our only barrier to a globalised, highly efficient [foreign workforce]... Then the commercialisation people will say: ‘well, of course, we’ve got this intellectual property, and we need some sort of up-front payment and then we need a royalty stream’. And industry says: ‘well, we’re going to take whatever is in this person’s head, and we’re going to develop it into our product’. And then we need to have a document
that does all this. And then along comes this formal apparatus, which probably works okay for the CSIRO but does not work for this situation” (Company D Interview 2007).

Venture capitalists similarly found the delays when dealing with universities unacceptable:

“It takes at least twelve, usually eighteen months, from the time that you first identify something to the time that you get a deal done – it takes that amount of time, that’s unbelievable!” Circumstances are similar in the US: “I have to say, it’s not unique to Australia. I think it’s one order of magnitude more challenging here, but it is not unique to Australia” (Aust VC1 Interview 2006).

(c) **Attitude of the TTOs**

Rather than acting as the gatekeeper of intellectual property and university ideas, a function that can put the TTO into conflict with academic faculty and the traditional notion of intellectual commons, the TTO may be better viewed, in the words of US Strategist, as an integral part of the research enterprise. The research enterprise comprises the idea supply chain, of which the university is one part, with the TTO there to support faculty members, industry and the greater good. As part of this research enterprise, “I think [universities] will become like a hybrid between academic, corporation, and foundation not-for-profit”. These changes have to promoted by the private sector – the government cannot be relied upon alone to stimulate these changes (US Strategist Interview 2007).

The idea of the TTO as gatekeeper was also mentioned by Aust VC2, which maintains relationships with TTOs that appear to work, but “… it doesn’t work well” (Aust VC2 Interview 2006). Aust VC2 would like to see greater urgency in many areas of the university. It may be that the perceived need by some TTOs that they should act as gatekeeper rather than as facilitator in the research enterprise promotes delay and adherence to procedure in order to protect the university’s interests, while the mindset associated with being a facilitator within the research enterprise may lead to faster and better outcomes. This view is supported by recent Australian research on the inadequacy of the existing university policy framework when collaboration using e-research is involved183.

(d) **Staff of the TTOs**

Industry finds dealing with Australian universities on commercialisation highly variable:

“… it’s uneven. You go to some universities and they’re not too bad in knowing what they want to do and how to do it; then there are others who don’t have an idea of how to do it, and they don’t even really have a good commercialisation team” (Aust VC2 Interview 2006).

Similarly, Aust VC1 said that some universities are easy to deal with because they have commercially aware TTO staff while others are “empty vessels”. Part of this arises from the inability of universities to pay TTO staff salaries commensurate with industry expectations for

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183 Reported in *The Australian* Higher Education 22 August 2007, commenting on research conducted by Queensland University of Technology on Legal and Project Issues in Collaboration and e-Research.
high quality operators. The issue of people “… is a real impediment. It’s hard enough to find people who do this stuff really well, but then [universities] exacerbate the situation by paying peanuts…”. Aust VC2 also commented on the variable quality of some university TTOs because of their shortage of sufficiently qualified staff.

As Company D put it, the problem in this regard seems to be that the TTO staff are not appropriately skilled: “… there is nobody qualified to actually qualify the state of play – they just all assume that it’s wonderful… They’ve still got no experienced people to monitor that”.

10.6.11 Availability of Development Capital

Venture capital appears to be in no real short supply in Australia. A good idea will usually get funding to take it through to market once the technical risk has been sufficiently ameliorated. The ready availability of venture capital available to universities, however, is not so assured. By investing in universities Aust VC1 believed that it is:

 “… doing something that, to my knowledge, has never been done before… Venture capital has always steered broad and clear of universities for a very good reason: they are extremely difficult to work with and are not commercial in orientation”.

A majority of case study companies (three out of five) had the backing of venture capital investors but, of course, they have all been trading successfully for a number of years, so the investment risk was considerably diminished.

The volume of venture capital increased enormously in the United States as a result of allowing pension funds to invest in certain new ventures under the ERISA Law (the Employee Retirement Income Security Act 1974184) which is a major factor in the increasing private equity merger and acquisition activity, and the same forces are at work in Australia through the accumulation of huge reserves in compulsory pension funds.

But:

 “… [v]enture capital is not incubation money. Venture capital in [the US] is not interested in giving you money to prove the concept, it is interested in you going into a serious round that eventually will take the company public and I can get my cash out pretty quick… They want to take risk on a time line… we don’t have as much ‘incubation’ money…” (US Strategist Interview 2007).

NZ Uni said that:

 “Basically venture capitalists want to finance market growth, [but] they don’t want to finance technology risk… Government in New Zealand is trying to stimulate the angel investor base, but again, angel investors really want to invest in just a smaller version of what the venture capitalists want to invest in. They don’t really want to come back and carry any more risk”.

184 The ERISA Act is a federal US law that established minimum standards for pension and welfare benefits plans that have been voluntarily established in private industry.
Similarly in Australia, venture capital is generally interested in larger investments in more mature companies and technology.

In Australia, and in the US to a lesser extent, the major gap in funding is in the early-stage of development, what is becoming called *translational development*. Government is a major source of funding – on the basis of matching funds or tax incentives (Rider, *et al.* 2006; Collier 2007) – but private funds are available, as well. In terms of what has been done by the Australian Government, Aust VC1 expressed the view that:

“... the government’s done really well. They’ve been very generous, and perhaps not been richly rewarded enough. I think AusIndustry is particularly good – as a department they are actually as close as you get to entrepreneurs in government; they do have a lot of empathy for what we do. I think the nature of the agreements that we have with them for our pre-seed program are pretty much sensible - as sensible as they can be given that there’s a lot of government policy surrounding it... And they really have stimulated the industry. They have allowed management teams to form and get experience. A number of new managers have benefited from these programs in the past”. Over the past four years or so the government has contributed about $40 million resulting in further private funding of $60 million being added which is now used to fund the development of Australian commercial technology. “I applaud them” (Aust VC1 Interview 2006).

This view makes an interesting contrast with the view of TT&C managers reported by Harman and Stone (2006) which showed that almost all federal and all State programs are rated as effective by fewer than fifty percent of respondents to their survey.

Another example of a fund that benefits from the Australian Government’s approach is Aust VC2, which operates two funds: a technology fund, a traditional venture capital fund; and a pre-seed fund. The technology fund has had only one university spin-out, largely because university spin-outs tend to be relatively immature at the time they are spun-out, and the venture capital fund cannot afford the resources to nurture smaller companies. The pre-seed fund has invested in a number of university ideas but, since the fund has been operating only since 2002, there are few results yet reported. The relative youth of this area of funding means that its effectiveness cannot be judged until it builds up a greater number of investments.

US VC was much less willing to countenance government involvement in funding. As a general philosophy, “I think government should not fill that gap...”. What government can do is “create incentives for private investment, and that’s something that’s extremely important” (US VC Interview 2007).

Australian industry finds interaction with universities useful in acting as a capital multiplier when it comes to seeking R&D funding. That is, while the company has to contribute cash and in-kind resources in its partnership with a university, funding agencies such as the Australian Research Council pay a multiple on the industry partner’s contribution, thus
providing leverage on the company’s investment for projects directed to areas of the company’s interest. The downside can be time spent educating a university:

“… into understanding the market. They have got zero knowledge of how the market operates”. Dealing with some universities has been problematic: “The more difficult ones have got this incredible fantasy in their mind that their mere presence in the room adds value to the whole enterprise, which is okay, because we value their contribution. But the reality is: it’s very long to get a product to market, but we need to move fast in the early stages” (Company D Interview 2007).

The predominant sentiment among industry was that, as long as government involvement is limited to creating investment incentives for private investment (and the management that goes along with that), that is the proper role for government. There is also a role for government in nurturing early-stage high-risk investments at some level although, ideally, this may be a role better taken on by experienced investors with government encouragement and incentives.

10.6.12 Government Involvement

Industry engagement with government is done principally in two ways: through PFROs; and through industry development agencies. The experience of the industry case studies is that working with government can be successful:

“… we do work with various government departments, some of them are more successful in their entrepreneurial or engineering activities than others. My experience is that the more engineering-focused a department is, the more likely the outcome is to succeed. If the endeavour is being run by bureaucrats, you’ve got almost no chance” (Company E Interview 2007).

(a) Publicly-Funded Research Organisations (PFROs)

A striking fact arising from the case study companies was the importance to them of PFROs as well as universities – every one of the five manufacturing case study companies reported dealings with PFROs. While Company E reported its dealings with CSIRO were not successful except recently when CSIRO was a customer, each of the others benefited from their interaction. Company B was, itself, a spin-out from CSIRO and maintains close working links with it as well as having worked with ANSTO on both research and projects. Company D has worked with CSIRO and the ATNF\textsuperscript{185} and found negotiating with it to be very straightforward and amicable. Company A’s experience with CSIRO was generally good, although, on a recent commercialisation being arranged through the CSIRO TTO, “… they were interested in someone a lot bigger than us because of funding [needed to develop further]”. This was obvious because it cost $20-30k just to become involved in discussions, and later discussions made it clear that they wanted someone larger than Company A to “… commercialise [the idea] and commercialise it internationally, so we withdrew” (Company A

\textsuperscript{185} The Australia Telescope National Facility, part of CSIRO - see: \url{http://www.atnf.csiro.au/}
Interview 2007). Company A and Company C have both dealt with the DSTO on research and projects with acceptable outcomes.

(b) Industry Development Agencies

Government funding and support for companies is available at both State and national level, and every one of the five case study companies had taken advantage of it. This has variously taken the form of cash grants, tax concessions, export market development grants, export promotion and trade assistance from Australian embassies. But it is not always an easy road to obtain cash from the government, as Company C lamented, the company found itself unable to benefit from Queensland State Government industry incentives because it was making either too little profit (in its early days) or too much profit (in later days). “The time that you need the money, they won’t give it to you, nobody will give it to you: banks, government, you name it, nobody’s interested” (Company C Interview 2007).

10.6.13 Clusters and Industry Groupings

Only one case study company mentioned clusters at all, and made the observation that “They are usually led by one of your consultant types who’s going to get some sort of funds provided by State government, or whatever, so that if the cluster project gets up, then they will be the winners, basically. But I haven’t really found any that are of any use to us” (Company C Interview 2007), which is anything but an endorsement of the concept.

Generally, co-location with other high-technology companies, where it occurred, was more a case of being located in technology parks as a result of accident rather than intent, although it provided some tangential benefit; for example, Company D found that the company “needed a commercial presence in order to try and get the venture capitalists to take us seriously”.

10.6.14 Intermediaries

It was noted earlier that Australia does not have any significant intermediaries between the research enterprise and industry. Aust Go8 Uni2 expressed the view that they are not needed when university TTOs are doing their job properly. But when compared with larger economies such as the US, UK and Germany, which support several types of intermediary, it is likely that an advanced economy such as Australia would benefit from the existence of intermediaries capable of providing a link between university and industry.

On the potential need for intermediaries Company E observed that universities:

“... come up with bright ideas and then they search for a market. But as an entity like [Company E], that is no good for us. We find a lot of difficulty working with ideas that come out of nothing [looking for a market]. We can’t deal with that. We’ve got to have a market
and then work the idea”. The company believed that this gap could be filled by an intermediary because they “… have different ways of handling [ideas], different time frames…” (Company E Interview 2007).

On the other hand, if a need for intermediaries existed in Australia it is arguable that it would have spawned a suitable entity. An intermediary really has only one of three ways to start: as a philanthropic exercise, as a commercial enterprise, or through the agency of government intervention. Australia does not have the history of philanthropy that created intermediaries in the US and Germany. It may be that one or more suitable intermediaries along the lines of commercial for-profit companies such as those in the UK could start in Australia providing a commercial case exists. The Australian Government has funded entities from time to time that have some of the attributes of an intermediary about them – National ICT Australia\(^\text{186}\) (NICTA) and the Australian Institute for Commercialisation are two examples – but cannot reasonably be expected either to contribute the substantial funding required, nor generally to have the management expertise to operate such enterprises. Surprisingly, none of the five case study companies, which operate in the electronics area, had had any dealings with NICTA. US Private University took the initiative of starting a European-inspired manufacturing intermediary in the US to provide a range of services there. It may be that an existing intermediary could be encouraged by an institution or benefactor to create a presence in Australia in order to assist industry here translate university and other sources of knowledge to the advantage of local industry. There is support from the Business Council of Australia for the creation of intermediaries in Australia to assist in linking researchers with industry along the lines of the German Fraunhofer Institute model (BCA 2006b).

Most of the case study companies commented on the fact that universities are not market orientated so that, when universities produce good ideas, they have to go looking for a market. In the future this could be done by a company established to take new ideas and seek a market – in effect, an intermediary. An intermediary is different from a manufacturing company in that they “… have different ways of handling [ideas], different time frames… you must not get them confused… Most of our focus for product development has been market orientated as opposed to what you might call ideas orientated” (Company E Interview 2007). Company E has recently developed a relationship with the Australian Institute for Commercialisation (not, strictly, an intermediary, but it has some common characteristics), “… and their prime focus … for product development is from market sources, not what you might call pure research”.

Aust VC1 made the point that venture capital companies are a version of outsourcing, and universities themselves simply require basic TTOs to support commercialisation.

“... If you look at the VC value chain: you source and screen, you structure, you negotiate, you create value, and then you capture value. Creating value is opening doors for commercialisation... in the seed and pre-seed stage, which is most of the stuff coming out of universities. What you are doing there in opening doors is you are creating that first co-development partner relationship, you are getting other people’s money into the deal, you’re building the senior team and the board in-phase with the growth of the company... providing superior guidance at board level”. After the TTO has agreed terms for commercialisation on behalf of the university “... I think that’s really where they should break-off [from involvement in the deal]. But there is no imperative for university staff to undertake most of the functions involved even up to this point. “You could outsource sourcing and screening [functions]... you could well imagine a model for doing this” (Aust VC1 Interview 2006).

Where universities do not have well-established TTOs, there may be an argument for them to outsource most of the activities and retain in-house only the expertise needed to manage the process. Many Australian universities appear to adopt this approach by retaining only small TTOs, but there is yet no suitable model operating as a paradigm for outsourcing. UniQuest at the University of Queensland has done this to some extent by bringing another (interstate) university within its operating model – so this other university has outsourced much of the practice and the operation to a proven model. It is unlikely that this approach could be adopted generally for reasons such as cultural differences between and professional rivalry among universities.

10.6.15 Regional and Smaller Universities

Case study companies never raised concerns over the location or size of partner universities – the issue for them was to identify the skills they needed and then develop personal relationships with relevant academics. Every one of the companies had relations with one or more regional and smaller universities, or universities interstate and overseas, for example (from Table 10.2, above):

- Company A – James Cook University; University of Technology Sydney
- Company B – Universities of Adelaide and South Australia; University of Western Australia; Camborne School of Mines (UK); Colorado School of Mines (US)
- Company C – RMIT University
- Company D – University of Wollongong; Barcelona University
- Company E – Central Queensland University

Venture capitalists made similar points. One venture capitalist, located in Sydney, observed that being distant from a university need not be fatal to a deal.

“We are so hungry [that for] a good quality deal we would happily overcome [distance]; we would do a deal in Western Australia. Again, we are investing in global technologies and it’s
not likely that that deal is going to remain in that locale [after the first two years]" (Aust VC1 Interview 2006).

Similarly, VC2, located in Melbourne, looked to universities Australia-wide for ideas "We’ve invested in spin-outs from Newcastle University, one out of Griffith University… we do keep across all of them".

This approach is consistent with the view of US VC which operates from New Jersey, but has done most of its deals with MIT and Californian universities. Lack of proximity need not be an impediment to a deal although distance may limit the ability of a university to publicise its outputs and abilities to industry because of the cost involved in doing so.

10.7 University-Industry Interaction – Narrative Review

This narrative review follows the order of headings used in the previous section (10.6) to allow for convenient comparison, except here the heading University Spin-off Companies has been substituted for Lack of Local Receptor Business used above. The narrative review draws on the extensive body of international and Australian literature on university TT&C.

The results obtained in section 10.6, Industry Case Studies, are correlated with the Narrative Review for the purpose of triangulating the results. Most of the issues and ideas found in the two approaches are complementary and can readily co-exist, in which case no elaboration is provided. However, commentary is offered at the end of a heading where the two approaches are mutually supporting or where an explanation is needed because of apparent inconsistency.

10.7.1 Knowledge by Industry of Relevant Research

It was noted that most information flows out of universities in traditional forms, not related to TT&C. Nonetheless, the balance of the 5% or so that has some commercialisation potential will result in increased community benefit only if it is effectively communicated to industry. University TTOs believe that the personal relationship between the researcher and industry, complemented by personal relationships involving the TTO are the most important links.

Research shows that inadequate linkages between Australian universities and industry, especially SMEs, represents an impediment to the utilisation of research (Productivity Commission 2007). Australian industry appears largely unaware of many of the schemes promoted by government to encourage university-industry interaction (Turpin, et al. 1999)

There is evidence that the most effective networks, in terms of the transfer of knowledge from the creators of knowledge (research providers) to industry users, are those that are sponsored and supported by industry through industry associations (Howard 2005a).
US research (Adams 2006) found that companies in mature industries were apparently more inclined to cite a certain group of universities (the mid-west and south), while companies in younger industries were more likely to cite private universities and universities in coastal areas. Unfortunately this research did not distinguish in this respect between specific industries, but younger industries are likely to include life sciences and ICT. This project has not attempted to identify any of these characteristics and it may be interesting to build upon Adams’ research to understand better which classes of research conducted at Australian universities are more likely to link universities with which type of industry.

10.7.2 Cultural Differences

Siegel, et al. (2003b, p.122) conducted ninety-eight interviews among fifty-five stakeholders in the university TT&C environment in order to understand the barriers to TT&C and how they may be overcome. Their suggested improvements to the university-industry technology transfer (UITT) process are shown in Table 10.5.

Suggested university and firm-bases improvements to the UITT process

* Suggested university-based improvements to the UITT process
  * Universities need to improve their understanding of the needs of their true “customers”, i.e., firms that can potentially commercialize their technologies
  * Adopt a more flexible stance in negotiating technology-transfer agreements and streamline UITT policies and procedures
  * Hire licensing officers and TTO managers with more business experience
  * Switch to incentive compensation in the TTO
  * Hire managers/research administrators with a strategic vision, who can serve as effective boundary spanners (tie to boundary spanning literature)
  * Devote additional resources to the TTO and patenting
  * Increase the rewards for faculty participation in UITT by valuing patents and licenses in promotion and tenure decisions and allow faculty members to keep a larger share of licensing revenue (as opposed to their department or university)
  * Recognize the value of personal relationships and social networks, involving scientists, graduate students, and alumni

* Suggested firm-based improvements to the UITT process
  * Be proactive in their efforts to bridge the cultural gap with academia
  * Hire technology managers with university experience
  * Explore alternative means for tapping into UITT social networks

Table 10.5 – Actions to Overcome Barriers to TT&C Source: Siegel, et al. (2003b, p.122)

Lee (2000, p.130) set out a rank list of factors (shown in Table 10.6) of what industry seeks in a research collaboration relationship with a university.
<table>
<thead>
<tr>
<th>Ranking</th>
<th>What firms seek from academics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Research on product development</td>
</tr>
<tr>
<td>2</td>
<td>Conduct ‘blue-sky’ research in search of new technology</td>
</tr>
<tr>
<td>3</td>
<td>Solve technical problems</td>
</tr>
<tr>
<td>4</td>
<td>Design prototypes</td>
</tr>
<tr>
<td>5</td>
<td>Provide seminars and workshops</td>
</tr>
<tr>
<td>6</td>
<td>Conduct fundamental research</td>
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<tr>
<td>7</td>
<td>Support universities</td>
</tr>
<tr>
<td>8</td>
<td>Develop software</td>
</tr>
</tbody>
</table>

Table 10.6 – What Industry Seeks when Collaborating with Universities  
Source: Lee (2000, p.130)

Closer to home, the Business Council of Australia (BCA 2004, p.34) reported the main factors that Australian industry felt could improve the attractiveness of commercialising research with universities and publicly-funded research institutions included:

- Improved incentives around manufacturing and marketing;
- Recognition by universities and publicly funded research institutions of the global nature of business;
- The need for universities and publicly funded research institutions to aim for repeat, rather than one-off business;
- The need to collaborate at all stages of development;
- Increased incentives for universities and publicly-funded research institutions to seek a commercialisation outcome;
- The requirement of R&D conducted by universities and publicly-funded research institutions to have a commercial mentor or sponsor;
- The refocusing of government R&D support to development rather than research.
- Encouraging the movement of technical staff between universities, publicly-funded research institutions and businesses;
- The need for greater understanding of the commercial application of intellectual property earlier in the R&D process; and
- Greater understanding by universities and publicly-funded research institutions of the requirements for successful commercialisation.
These important results from scholars and industry are consistent with the results obtained from the case studies developed here and invite similar conclusions and suggestions for improvement. In particular Siegel, et al. (2003b) made one important point: most of the changes should take place in the way the TTO is structured and run. Their research also recognised, as others have done, the vital importance of the personal relationship – structure is important, but it is not the decisive factor in TT&C success – the impact of culture and university support in building personal relationships should be recognised and encouraged. Similarly, Santoro and Gopalakrishnan (2001) reported that probably the greatest factor correlating successful technology transfer between university and firm was trust, a factor that is closely bound to the oft-reported importance of personal relationships.

Powers (2003) used organisational theory (in this case a resource-based view of the firm) in order to attempt to identify correlations between TT&C outcomes (measured as patents held, licences executed and licensing income realised) and particular resource attributes of the university. His study provided a measure of empirical support for a number of findings made by others and drew some interesting new conclusions. While his research was based on US data, most of the results would be relevant universally. He found that the factors that correlated most strongly with TT&C results were the quality and reputation of the academic faculty, and the size (by professional FTE) and age of the university TTO. Weaker correlations were identified between federal and industry R&D support (it resulted in an increase in patents only, but neither licences executed nor licence income), with no correlation found between the existence of a medical or engineering school at the university, nor between private and public universities, while a negative correlation was found between TT&C and the availability of venture capital and state financial support for higher education (for reasons that may be specific to the US environment). A similar analysis in Australia would be very interesting, although it would be preferable to use data captured by DEST (2004b, 2007), and to include as independent variables two additional factors: the quality of the TTO management, and the support for TT&C activities evinced by university management, although it is acknowledged that these would be very difficult to measure objectively.

10.7.3 Fields of Research

Consistent with other studies, analysis by Cohen, et al. (2002) using data from the 1994 Carnegie-Mellon Survey of Industrial R&D found that the contribution of public research varies between industries, with a substantial impact on industrial R&D in a few industries, particularly pharmaceuticals, and is generally important across a broad segment of the manufacturing sector. This reflects the earlier findings of Mansfield (1986, 1991, 1998).
One aspect of university ability that is rarely mentioned by researchers is the need to have a mix of institutional abilities if TT&C is to be implemented successfully. A study that did so by Debackere and Veugeleres (2005) noted the need for complementary basic and applied research both to create new ideas and allow them to be brought closer to industry, as well as the mutual reinforcement between teaching and applied research through, for example, graduates providing the necessary contacts and absorptive capacity for applied research with industry. They said (p.327), “A university that can exploit the complementarities between teaching, basic research and applied research will thus be a strong player in the knowledge market”.

10.7.4 Linkages

The gulf between universities and industry is manifest in their different missions, structures, organisation cultures and research orientations so, in one sense, it is a wonder that they can work together at all. But they do work together, as evident in many cases, particularly from the US, and the linkages between them take many forms. The most important of these is the informal one of the personal relationship while, in Australia, the principal formal linkage promoted by government involves co-operative research centres (CRCs).

The importance of the personal relationship in creating the best and strongest linkages between universities and industry is inferred by DEST (2002, p.viii) in its perceptive comment that “The development of linkages with industry is best performed by the researcher, though the commercialisation office can provide support, particularly through the organisation of networking opportunities”. In this report for DEST, the authors made the important point that the TTO supports commercialisation, but researchers actually drive it. They also noted the fact that researchers are not provided with funding to assist in commercialisation and, in fact, are rarely funded for attendance at conferences, denying them a potent source of industry interaction.

University-industry interaction was elegantly described by DEST (2002, p.17) as a supply chain as follows:

“A knowledge supply chain relies on communication. This is socially, not technologically driven. It involves tangible (material) knowledge and increasingly intangible (immaterial) knowledge. Moreover, the emphasis is on the sharing, rather than the transfer, of knowledge. Public research organisations have an important role to play in assisting in the development of knowledge chains”.

An important point in this statement is the value of sharing knowledge rather than any emphasis on its transfer or commercialisation.

The importance of personal relationships and the propensity for academic faculty to deal with industry is largely a personal characteristic. Rahm (1994, p.271) reported research that
showed that what she called “spanning researchers”, those with links into industry (as distinct from “university-bound researchers”):

“... tend to initiate communication with firms personally, and they are far more inclined than their university-bound colleagues to have informal links to firms. Eighty-seven percent of spanning researchers report that they have independently approached firms, 95% of spanning researchers testify they have been contacted by firms, and 45% of spanning researchers suggest that they have been introduced to firm personnel by university technology transfer staff. Several other informal links are of considerable importance. Seventy-five percent of spanning researchers say they engage in paid industrial consulting. Perhaps more importantly, 80% of spanning researchers say that former university students now working in industry sometimes of often contact them regarding firm needs”.

Rahm also noted that spanning researchers tend to come from faculties that are more firm-friendly, and are more likely to be affiliated with a research centre and to engage in cross-disciplinary research.

The fact that personal relationships form the most important element in industry-university engagement is identified by many researchers and scholars in this field (Harmon, et al. 1997). This experience is not limited to western economies, but is similarly identified in research in Taiwan (Chang, et al. 2005). In particular, Chang, et al. noted that (p.47) “The major links between industry and academia remain short-term, informal personal, and contract-based collaboration rather than long-term, formal organizational, and joint capability development”.

Both the primary data and the narrative review reinforce the view that the vital link in TT&C, especially for SMEs, is the personal relationship. Without a personal relationship no linkage is likely between universities and industry.

10.7.5 Co-Operative Research Centres

Australian case study university TTOs reported that they were largely indifferent to the existence of CRCs, and case study companies generally expressed a similar sentiment. International experience is largely supportive of co-operative vehicles (Bozeman and Boardman 2003; Kumar 1995), although Bozeman and Boardman (p.2) opined that outcomes and impacts are not the sole criteria for their creation, and that “... many of the findings show that process and political criteria often drive collaborations or shape them in important ways”. As far back as 1995, Kumar (p.iii) estimated that the US had 350 technology consortia of which nine out of ten were initiated by the private sector. Australian industry has expressed support for the CRC program and said that “The positives clearly outweigh the negatives...” (BHERT 1998, p.6). However, this positive assessment may be something of a triumph of hope over reality when the later views of BHERT (1999) or those of Milton-Smith (2001) are considered. Assessments of the program by or for the Australian Government are generally supportive and provide evidence of the efficacy of the program
(Howard 2003; Allen 2005; Insight Economics 2006). However, when it comes to the commercialisation results achieved, the reports are less positive. Howard (2003, p.76) averred that, in terms of results achieved to 2003, “… the overall performance of the Programme in the area of commercialisation and technology transfer must be seen as disappointing”. For example (p.74), he cites AVCAL, the representative of the private equity and venture capitalists of Australia, as being concerned that the CRC Programme, with some notable exceptions, is on the whole failing to realise commercial benefits to their full potential. And while the later reports by Allen (2005) and Insight Economics (2006) evaluated the overall economic contribution made by CRCs, they did not identify (and were not asked to do so) the financial consequences for universities of participation in the CRC program.

Even in the relatively compact space of the Western Australia electronics industry, Mazzarol (2003, p.2) found that:

“… the industry lacks sufficient concentration and is somewhat fragmented with little evidence of collaboration across the resource network. This is particularly the case with respect to joint research linkages with local universities or research centres (e.g. CRC, CSIRO), where such networking was ad hoc and linkages weak”.

So, even with resources such as CRCs at their disposal, the electronics industry – one of the prime candidates to work with CRCs – was not doing so in Western Australia, a result found also in the Brisbane-based electronics manufacturing case study companies.

The primary data and the narrative review are both strongly suggestive that CRCs are of limited interest or use to industry, especially SMEs, unless they are already part of a CRC, due to the high participation cost and the fact that outcomes are available only to direct participants in the CRC. The exception to this generalisation is that Australian venture capitalists like to deal with CRCs because, compared to universities, they offer research outcomes that are more mature and usually directed toward an identified market.

10.7.6 Australian Industry Capacity to Absorb University Research

(a) University Spin-off Companies

Thorburn (2000, p.259) summarised three rationales for creating a spin-off:

- to resolve tensions between academia and an individual who wishes to operate in a more commercial fashion;
- to transfer technology into the marketplace when an appropriate licensee cannot be found; and
- to allow institutions to retain the financial rewards from commercialising their technology as well as control of when and how the technology is applied.
Thorburn also noted a survival rate of 88% for companies spun-out from the CSIRO (compared to around 25% of businesses after the first five years among the general population). She attributed this to three components she referred to as the formal (transfer of intellectual property), the informal (transfer of tacit knowledge) and the supplementary (extensive post-founding informal research and industry linkages). While her data did not specifically aver to universities, in the absence of any complementary research her results in this respect are likely to be reasonably indicative of spin-offs from universities.

Research has found that universities that are successful in technology spin-off companies are much more inclined to use external entrepreneurs than principal researchers to manage the newly-formed enterprise (Franklin et al. 2001). External entrepreneurs are seen as particularly useful in exploiting their networks and engaging input from other partners. But it is not really a case of either/or, and Franklin et al. noted that (p.139) “… the academic and [external] entrepreneur approaches may not be mutually exclusive and there may be benefits from combining the relative advantages of both”.

Thorburn (2000, p.268) quoted the founder of a CSIRO spin-off company on the importance of transferring relevant personnel from the research enterprise to the new company: “I believe you can’t transfer technology without transferring people. You can put as much as you like down on paper but unless you’re transferring people you’re not transferring technology”. This makes an interesting juxtaposition with universities where, as stated by the Director of the NZ Uni TTO, good researchers are hard to locate and are more valuable to universities than a spin-off company. It would be very difficult for a university (or PFRO) to release an eminent researcher to a spin-off company, and if obliged to do so would have to represent the least undesirable of the available options.

(b) Lack of Local Management Expertise

The Productivity Commission (2007, p.284) noted that while Australian universities have been accused of seeking unrealistic returns on their intellectual property: “… Australian firms do not always have realistic expectations in negotiating technology transfer deals with universities and, in this regard, universities sometimes find it easier to negotiate with foreign firms” (author’s italics for emphasis).

There is a general perception that Australian management, particularly among SMEs, is weaker than in other jurisdictions (Productivity Commission 2007, p.307), implying that there is little justification for doing anything more than is presently being done by the government. To the extent that more work is needed, entities such as industry associations are at least as well placed as any other entity to remedy the situation.
Cebon (2006), in his case studies, noted that some companies attracted good managers and board members, but not managers and board members experienced in both the relevant technical domain and dealing in small, nimble and innovative companies. This view is reinforced in the comment by US Private University in respect of Australian university commercialisation: “Certainly, one of my observations…was the limitation on technology transfer from Australian universities was not [with] the universities … but it was on …the availability of experienced management who knew how to do start-ups” (US Private University Interview 2007). It is the special skill and experience in start-ups that appears deficient.

While many commentators assert that spin-off companies should be managed by entrepreneurs skilled in business, Zucker, et al. (2002) argued that scientific ability is central to the founding and performance of new biotechnology companies. They found that firms founded by "star scientists" (as measured in terms of their productivity in publishing significant scientific papers) outperform other firms even after accounting for the location of these firms and the amount of venture capital financing they received. It may be that this is a particular characteristic of biotechnology discoveries because intellectual property is often patented early in the R&D cycle, making continuing involvement of the investigators vital because their tacit knowledge is an essential ingredient for successful commercialisation.

(c) Business Risk Aversion

There is evidence from the US that industry there is risk-averse. For example, Lee and Gaertner (1994, p.385) opined that:

“… American industry historically has been risk averse, and this risk-aversion behaviour stems largely from its inordinate emphasis on short-term financial results. Many of the largest United States companies would not consider externally-developed technology for this reason”.

While the aversion to external technology may have diminished over the intervening years since 1994, the emphasis on the short-term financial imperative has not. The authors also referred (p.392) to three perceptions of industry which impede the commercialisation of university research:

“… first, that university research presents too high a risk for commercialization; second, that the time required to develop usable technology from basic research is too long to be of much value to industry; and, third, that there is a cultural gap between the university and industry”.

Australian industry is often believed to be risk averse. There are rational reasons for this according to Ferris (2001, pp.47-48):

“A small domestic economy separated by time and space from other economies, has produced a rationally risk averse management culture. There is, after all, little room for error
in a small market place. There are fewer economies of scale where even a 50% market share may not yield production volumes on a scale that allows unit costs to rapidly decline. “Similarly, a US manufacturer may have a successful product on his hands if it works, say in California, even it is fails in the mid-West and on the East Coast. Such a luxury is not available to an Australian manufacturer”.

(d) The Size of the Receptors - SMEs

The Productivity Commission (2007, p.302) made the point that the routes through which new and cutting-edge technologies are diffused are less developed than those for existing technologies. This makes the small SME target group even harder to match with university research outcomes and the cost of doing so high. In response to this problem the Australian Government has proposed an Intermediary Access Program187 under which $20.1 million will be provided over five years from 2007-08 to assist SMEs gain access to new technologies and partnerships.

Mazarol (2003, p.2) found that the Western Australian ICT industry, of which a majority comprises small businesses, was quite dynamic with over 50% exporting and a high level of innovation. While he found little evidence of collaboration between this relatively small industry and local universities, his conclusion may reflect more on formal linkages rather than the myriad of informal linkages reported by the manufacturing industry case study companies noted earlier.

The size of receptors need not be an inhibiting factor if the right policy is put in place, such as the US SBIR (Connell 2006). Research by Cohen, et al. (2002) suggested that public research (university and government) is principally important to two sections of industry: large companies and start-ups. Larger corporations were also seen as the natural allies of US federal laboratories and universities by Roessner and Wise (1994). This conclusion is consistent with the views expressed in the university case studies where SMEs are not rated as important receptors. Santoro and Gopalakrishnan (2001) reported that technology transfer increases as the size of the receptor firm increases but, again, they were looking at formal transfer mechanisms rather than the broad spectrum of engagement.

The disconnection between university TTOs and SMEs is noted in both the primary data and the narrative review. University TTOs generally direct their TT&C effort towards research that has potential global impact, while SMEs and most other businesses seek smaller-scale assistance in product and process innovation.

10.7.7 Making the Connections

There are different audiences for and different modes of dissemination appropriate to different types of university research (Faley and Sharer 2005). For example, scientific researchers are the principal audience for pure basic research results, while industry is often more interested in use-inspired basic research and applied research. Faley and Sharer (pp.119-120) described a general model of knowledge production and dissemination involving seven steps:

1. Create new knowledge;
2. Identify the appropriate external audience(s) through which the benefit of the knowledge can be maximized;
3. Choose the optimal dissemination method(s) for the knowledge;
4. Package the new knowledge in a form that can be capitalized on by the identified audience consistent with the chosen method of dissemination;
5. Transfer the appropriate use rights of the new knowledge package;
6. Develop a product based on the new knowledge package; and
7. Broadly disseminate the product.

They concluded (pp.123-124) that an institution must effectively execute five important functions in order to successfully transfer commercially relevant new knowledge. These functions are normally handled by the TTO. The functions, along with their relation to the corresponding seven-step knowledge dissemination process (shown in parentheses), are:

(a) Deciding how to best maximize the benefit of the new knowledge (Step 3);
(b) Identifying the audience(s) that can best attain this benefit (Step 2);
(c) Deciding on the most appropriate type(s) of packaging (given the nature of the new knowledge and the needs of the audience(s) that will be the primary utilizers of the new knowledge) (Step 4);
(d) Managing the new knowledge-based assets; and
(e) Transferring use rights to the new knowledge assets (Step 5).

Research on connections between industry and universities in Australia by Johnston (2004) correlates very closely with the primary data reported earlier. On the issue of industry-university relations Johnston reported (p.8) that “…these relationships also appear to have changed, with a much stronger alignment with company business strategy, linked to a greater use of informal alliance and partnership arrangements rather than contracted projects or involvement with Cooperative Research Centres”.

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10.7.8 Technology Parks and Incubators

The literature strongly suggests that incubators affect economic development and job creation marginally at best (Di Gregorio and Shane 2003; OECD 1994). It was also noted earlier that a paper by Siegel, et al. (2003c, p.177) concluded “...that the ‘returns’ to being located on a science park [in the UK] are negligible”.

The importance of technology parks and incubators to university TT&C in the Australian context was put succinctly, if rather trenchantly, by Milton-Smith (2001, p.142):

“Other well-intentioned attempts to bring business and academia together have been equally futile – Technology Parks, for example. The theory is compelling – the concept provides for applied research centres, incubators, spin-offs, lots of cocktail parties, and talks by politicians and visiting gurus on the general theme of technology transfer but, as a rule, not much synergy develops in practice. The presence of the university is little more than a real estate feature – nice to have, pleasant to look at, but not much use”.

Mazzarol (2003, p.78) reported that the presence of a university to a technology park (in this case Curtin University in Western Australia) “…was considered by most firms in the survey to be of little importance”.

There is an expectation among some stakeholders, politicians in particular, that incubators will lead to rapid economic improvements and job creation. While incubators can play a role in assisting new firms, their effect is far from clear, their timelines longer than political cycles and expectations upon them often inflated (Ventris and Gurdon 2006). The processes at work in incubators are uncertain (Peters, et al. 2004), making them a curious entity of vague value.

The conclusions drawn from the literature are consistent with the views of the case study entities interviewed in this project.

10.7.9 Intellectual Property

The Productivity Commission (2007, p.286) found that there is a balance to be struck between the need for consistent rules as they concern university intellectual property against the need for flexibility, with industry expressing a preference for flexibility in this regard. This is not an easy balance to achieve, and suggests that there is no one correct answer. When it comes to dealing with business, the flexibility of the Canadian and New Zealand regimes may work to their advantage as often as their disadvantage. And, given the criticism of some industry experts about the Bayh-Dole regime in the US (US Strategist Interview 2007), there is at least an arguable proposition that the UK and Australian medium of providing institutional guidance in the matter of university intellectual property rules may provide the best option by giving, to some degree, the certainty desired by industry while not inhibiting the flexibility sought by universities.
The Productivity Commission (2007, p.290) argued that there are two occasions when universities should seek to protect intellectual property:

- When protecting the intellectual property makes it more likely that the research will be picked up by firms; and
- When the common pathway for ensuring the utilisation of the research involves transferring the intellectual property to a foreign firm.

In other cases the Productivity Commission would have research results given away by universities.

The conventional approach to intellectual property licensing by universities is either for a sponsoring company to have some first right of use, or for a TTO to seek a licensee at some time after a disclosure has been made by the investigators and intellectual property registration, as necessary, has been effected. Shane (2002) found that faculty members, staff, and students were more likely to found firms to commercialise their inventions when their discoveries did not enjoy strong patent protection, while external parties were more likely to commercialise in cases when patent protection was strong. Alternatives to this conventional approach have been tried from time to time. For example, Martin, et al. (2004) reported on a United States attempt to combine intellectual property from two universities into attractive packages for industry – in this case in nanotechnology. They found that this approach had a number of disadvantages: there is an element of luck in choosing the right combination of intellectual property so that it is of interest to industry; packages of intellectual property may give only an indication of research areas and can suffer from time lags before they are available; and the process is very resource intensive, requiring considerable skill on the part of the analysts compiling the clusters of intellectual property. The process is being refined to make it more effective but has yet to be further reported upon.

Owen-Smith and Powell (2001) identified the different strategic purposes for which physical and life scientists tend to patent, and which flows into their general relationship with industry. They said (p.106):

“… that physical scientists, whose inventions are typically improvements on established products or processes, will use patents to develop relationships with firms and as chips to use to exchange for the use of other proprietary technology, access to equipment, or other opportunities. In keeping with this more relational approach, physical scientists should (1) expect less direct personal gain from patent royalties, (2) favour non-exclusive licensing arrangements, and (3) be less concerned with finding the ‘right’ licensee, opting instead to open relationships with multiple corporate partners.

“The inventions of life scientists commonly involve therapeutic compounds or medical devices. If they are seeking strategic advantage for these novel entities, then these faculty

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188 Shane also found that licensing back to inventors increases the likelihood of license termination and reduces the likelihood of invention commercialisation.
should view patents more as tangible properties to be protected and sold. Rather than using patents to establish relationships with multiple partners, then, these scientists will be concerned with best partner to develop and market a drug or device. In keeping with this more proprietary approach to IP, life scientists should (1) expect personal gains from patent royalties, (2) favour exclusive licensing arrangements, and (3) be concerned with defending IP.

There is no correct answer on this issue, while the uncertainty generated by the Federal Court of Australia in the case of University of Western Australia -v- Gray (No 20) [2008] FCA 498, mentioned above, adds considerably to the complexity.

10.7.10 University Technology Transfer Offices

The literature raises three issues relevant to university TTOs:

- The sustainability of a dedicated TTO at all universities;
- Whether university TTOs should have some government funding; and
- A lack of incentives for facilitating commercialisation

It was noted by several of the Australian case study universities that universities are provided with no funding to operate TT&C activities, which can impose financial limitations on a university’s ability to undertake commercialisation. The Business, Industry and Higher Education Collaborative Council (BIHECC), sponsored by DEST, has been requested by the Australian Minister for Education, Science and Training to inquire into the need for so-called third stream funding for universities to establish or develop university TTOs but, as of mid-2008, had not yet published its recommendations. The Productivity Commission (2007, p.295) in its report allowed that there may be a case for some funding on a case-by-case basis. In the UK, under the Knowledge Transfer Capability Fund (HEFCE 2005), a fund of up to £12 million was established to cover the years 2004-06 to assist in TTO development. It was allocated to 40 higher education institutions (HEIs), to underpin their knowledge transfer activity until 2006-7, by which stage a third round of the Higher Education Innovation Fund was to be introduced. The Office of Science and Technology (OST) and HEFCE contributed up to £9 million, while HEIs themselves contributed around £3 million. There may be a case for individual Australian universities to be supported, for a limited period of time, through either grants or loans, to create stable TT&C operations customised to the needs, character and culture of individual universities. Such a commitment could not be open-ended but, using the better examples as a model, could provide some level of capitalisation in order to place individual TTOs on a stable footing after which they must become self-sustaining or, if a university is not able to provide long-term financial support if needed, even allowed to fail.

It was suggested by Owen-Smith and Powell (2001) that there are three factors at work that predict institutional success at patenting (and, by extension, TT&C generally) (p.99): “...
faculty perceptions of the benefits of patenting, the quality of the TTO, and the institution as a collective enterprise”. They also said that (p.100), “… regardless of important organizational and capacity differences, institutional environments that catalyse or inhibit academic patenting play a large role in explaining the varied outcomes”. These conclusions were derived after extensive interviews at an elite private university and a big state university. They made clear that the quality of the TTO is a vital factor in success in TT&C. Quality embraces the size of the TTO (and therefore its capacity to undertake the work), the qualifications of the TTO staff and the culture of the TTO. For example, they believe that a TTO that focuses on landing a blockbuster deal and negotiating the most lucrative licensing deal minimizes the leverage benefits of patenting, alienates other, usually non-life scientists and slows the process.

There was evidence identified earlier that a TTO, certainly at a larger university, generally has to have been established for at least ten years before it can make a substantial contribution to TT&C and, importantly, become self-financing. A reason that TTOs require time to become effective was postulated by Mowery et al. (2001) as being due to their learning from other institutions’ behaviour. Of course, they also have to understand and adapt to their own university’s culture and devise procedures that work within the cultural and governance constraints of their university. Debackere and Veugelers (2005, p.333) said that, in their case study, having the TTO in place at the university for thirty-one years was “… perhaps the single most important learning effect that has occurred within the university as to academic involvement in the processes of knowledge transfer for industrial and entrepreneurial innovation”.

Siegel, et al. (2003a) identified the three most critical organisational factors at work on the productivity of university TTOs as: faculty reward systems, TTO staffing/compensation practices, and cultural barriers between universities and firms, which is consistent with data from interviews with Australian universities and industry. Similarly, Siegel, et al. (1999) noted that many firms believe that universities are too aggressive in exercising their intellectual property rights and too bureaucratic and inflexible, factors which are reported by the Australian industry case studies, which suggests that some of the attitude of universities transcend national borders.

Debackere and Veugelers (2005) made reference to the need for decentralised management of TT&C, which they said (p.339):

“… implies sufficient freedom to engage and to operate for the researchers and their groups whenever transfer opportunities occur. Decentralization also implies that the research groups are pivotal in deciding how the proceeds from their exploitation activities will be used. Finally, decentralization also stimulates the research groups to compete with their findings and results in the market for exploitation and innovation”. 
This conclusion is consistent with the need for researchers to be actively involved in finding potential industry partners and work on the transfer of their research results as necessary with industry. The authors emphasised the need for an effective TTO to assist in the process, so the autonomy that they believed was needed for researchers to be effective in TT&C is consistent with the other themes noted above.

Both the primary data and the narrative review disclose cultural differences between the TTO and industry as a key problem in TT&C, although this appears to be more of a problem in TTOs that are less successful. Two additional barriers are identified in both data sets: limitations in the reward systems for researchers and their perception of benefits; and the quality of TTO staff and their reward systems.

Both data sets suggest that the role of the TTO should be more in the role of deal facilitator than knowledge gatekeeper, and that TT&C decision making should be decentralised – that is, largely left to the discretion of the researchers.

10.7.11 Availability of Development Capital

An accurate picture of universities’ needs for development capital was expressed by DEST (2002, p.vii):

“The most common financial needs for universities in research commercialisation are for pre-seed capital to fund proof-of-concept and prototype development, and for funds to support adequate IP protection. Given the extreme pressures on the block grant, the only sources of this finance are the new pre-seed funds, angel investors, and in a few cases, returns from previous investments”.

There is ample evidence that few investors are willing to take on university research before it has been sufficiently proven and is sufficiently mature. Investors would prefer that most of the technology risk had been removed. It is likely that, over time, some astute investors will engage earlier in the process (as occurs in the US), but this will take time in Australia. Even the economically driest of Australian government agencies, the Productivity Commission (2007, p.295) conceded that there is a case to be made for government funding in three particular cases:

- “university commercialisation arms. Some additional funding may be required on a case-by-case basis to help facilitate the development of more flexible arrangements…;
- the creation of university spin-off companies, which in general do not provide a strong rationale for extra funding. If universities decide to invest in these commercial ventures it should be in the expectation that they will generate sufficient revenue to at least meet the associated costs; and
- funding research projects to the point of ‘proof-of-concept’. There may be a case for providing some additional support for taking research through to the point ‘proof-of-concept’.”

While there is plenty of venture capital available in Australia (ABS 2005b), there is little doubt that there has been and remains a gap in funds available for early-stage commercialisation
(AIC 2003), particularly in the range up to $2 million, where it is often risky to invest and difficult to administer such relatively small sums. The gap has been addressed to some extent by the Australian Government through the Pre-Seed Fund (AusIndustry 2003) which is administered through private suppliers such as Aust VC2. Nonetheless, it is not the role of government to de-risk highly risky commercial ventures. Intervention by government also has the undesirable outcomes of high administration costs, crowding-out private finance, and subsidising projects with poor commercial prospects (Productivity Commission 2007, p.313). Despite urging in some quarters that it should do so, the Productivity Commission (2007, p.298) expressed unwillingness to support hypothecated grants for proof-of-concept activities by universities for three reasons: hypothecated funds deny universities the right to trade-off the spending options open to them of un-tied funds; the decision to spend funds on proof-of-concept is a commercial one and should be made by the university from other funds so that successful investments eventually become self-funding; and, since commercialisation is not a primary university function, there is a risk that universities will make poor decisions without any risk of commercial consequence. It noted, also, the high cost of administering such a scheme, and the potential for alternatives such as loans. The Commission also said (p.310) that “… within the venture capital segment of the private equity market, a significant proportion of the funds go to the expansion of existing ventures rather than emerging commercialisation ventures”.

Industry is much more likely to look favourably on private equity wherever possible (US VC Interview 2007) with the role of government limited to that of providing an appropriate environment. IPRIA (Rider, et al. 2006) noted many of the shortcomings to investing in technology-based enterprises in Australia, while AVCAL (2005) recommended the government should do two principal things: allow full exemption from capital gains tax on gains realised from disposal of shares in a qualified early-stage enterprise (ESE) if the investor has held the shares for at least 12 months; and grant some level of deductibility for funds invested into an ESE. The Australian Government responded to agitation about discrimination against foreign funds used for high-risk investments in Australia by implementing the venture capital limited partnership and, despite some criticisms, there is a general recognition that the Government works hard to provide an environment favourable to investment (Aust VC1 Interview 2006).

Most universities themselves provide a degree of funding to assist their spin-out companies, with the best of them: Aust Go8 Uni2 and NZ Uni, for example, doing so largely out of retained earnings. Subject to having sufficient funds to start the investment cycle, this appears to be an efficient and disciplined approach to funding the gap for universities.
Canada has a significant number of private equity investors in the informal investor/angel category (Riding, et al. 2001) and has recommended the formation of a national panel of informal investors to provide a voice for participants and to allow the government to understand the environment better. Such a scheme in Australia may assist in understanding better the local environment.

It was noted by a number of authors that Australasian ideas are often commercialised too early with the result that they may not find an industry partner because of the large investment still needed to make the technology mature. Similarly, a company that is listed too early may have difficulty in sustaining the enterprise because it is still engaged early in the technology cycle. Wells, et al. (2003) attributed taking this risk, in part, to the relative immaturity of the Australasian venture capital market.

There is agreement in the data sets that venture capital is neither generally available nor appropriate for development involving substantial technical risk. There is consensus, but not enthusiasm, for the conclusion that government funding remains necessary in Australia for early-stage development, although the preferred model involves the government establishing a regime that encourages private investment.

10.7.12 Government Involvement

A role for government in TT&C policy is usually predicated on some perceived market failure. As Bozeman (2000, p.632) said:

“The market failure policy paradigm recognizes that there may be a role for government in science and technology policy when there are clear externalities (i.e., that benefits cannot be captured in the market); when transactions costs are extremely high; and when information is unavailable or there are distortions in information so that market signals are not clear”.

When a market failure exists, Bozeman went on (p.632) (author’s emphasis):

“… the government role in technology transfer should chiefly be limited to removing barriers to the free market, through appropriate intellectual property policies, free trade agreements, neutral impact taxation, and limited regulation of enterprise”.

He also observed that universities have evolved to become the chief source of basic research which is consistent with market failure theory (because of the high cost and uncertain outcomes arising to any individual firm from basic research, but which otherwise confers a worthwhile benefit to society at large). Bozeman described two other paradigms of government intervention: mission (where there is not sufficient private interest in research, such as defence); and co-operative technology policy. Bozeman’s conclusions on the appropriate role of government are supported by Australian research by Johnston (2004, p.8) where he said large companies with a global outlook “… saw the major role for Government as ensuring a reliable and business-friendly economic, regulatory and legal context”.

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The United States has implemented policies that actively assist industry, such as the rules requiring preference to SMEs in the *Bayh-Dole Act*, and the SBIR Program (Connell 2006). An attempt at a similar, although somewhat truncated initiative in the UK, the Small Business Research Initiative (SBRI) has been less than successful for reasons such as not including the powerful Ministry of Defence (Connell 2004). Nonetheless, the UK has recognised that there is a need to provide some level of bias towards SMEs if they are to participate in commercialising university research outcomes. In Australia, the Productivity Commission (2007) was of the view that such schemes do not represent an adequate return and displace private capital activity, yet the US schemes have existed for many years and are evidently working. The US also invests heavily in mission paradigm research in areas such as defence, energy and health, and co-operative technology under the *National Co-operative Research Act*, the *Federal Technology Transfer Act* and CRADAs.

Further support for the US model can be found in a comparison between Sweden and the US. While there is unlikely to be any remnant in Australia of the view that governments should attempt to pick technological and business winners, the role of government is still important, as it is in both Sweden and the US. The difference is that, while Sweden adopts a “top-down” policy involving greater government intervention, the US has a “bottom-up” approach which encourages greater individual freedom and competition amongst institutions and researchers (Goldfarb and Henrekson 2003). Australia probably stands between these two models and, on the evidence available, may be better served by pursuing one closer to that of the US, provided the culture of entrepreneurialism is sufficiently strong at individual and university level. This may be more of a challenge for Australia because almost all research universities are state-owned, but it is unlikely to be as difficult as in Sweden (and much of Europe), because Australian universities are accustomed to competing for research funding, there is some element of institutional rivalry, and the changing face of Australian universities, as evidenced by the University of Melbourne fundamental re-structuring of its courses (Melbourne 2006), all make the Australian system somewhat more competitive.

The Australian Government intervenes in research and TT&C in numerous ways, some redolent of removing barriers, and some more directly interventionist (Yencken and Ralston 2005; DETYA 1999), in particular the CRC Program. The Australian CRC program was established during the period when Bozeman (2000) found that the co-operative technology paradigm was at its brief zenith (1992-1994), suggesting that CRCs may no longer be optimum vehicles for university-industry interaction.

Australian States and Territories (and, in some cases local government) are generally keen to embrace the knowledge economy and do so through a range of interventions such as infrastructure provision, centres of excellence and commercialisation support (Allen 2003b).
The position in the US (Geiger and Sá 2005) is similar, with larger and more prosperous States generally providing greater funding and support; although in most cases the States are not in a position to measure the specific economic benefits that result, and the global nature of research and business makes it difficult to ensure that regional economies realise the benefits. Geiger and Sá (2005, p.19) observed that:

“… the dominant actors in the ‘knowledge-based economy’ remain knowledge-intensive firms, especially the major corporations. Start-up firms, which assume great risk to translate knowledge into commercial products, are smaller complements of a much larger process. The role of universities lies in their capacity to produce new knowledge. In fiercely competitive industries, privileged access to cutting-edge knowledge is uniquely valuable. The role of State policies is to weld these components together, and to lubricate the process”.

If this proposition is correct and applicable to Australia, and it is suggested that it is, Australian States and Territories are in a position to assist industry at a closer level and in a different way to the federal Government. Each Australian State and Territory has something in the manner of a Department of State Development responsible for encouraging and assisting local industry (Collier 2007). There is real potential for these agencies to work as a major link between universities and industry, and is an issue worthy of further research.

10.7.13 Clusters and Industry Groupings

Michael Porter (1998) is the principal intellectual force behind the concept of industry clusters. He defined them in the following terms:

“Clusters are geographic concentrations of interconnected companies and institutions in a particular field. Clusters encompass an array of linked industries and other entities important to competition. They include, for example, suppliers of specialized inputs such as components, machinery, and services, and providers of specialized infrastructure. Clusters also often extend downstream to channels and customers and laterally to manufacturers of complementary products and to companies in industries related by skills, technologies, or common inputs. Finally, many clusters include governmental and other institutions -- such as universities, standards-setting agencies, think tanks, vocational training providers, and trade associations -- that provide specialized training, education, information, research, and technical support”.

Porter (1998) believed that clusters:

“… affect competition in three broad ways: first, by increasing the productivity of companies based in the area; second, by driving the direction and pace of innovation, which underpins future productivity growth; and third, by stimulating the formation of new businesses, which expands and strengthens the cluster itself”.

Acs, et al. (1999) found statistically significant and robust spillover to employment in a number of high-technology sectors at a city level, and asserted that their results support the importance of high-technology clusters.

Audretsch (2001) concluded that the existence of world-class scientific talent is a necessary but not sufficient condition to generate successful clusters. He identified three other factors essential to commercialise knowledge (p.3): “the presence of venture capital and other forms
of finance, the existence of an entrepreneurial culture, and transparent and minimal regulations fostering the start-up and growth processes”.

According to Johnston (2003), clusters are a potentially effective mechanism for enhancing competitive advantage. There are a variety of types of cluster, the most fundamental being between trade-driven clusters, where the emphasis is on trade between the members of the cluster and on collaborating in pre-competitive activities, and knowledge-driven clusters, where the benefits are based on access to new knowledge emerging from research organisations, and knowledge held by other firms. Johnston concluded that clusters cannot be easily 'manufactured' and the risk of failure is higher if any of three conditions is satisfied: where the focus is on real estate; where there is a concentration on attracting outside investment; or when government agencies plan the development of an industry cluster. Effective clusters tend to be 'natural' clusters, and their naturalness only becomes evident in hindsight and there is a wide variety of factors that contribute to their success or failure. However he said that conditions can be established which facilitate the formation of clusters and their contribution to economic value and actions by government can help build clusters and help make them sustainable. Universities can be a part of a cluster or even form the prime element in a cluster.

Mazzarol (2003) in examining a major technology park in Western Australia found no evidence of anything in the nature of a cluster in the technology park nor among the electronics industry companies that formed the substance of his report.

Beaudry and Breschi (2003, p.339) examined clustering of firms and reported that:

“… [t]he main result emerging from a firm level analysis of patent counts for two countries is that clustering in itself is not a source of benefits for firms’ innovative activities, and it may even be a source of negative externalities”.

Their analysis relied upon patent counts which meant that it was quite a narrow analysis, but they concluded that clustering, calculated using patents counts as the metric, generally gave an outcome ranging between equivocal and negative.

Casper and Karamanos (2003), who examined the Cambridge biotechnology cluster, concluded that the conventionally accepted notion that clusters are driven by proximity or the need to share tacit knowledge is, while not wrong, not a convincing argument to explain the existence of a cluster such as Cambridge. They said (p.816) that “… there are at least two reasons to believe that classical cluster policies aimed at facilitating networks of actors that can exploit local tacit knowledge may be misdirected”. They concluded, first, that relevant networks between companies in the cluster:

“… most plausibly have their origin in other activities that fall outside the scope of traditional cluster policies – for example long-standing scientific research communities, or contacts
forged through previous affiliations in firms or laboratories. Second, the growth of Cambridge has been relatively slow, decentralized, and organic”.

This description of the Cambridge cluster resonates with the Australian experience and suggests that clusters are not likely to be created either artificially or quickly. The authors’ principal conclusion was that, while a university may act as an attraction, or even a catalyst, the momentum actually comes from the cluster as a marketplace, a metaphor which (p.818):
“... emphasizes the development of rules, norms, or frameworks that govern the market”. This probably means that the cluster can develop slowly and organically (as in the case of the Cambridge cluster and generally in Australian experience), or it can develop more quickly if the marketplace is sufficiently deep and dynamic (as appears to be the American case).

Without explaining why, Feldman (2000, p.354) noted that:

“... industries appear to cluster geographically in a few sites in the early stages of development. As the industry matures, the typical pattern is that one or two sites will become dominant. The economic question [particularly for state governments] is how may policy best anchor an industry in a region”.

A factor that has been identified as important in the development of industry clusters is the availability of a deep and flexible labour market. The deeper the market the easier it is to get another job in the event that a venture fails. As well, deep labour markets facilitate the transfer of tacit knowledge in technologies where this is important such as biotechnology (Casper and Karamanos 2003).

It seems that most economies look to the likes of Silicon Valley with envy, and desire their replication locally. They believe that in this way synergies between education, industry and capital will allow high-technology business to flourish and national economies to boom. But “efforts to replicate Silicon Valley in the Asia-Pacific have fallen far short” (Milton-Smith 2001, p.147). In the same vein, Miles and Daniels (2007) do not expect a Silicon Valley to emerge even in the Oxford-Cambridge arc in the UK. Realistically, it will not happen in Australia within the foreseeable future.

This raises the issue of how practical it is for a country with a relatively small population, such as Australia, to compete in a broad range of fields; it is really constrained to niches where it has the labour market depth to encourage the risk-taking inherent in new ventures and commercialising innovative technologies. This is exactly the view recently enunciated by Miles and Daniels (2007) in respect of the UK, and the evidence from the primary data here supports these conclusions.

10.7.14 Intermediaries

Intermediaries have had a recognised role in the literature as linkage enablers for some time. Mohannak (1999) suggested that intermediaries can work in one of two ways: either in
“direct” mode, or in “systemic” mode. In direct mode the intermediary interposes directly in the path of communication and interaction between the parties, while in the systemic mode the parties communicate and interact directly, while the intermediary acts as a form of control node. From these simple models more complex forms of communication and interaction can be constructed. Mohannak also listed some of the usual roles of an intermediary, such as (p.331): marketing/business consulting; brokering companies’ strategic alliances for technology transfer; translation between cultures; special project management; education and training; and technology distribution channel.

Milton-Smith (2001, p.144) suggested that the vital additional element needed to improve Australia’s indifferent commercialisation track record “…is a creative intermediary or broker to provide planning support, access to networks and know-how, introductions to potential partners and solutions to financing and marketing requirements”. His thesis was that Australia lacks these essential functions, although there are some nascent examples: one a subsidiary of a Dutch enterprise, and another a part-time firm comprising four high-profile individuals.

Both data sets provide support for the proposition that intermediaries are needed in Australia to assist universities in the TT&C process.

10.7.15 Regional and Smaller Universities

The literature paints a largely pessimistic picture of the potential for smaller and regional universities to participate in TT&C. DEST (2002, p.ix) said that “Research commercialisation success is largely driven by considerations of scale. While these attributes of scale are fairly readily available to the larger and research-intensive universities, the smaller and regional universities do not have this capacity”, a sentiment not supported by the results of this project.

The Productivity Commission (2007, p.272) noted that established “…metrics for gauging commercialisation are likely to be biased against smaller and regional universities whose role in the provision of advice and consulting services” is likely to dominate their activities over licenses and spin-off companies – an observation that is largely supported by the data collected in this project by virtue of the importance of advice and consulting to SMEs, which are likely to be a natural market for smaller and regional universities.

de la Mothe and Mallory (2006, p.25) asserted that “Cities of course are at the heart of economic growth in any country”. They then went on to describe the important factors in the growth of an innovative environment: good infrastructure, smart people and capital. This would appear to suggest that while the role of regional universities in innovation is more
difficult, there must be some factors in their favour, and some areas in which they can and do excel. For example Santoro and Gopalakrishnan (2001) in their study suggested the importance of proximity between university and firm being a crucial factor in co-operation.

Gunesakara (2005, p.526) in exploring the role of universities in regional agglomeration in an Australian context asserted that:

“... [w]hile European countries and the Community, as well as the UK and USA have been pursuing policies that, increasingly, aim to link universities to the development of regional innovation systems, Australia, at present, lacks this emphasis”.

In his study he found that university contributions to the knowledge base of regional industries were not such as to trigger networking or even firm concentration. In other words, his three university case studies appeared to have marginal impact on industry in their local areas, a factor that he attributed largely to the evident lack of interest on the part of local firms. He concluded that (p.537):

“... the existing policy mechanisms for university-industry collaboration [in Australia] that have been implemented by government are grounded in doing excellent research but have a weak imperative for benefits realisation. This is left largely to the market”.

The perpetual issue facing regional universities is described by Feldman (2000, p.353), who said that, in interviews, she asked:

“... scientists where they would like to set up shop if they could locate anywhere in the world. The response is that even though they are part of global networks, have international opportunities, and easily could locate anywhere and still stay connected with new telecommunications technologies, they typically want to stay where they are. Working spouses, children, and familiar surroundings, among other factors, create what may be termed locational inertia – people simply like to stay put. This seems especially true if they are going to start a new company. Staying in a location that one knows minimizes the disruption and uncertainty that result from adapting to a new environment”.

This suggests that regional universities may find it difficult to recruit new faculty members and may suffer the risk of ossification if researchers remain in situ for decades.

An important distinguishing characteristic of Australia’s regional universities is the role played by the Rural Research and Development Corporations (Rural RDC) which have the following characteristics:\[189\]:

- “Rural RDCs take a leading national role in planning, investing in and managing R&D for their respective industries;
- Rural RDCs are not research ‘grant’ agencies. Their enabling legislation requires them to treat R&D as an investment in economic, environmental and social benefits to their respective industries and the people of Australia;

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• Rather than focusing mainly on generating new knowledge for its own sake, Rural RDCs strive to deliver high rates of return on R&D investment by influencing the full range of interactions along the innovation chain;

• Striving for high returns on investment also leads Rural RDCs to apply significant resources to translating research outputs into practical outcomes;

• Rural RDCs are required to conduct their activities in accordance with strategic R&D plans and annual operational plans that take account of the R&D needs of end-users and other stakeholders. The plans are approved at ministerial level;

• Although Rural RDCs fund basic research, a high proportion of activity is applied R&D - both short term and long term; and

• Rural RDCs are fully accountable to their major stakeholders and to the wider community”.

The fact is that regional universities are home to some sophisticated programs in agriculture, mining, veterinary science and environmental science (and, increasingly, medical science), which are areas in which Australia has some natural advantage. Regional universities have proportionally larger research expenditure in these areas than metropolitan universities (DEST 2003b, pp.10-11), which suggests that Australia’s regional universities should be in a position to benefit from TT&C if approached in the right way, in much the same way as NZ Uni. As Etzkowitz, et al. (2000, p.314) said:

“The entrepreneurial paradigm is by no means confined to newly invented technologies or research intensive universities. It can be enacted at teaching as well as research universities through innovations in undergraduate education and continuing education. A two-way flow of influence is created between the university and an increasingly knowledge-based society as the distance among institutional spheres is reduced”.

This is cogent evidence that entrepreneurialism in universities is not confined to research-intensive universities, which is consistent with data obtained in this project.

The narrative review evidence does not offer a consistent theme in relation to regional universities. There is some evidence that smaller and regional universities suffer from a lack of research scale and the fact that metrics (which emphasise LOAs and spin-off companies) are biased against them because these universities tend to offer assistance to industry more in consulting and advisory roles. The necessary implication in the narrative review is that that metropolitan universities perform better in TT&C than smaller and regional universities.

The narrative review is clearly at odds with the primary data on regional and smaller universities, certainly as far as the primary data, which examined SMEs, can be extrapolated. SMEs want to deal with the best professor wherever he or she is located without regard to university location, size or prestige. The primary data disclose that SMEs had more dealings with universities remote from their city than local universities. Similarly, the venture capitalists
all looked to the best ideas wherever they were located and expressed no preference for local or metropolitan universities.

10.8 Conclusion

University TTOs generally believe that the market for research results is global, particularly in terms of results that can be licensed or placed into spin-out companies. This means that unless an Australian company can offer access to a global market, ideas will migrate offshore to wherever this access is offered.

In making the connection between university and industry the personal relationship is the most important element in TT&C however the technology is delivered. This means that opportunities for personal interaction between researchers and industry should be encouraged regularly and deeply. This has been done by better-performing universities having researchers attend conferences, inviting industry into groups and consortia, establishing entrepreneur-in-residence programs and a host of other activities that encourage personal relationships. Appropriate modes of interaction will depend on the type of technology involved and the culture of the academic departments, but this is a matter that can be guided by an outstanding TTO Director, and the case studies offer numerous examples.

While TTOs generally concentrate on four modes of interaction with industry: consulting, contract research, intellectual property licensing and spin-off companies (and many only the latter two), there is a much richer engagement with industry going on. This means that the TTO is not and never should be the sole interface with industry. This has to be so if for no other reason than because SMEs (a large part of Australian industry) are almost invisible to TTOs, yet university interaction is vitally important to high-technology SMEs in their innovation strategies. SMEs and industry generally seek assistance from the best and most appropriate academic faculty irrespective of location or institution. Because high-technology industry, SMEs in particular, regularly seeks to engage with individual academic faculty while rarely seeking to license intellectual property, TTOs are often irrelevant to much of industry. This is not a criticism of any actor in this environment but follows from the finding that TTOs and SMEs often inhabit different spaces and rarely appear to need to interact.

Regional and smaller universities are likely to be involved in much of the rich interaction with industry that does not need a TTO, most of which is invisible and difficult to capture formally. While regional universities may have some disadvantage of proximity, the data suggest that industry seeks the best professors wherever they are located. This means that the task for both regional and smaller universities is to attract the best researchers in fields where the universities wish to excel. The challenge here for regional universities may be in attracting
the best researchers to regional areas, and for smaller universities with lower research budgets to attract leading researchers. But the data show that it can be done, particularly in specialist niches.

Apart from constructing a workable common infrastructure, the role of government in providing some continuing level of early-stage funding is acknowledged. The general view arising from the data is, however, that the role of government should be directed more towards encouraging the involvement of private capital wherever possible, although this may not be practical in the foreseeable future until appropriate vehicles such as not-for-profit foundations and for-profit intermediaries are more common.

The data indicate that Australia has few intermediaries to provide links between universities and industry. Intermediaries are more common in the US and the UK, and may be of some assistance to Australian universities that do not have a present disposition or available funds to establish a fully-resourced TTO.

The data here also demonstrate that a number of modes of engagement between universities and industry appear to have little effect apart from a limited few examples, including static databases, clusters, co-operative research centres and technology parks and incubators.
PART VI – CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

11 Conclusions

This Part comprises two chapters: Chapter 11 summarises the results of the research, draws the key conclusions, and answers each of the propositions developed earlier; and Chapter 12 lists areas related to this project that would benefit from further research.

11.1 Summary of Key Findings

11.1.1 Factors that Enhance TT&C Performance

It would be convenient to conclude that there are a number of common threads that run through all successful TTOs and, to an extent, this is true. But there are also a number of threads that should, at first glance, be important in TT&C success but, after analysis, appear less important. Many analysts and researchers have, after weighty analysis produced lists of qualities and characteristics that universities and TTOs should possess, or of resources that governments should provide if TT&C success is to be achieved. But lists are at best guides and provide little insight into what makes any particular TTO a success, and whether and how such success could be replicated in other institutions (Rousseau 2006). In particular, such an approach makes little allowance for that most esoteric and individual characteristic of any organisation: its culture, and universities are no exception to this rule. This cautionary note about the compilation of lists or solutions that purport to reflect a set of problems common across the body of Australian universities was sounded also by the Productivity Commission (2007, p.283) when it said that “Australian universities are not a homogeneous group. Each of these organisations will have its own governance structures, incentives and culture”.

There are many factors identified earlier, particularly in Chapter 4, that influence a university’s success in TT&C. Of the three groups of factors identified by Tornatzky, et al. (2002) discussed in Chapter 4, namely mechanisms and facilitators, institutional enablers, and boundary-spanning, universities may have some incidental influence on the first and third of these (mechanisms and facilitators and boundary-spanning), but they are substantially constructed by forces outside the control of individual universities. This external environment, or common infrastructure\(^\text{190}\), to use the term of Gans and Stern (2003, p.13), is

\(^{190}\) Common infrastructure includes such factors as; investment in basic research; tax policies affecting corporate R&D and investment spending; supply of risk capital; aggregate level of education in the population; pool of talent
effectively the same for all Australian universities. However, each university normally has control over the second group of factors, the *institutional enablers*. If the common infrastructure offers a workable national regime, and there is ample evidence that Australia’s does, then success or lack of it in TT&C by any individual university must be determined largely through the agency of suitable *institutional enablers*. However, it is important to acknowledge that suitable institutional enablers will not necessarily be exactly the same for each university. The evidence above makes it clear that each university has its own individual character, culture, history and environment around which institutional enablers have been constructed.

In one sense, this conclusion is largely self-evident. If the common infrastructure around which university TT&C is built is unworkable, it would be reasonable to expect that all the universities in such a nation would produce no substantial TT&C results. Yet in every jurisdiction there are examples of superior performance among some universities, and just as clear evidence of poor TT&C performance among others. Since UniQuest at the University of Queensland operates with the same common infrastructure as other universities in Australia, why is its performance in TT&C so evidently superior? Similarly, what makes NZ Uni successful in TT&C when some other universities in New Zealand (and US universities in the US, or Canadian universities in Canada for that matter) are not demonstrably successful?

Based on extensive interviews, Siegel, *et al.* (1999, 2004) concluded that there are three organisational factors that are most critical in determining TTO efficiency, “... reward systems for faculty, TTO staffing and compensation practices, and actions taken by administrators to extirpate informational and cultural barriers between universities and firms”. The data in this project support and expand on this conclusion of Siegel, *et al.* with the exception that the reward systems for faculty members may not be quite so crucial, at least in the Australian environment, although adequate remuneration for TT&C managers is an important factor (Harman and Stone 2006). On top of these requirements for TTO efficiency, the remaining key factor in TT&C success in a university is senior management support. The findings here are consistent with the view expressed by Rousseau (2006) on the role of evidence-based practice (of which, it is suggested, the case studies are an outstanding example), that (p.267): “Evidence-based practice is not one size-fits-all; it’s the best current evidence coupled with informed expert judgment”. It is this role of informed expert judgment in applying evidence-based practice that is the vital factor in the success of better-performing TTOs.

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in science and technology; information and communication infrastructure; protection of intellectual property; openness to international trade and investment; and overall sophistication of demand.
The factors that are consistent in every instance of successful university commercialisation performance from the case studies are two-fold. First, the university President and other executives concerned in commercialisation have to believe in it and make a genuine commitment to its success. Without this (DEST 2002, p.52):

“What emerges strongly from experience is that if the research commercialisation function is set up without strong links with, and support from, the institution, it will be marginalised and, in all probability, fail. Research commercialisation is not simply an ‘add-on’ function; it requires a reworking of strategy and resource allocation to make it an integral part of the university’s objectives and operations”.

The second factor is that the TTO has to be led by an individual that possesses an unusual combination of at least four attributes: the ability and willingness to work in the arcane structure of the university; the ability to be both an entrepreneur and a manager; the flexibility of mind and perceptiveness to see what is happening in a dynamic field as the environment evolves and matures; and a leader of people and business. The capabilities of this individual allow him or her to select staff for the TTO that complement the business because, of course, quality staff are also essential. Technical domain skills are not a significant skill required in the leader, although the ability to empathise with researchers is. The importance of the founder in an entrepreneurial entity – and a new university TTO, in particular, is an entrepreneurial entity – has been well established in the literature (Bruderl, et al. 1992; Shane and Stuart 2002). As a university TTO grows, other factors such as available capital and size and skills of the work-force begin to grow in importance, although it is suggested that the sense of entrepreneurialism, as well as the other attributes listed above, required of the leader of the TTO never cease to be relevant. The attributes mentioned here were recognised by Debackere and Veugelers (2005, p.340), when they said, in respect of researchers at their case study university who successfully commercialise: “Assistance and funding have helped in this process [exploiting the university’s knowledge base], though they cannot act as a substitute for the ambition, the strategic thinking and the drive for implementation of the researchers themselves”. It is suggested that these essential attributes are not limited to the academic researchers alone but apply, also, to the TTO staff generally, and the TTO Director in particular. Most of the higher-performing TTOs identified among the case studies do not have a domain specialist as their Director; most successful Directors appear to have first degrees sometimes supplemented by a MBA. This notion of the importance of an entrepreneurial TTO led by a business-savvy director is consistent with the

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191 These characteristics may be compared and contrasted to those enunciated by Bellone and Goerl (1992) who said that private entrepreneurs possess four characteristics: autonomy, a personal vision of the future, secrecy, and risk-taking propensity. Certainly a person prepared to lead a university TTO probably needs a slightly different set of capabilities to those described by Bellone and Goerl by virtue of the significantly different environment in which they work.

192 And the shortage of this class of person is also emphasised by Mowery and Shane (2002, p.viii) when they say “… management by universities of technology licensing activities requires a set of skills that are extremely rare within universities and in short supply more generally”. This fact was identified in the data in this research, as well.
principal requirement usually identified by scholars as essential to TT&C success: the personal relationship. The essential pre-conditions to Silicon Valley were leadership and social networks (Rogers and Larsen 1984), and the quality of the human infrastructure is just as relevant in a university TTO as it is in any other business undertaking. Thus, while the processes of the TTO are important, they are not sufficient in themselves to ensure success without the ability of the TTO, and its Director in particular, to develop the personal relationships and apply the principles of entrepreneurial business that are essential to TT&C success.

It is important to note that the conclusions drawn here on the characteristics possessed by universities successful in TT&C apply to universities in developed economies irrespective of size, prestige or location. Clearly, then, smaller and regional universities are subject to the same factors – in this matter they are not unique and should approach TT&C in the same way as universities generally, although it is acknowledged that they will still have particular issues resulting from their individual culture and profiles.

Measured by the money they return to the university, there are relatively few successful TTOs in the US, Canada, the UK, Australia or New Zealand. Given the combination of qualities needed to be a successful TTO leader, and thus the rarity of such individuals, this fact should come as no particular surprise.

This analysis has also indicated that successful TTOs can be divided into two particular types (although, of course, there are many potential ways to categorise them). In broad terms they may be called the young and small TTOs, and the large and established TTOs. Each has a slightly different profile in terms of its leadership, although university commitment to commercialisation remains a characteristic common to both.

Among the more successful TTOs, such as NZ Uni and Curtin University in Western Australia, TTO leadership is characterised more by its entrepreneurialism. The energetic serial entrepreneur or imaginative leader is required in the younger and smaller office just as such a leader is needed in new innovative companies of any type. At the larger and established end of the spectrum, Aust Go8 Uni2 and Canadian Uni1 for example, TTOs are characterised by having been in existence for well over ten years and led by managers who retain an entrepreneurial enthusiasm and have imbued their office with the same spirit. Canadian Uni1 is an exemplar – innovative programs, entrepreneur-in-residence, embracing more open-source relationships and multiple connections with industry are evidence of an inherent entrepreneurial spirit.
Successful TTOs have particular qualities of entrepreneurialism and commerciality, characteristics that are not part of university culture. As the Director of the NZ Uni TTO expressed it: “…we have a business culture, the university hasn’t” (NZ Uni Interview 2007).

The data also suggest that success breeds success. There is evidence in reported research by the likes of Lee (2000) that university-industry collaboration is sustainable for the foreseeable future, while some are tempted to suggest, like Feller (1997, p.36), that “Technology transfer has the potential to become [a] self-propelling force within the university”.

This research has identified examples of individuals who are exemplars of TTO leadership, but it has not examined in depth the qualities and character traits possessed by them. There would be significant value in undertaking research to identify the qualities and characteristics of successful TTO leaders and how such individuals relate to the received culture of the university. Harman and Stone (2006) made a significant contribution to understanding the characteristics of Australian technology transfer managers, but there remains a hiatus as it concerns TTO directors specifically.

The second major result from this analysis is that the objective of university research has to be the greater welfare of the community. The question becomes: does university emphasis on TT&C and the existence of a university TTO promote this primary objective of greater welfare of the community? Or is it neutral, or does it act as an inhibitor? And what are the metrics by which the question may be answered? It is arguable that commercialisation among Australian universities is being enhanced only if TT&C and TTOs serve the greater welfare of the community. This question is not presently capable of definitive answer because devising adequate metrics has proven to be all but intractable. Metrics represented by reasonable proxies go some way to providing an answer, but even some of the most thoughtfull analyses (Allen 2003a) struggle to make a convincing case using numerical results. The proxy in the case of this research has had to be Australian university performance against international benchmarks. It is possible to argue that this proposes a circular argument because it starts from the presumption that TT&C is a good thing. To this extent such a criticism is true. But the counterpoint is that there is a convincing case that TT&C is good because it is a continuation of the traditional role of universities – the dissemination of knowledge – and because it has been so soundly embraced by every advanced economy. Allowing that all major economies are not suffering from the same delusion, the virtue of TT&C has to be declared self-evident, and in the absence of adequate numerical indicators, benchmarking is a valid and appropriate tool.
But even here, what constitutes the greater welfare of the community has many facets. Having universities merely insert into the community the fruits of their work as quickly and economically as possible is not worthwhile unless their work is of true value to the community. Therefore a university has to undertake research of value in order for society to benefit, but it can only do this if it has the best researchers supported by the best infrastructure. But the best researchers will, increasingly, only be attracted to universities where their work is being effectively disseminated into the community – that is, a good research university has to support TT&C\textsuperscript{193}. Therefore, TT&C is as much a part of an effective research enterprise as any other part of the system\textsuperscript{194}. And the TT&C element of the research enterprise may be measured against such factors as used above to identify the benchmark universities and then compare Australian practice to these benchmarks. This analysis suggests that there is a growing connection between TT&C and quality research.

It is of vital importance to recognise in undertaking this comparison that no two universities will be exactly the same. As a result there is no one single approach that can be adopted by them all, and producing lists of this or that provides little useful guidance. The important factor is to have an environment in which each university can implement TT&C to the degree and in the way that best suits its circumstances, while encouraging each of them to use every avenue to continue to pursue the welfare of the community as their understanding and experience in different ways of undertaking TT&C develop (Litan, et al. 2007).

\textbf{11.1.2 Other Factors}

While the two factors mentioned above are key to university TT&C success, they are not the only factors. The literature and this research have identified a number of other important factors, the \textit{institutional enablers}, that are needed to encourage success, which are discussed below. But without the two key factors identified above in place any structure, no matter how good, is unlikely to produce acceptable results, while having the best institutional support, leading TTO management and world-class research can go a long way to overcoming even indifferent institutional structure.

First, the factors that may, at first glance, appear important. A common metric employed when measuring university commercialisation is the amount spent on research. It is expected that the more a university spends on research the greater the quantum of research results and the greater the amount of commercialisation. TTOs at successful universities such as

\footnote{193 It is not intended to confuse TT&C at this stage with any concept associated with income from TT&C and resulting financial consequences.}

\footnote{194 This view is supported by the Productivity Commission (2007, p.294) which eschews use of the term third stream funding “...which implies knowledge transfer and diffusion are somehow separate and distinct from the research and teaching functions of a university when, in fact, they are intrinsic to these functions”.
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Aust Go8 Uni2 and Canadian Uni1, both with large research budgets, say that if they had more TTO resources they could get even more commercialisation results, and there is no reason to gainsay this. But NZ Uni and Curtin University in Western Australia\textsuperscript{195} (mentioned by Aust VC1 in its case note) are both examples of universities with quite small research budgets that are at the leading edge of commercialisation. At the same time, Princeton University in the US, an ivy league university of the first rank (mentioned by US VC), is not recognised as a commercialisation leader in the US. There are factors at work other than research expenditure by universities that demonstrate premier commercialisation performance. While volume of research may not be quite so important, quality of research is. This is evident from the comment of NZ Uni that “While the university is small,... we just happen to be able to attract really good researchers, and we've got some fantastic world-class researchers here; so the quality of technology is high” (NZ Uni Interview 2007). The important factor is that a university must produce a sufficient volume of world-class research if it is to produce superior TT&C performance.

The proximity of universities to sources of venture capital could be expected to give them an edge when it comes to commercialisation performance. But for every case where this could be true: Stanford and Berkeley in California, and MIT and Harvard University in Massachusetts, there are contrary examples: NZ Uni in regional New Zealand, and most Australian universities. There may be some advantage in proximity to major capital sources, but it is not compelling.

The ready availability of early-stage funding: pre-seed, seed, proof-of-principle and the like, could be an important issue in encouraging commercialisation. This is a reasonable conclusion, although the amounts available for this are rarely large in any university, most commonly coming from retained earnings of the TTO, from the university itself, from government, from business and industry and, possibly, not-for-profit foundations. There is a case to be made (US VC Interview 2007) that government should have no role in supplying such funding, although in smaller economies this may not be realistic. US Public University has no internal funds for early-stage development and largely relies on industry taking an interest and funding potential technologies. But even universities with relatively young TTOs, such as NZ Uni, as well as mature TTOs, such as US Private University, are able to use retained earnings to fund early-stage development. This approach enforces considerable discipline on the allocation of funding and may be the best approach and consistent with Productivity Commission (2007) recommendations. But, in any event, the availability of funding that is supplied through government, industry and other sources, is not a

\textsuperscript{195} In the relevant research period the annual research expenditure at these universities was $<20m$ and $<35m$ respectively.
differentiator between successful and other TTOs, because funding appears to be available to some extent for any good idea, irrespective of university background and size.

Access to an incubator can be important in some cases, more especially in life sciences where the cost of establishing wet laboratories can be prohibitive, but there is no need for a university to own or operate one. In Australia and New Zealand incubators are generally government-sponsored. No case study university expressed any enthusiasm to own and operate an incubator, while all university TTO managements were strongly opposed to the university being involved in their provision. To the extent that they are necessary or desirable, incubators should be provided outside the aegis of universities by government (less desirable) or private capital through foundations (more desirable).

Co-operative Research Centres were created with the intention of providing a bridge between universities and industry and to encourage a more commercial orientation on the part of universities. They were created during a brief period when the view of university-industry co-operative structures was in the ascendant, but CRCs are viewed by case study university TTOs and SMEs as making little worthwhile contribution to TT&C – a view reinforced by many government reports. CRCs have probably contributed what they can to the environment and their demise would cause little apparent offence to university TTOs or most of industry. Where they supply a real industry need and their continued existence would be desirable, it is reasonable to expect that they would be sustained by private funding as occurs in most cases in the United States.

Finally, among the factors that may appear to be important but evidence suggests otherwise: clusters. While they can have a profound effect on particular industries at particular times, they emerge spontaneously and appear incapable of being created artificially by government wish or fiat. Smaller economies like Australia are unlikely ever to have anything in the manner of a Silicon Valley, although the valuable clusters of life sciences entities in the major Eastern State cities of Australia provide nascent potential in specific fields.

Turning to the other institutional enablers that support successful TT&C, the two most important: institutional support and exceptional TTO leadership have been identified. The third element essential for TT&C success within the control of a university is a flow of sufficient world-class research. As discussed earlier it is the quality rather than the volume of world-class research that is important, but there must be a continuing flow available to sustain the commercialisation enterprise. The best example of this comes from NZ Uni which, on a small research budget, has managed to develop a very successful TTO.

Another institutional enabler important to commercialisation success is the possession of a suitable intellectual property regime within universities. Collectively, universities (and other
PFROs) in Australia and the UK have developed sets of principles which are used to inform individual university intellectual property policies and practices. Neither the prescriptive approach used in the US nor the laissez-faire approach of Canada and New Zealand appear to be superior to that adopted in Australia and the UK. US-style prescription is unlikely to be necessary in Australia to overcome any existing problem, while analysis of the Canadian intellectual property environment shows that the significantly different policies and practices adopted by individual universities make it somewhat more difficult to get some ideas commercialised. While the Australian position is not yet ideal, with individual universities having the right to adopt different intellectual property policies and practices, universities appear to be iterating, over many years, towards a more common approach.

The importance of sound linkages between university and industry arises in almost every review of the environment as an essential component of effective TT&C. This research has shown that there are many modes of linkage; which among these many modes may suit an individual university will depend on a number of factors including the profile of the university, its culture, and its history and experience. It is impossible, for this reason, to offer a universal prescription as to which linkages should be adopted by any particular university. However, two key factors are important in ensuring that a university builds and maintains appropriate and strong industry links: institutional support for TT&C, and the leadership of the TTO, which are the same factors important in university TT&C success generally. In other words, by establishing the environment that fosters TT&C, the creation of the other important components necessary to make it work should necessarily follow-on. Through its structure and its academic faculty and staff a university will be able to identify and promote the linkages that will work best for it.

This research has identified one particularly important issue within the purview of the government impinging on university TT&C: its fiscal power. This includes early-stage capital for the development of ideas and a general environment (Rider, et al. 2006) conducive to TT&C. Concern about the lack of early-stage capital to develop nascent ideas at universities is common across jurisdictions. While the ideal would involve the deployment of well-educated private capital to fill this need, this may be unrealistic for two main reasons. First, there may always be some ideas for which private capital is simply unavailable due to market failure and which has to be supplied otherwise, or there may be some ideas that are of interest to only one or a few buyers on matters such as defence. Second, potential investors in early-stage ideas are only beginning to emerge and it may take time – probably many years – for them to acquire the skill and confidence to invest in this area. In both cases there

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196 Although the potential problems that may arise from the 2008 case of University of Western Australia v Gray (No 20) [2008] FCA 498 may require this conclusion to be re-visited once appeals have been exhausted.
may have to be an alternative investor interested in a greater public good such as government, private foundations, or other patient capital such as pension funds. Private foundations are well developed in the US but less so in other jurisdictions, while there are, as yet, few pension funds eager to invest in early-stage developments\textsuperscript{197}, meaning that the government is likely to have some continuing role in financing early-stage ideas if they are to be captured and developed. Just as the best place for decisions on commercialisation is at university level (which is the fundamental premise of the Bayh-Dole Act), so the best place to make the decision on whether to invest in the further development of an idea is close to the idea, in conjunction with a well-informed and experienced investor. The ideal environment involves the government establishing a fiscal regime that encourages the involvement of private capital in early-stage investment with the government providing direct financial support only where essential, with the majority of investments made by the universities themselves, or in conjunction with private capital and not-for-profit foundations.

Finally, this research has identified one area where Australia could adopt an approach used in other larger jurisdictions: the use of intermediaries in the commercialisation process. Intermediaries such as Battelle have existed in the US for many decades and their importance is increasing. In the UK the existence of listed and private companies that have commercialisation arrangements with universities has increased enormously over the past decade, but in Australia intermediaries scarcely exist. It may be that, as Aust Go8 Uni2 noted, intermediaries are not important where TTOs are doing their job effectively. But, for the many Australian universities where the TTO is resourced sub-optimally and producing below-par results, intermediaries could offer a suitable vector for research to reach industry effectively and efficiently.

\section*{11.2 Answers to the Propositions}

\subsection*{11.2.1 Outline}

This section answers each of the propositions developed in Section 6 based on the evidence collected and analysis conducted in this project. Propositions relevant to both universities and industry are dealt with below. Answers to the propositions covering industry are relevant principally to the segment of business examined, namely SMEs in the non-life sciences high-technology sector. The order in which the propositions are listed is not intended to rank their relative importance.

\footnote{\textsuperscript{197} Westscheme, a Western Australian pension fund mentioned earlier, is one scheme able and willing to invest for the longer term.}
11.2.2 Structure of the TTO

Proposition: The structure of the TTO and the processes used within the university influence success in TT&C.

This proposition was found to contain four pertinent elements: the quality of the staff, especially the TTO Director; the structure of the TTO entity; the processes used by the TTO/university in undertaking TT&C; and age of the TTO.

In relation to the first element, while the most usual qualification held by TTO professional staff is a PhD, among the better-performing TTOs the Director typically does not hold a PhD, but a first degree and, sometimes, a MBA. What the Director needs is flair, imagination and a degree of entrepreneurship ahead of expertise in any particular technical domain. The quality of the TTO Director was found to be one of the three most important factors in successful university TT&C

Universities use, essentially, one of two types of TTO structure: as a unit of the university (most commonly within the purview of the Deputy Vice-Chancellor Research or Vice-President Research); or as a company, usually wholly-owned by the university. There are other options such as outsourcing some or all TT&C functions but these have yet to be embraced to any significant extent in Australia. Having a university-owned company acting as TTO should be distinguished from companies used for purposes such as patent-holding companies or spin-off companies that the university may own.

In each North American university case study the TTO was a unit of the university while, in New Zealand, the TTO was a university-owned company. Of the Australian case studies, TTO companies were used by both Group of 8 universities and one of the ATN universities but, in all other cases, the TTO was a unit of the university. Several universities, both in Australia and elsewhere, have transitioned between the two structures, and neither could be held out as representing the ideal. The company structure in Australia has at least two advantages over being a unit of the university: it can claim funding under some government programs that require a corporate structure in order to participate; and it is able to offer the greater salaries and incentives needed to recruit and retain talented TTO staff, while university units appear obliged to offer benefits within the usual constraints of university staff classifications.

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198 For example through the medium of intermediaries such as, in the United States: Battelle Memorial Institute; in the UK: Imperial Innovations plc and IP Group plc; in Germany: Fraunhofer Society and Max Planck Institute.

199 Although, in some cases, universities used a separate company to hold intellectual property or for the purpose of applying for government funding when a company structure is required.
The downside reported by universities in having a company structure is principally that some have operated independently and without sufficient oversight by the university resulting in substantial financial losses. This is really a matter of proper corporate governance, and there are examples of university TTO companies that are well-run, profitable and responsive to university needs.

Finally, many Australian universities are quite young as a result of being created during the university expansion of the 1960s and 1970s, or as a result of their creation from former institutes of technology and colleges of advanced education during the 1980s. There is evidence that successful TTOs need to have been in existence for at least ten years before they begin to become self-sustaining, particularly in the case of TTOs at larger universities, but merely having a long-established TTO is not conclusive of having a successful TTO. Some Australian TTOs have been in existence for many years (Allen 2003, p.38) but still do not produce superior results. Some recently-formed TTOs, such as the New Zealand case study university, established for less than a decade, have produced outstanding results.

11.2.3 Incentives to Engage in TT&C

Proposition: Research staff are motivated by incentives to undertake TT&C activity.

The greatest incentive for researchers to undertake TT&C is usually their wish to bestow a benefit on the community that funds the research. Apart from this, most academic researchers are motivated by rather prosaic benefits as teaching relief, with personal profit generally lower in the spectrum of importance. Nonetheless, all Australian universities provide two particular incentives for academics to engage in commercialisation: they allow up to 20% of paid time for academics to undertake personal commercial activities (fairly much the same is allowed in North America), and a share in commercialisation profits.

Where researchers are employed in private or public enterprise other than universities the employer will normally own all the right, title and interest in any intellectual property created by an employee and will usually exploit such intellectual property for the benefit of the company alone (subject to the 2008 decision of the Federal Court of Australia in University of Western Australia -v- Gray mentioned earlier). Almost all universities claim rights over the intellectual property of employed academic staff but, because of the distinctive nature of the relationship between academic staff and university, will normally allow the academic researcher to share anywhere between one-third and half or more of the profits arising from the exploitation of intellectual property created by the academic. This situation is complicated by the different rules that apply to students and visiting researchers as a result of the application of general intellectual property laws, but the principle of profit-sharing is now well established.
Evidence from the case studies, however, suggests that the incentive value of big dollars from the block-buster discovery is not generally a great motivator principally for the reason that such events are rare. The freedom for researchers to undertake extensive private commercial activity appears to act as a more potent incentive to engage in commercialisation than any set of official parameters, however well intentioned they may be.

### 11.2.4 Entrepreneurship and Culture

Proposition: *A culture of entrepreneurship and support is vital if a university is to succeed at TT&C.*

A successful culture extends across the university starting with its Council, through senior executives, the TTO to researchers. If a university’s Council and senior executives do not explicitly support TT&C the probability of it succeeding is quite low. Support must be symbolic, but it must also be tangible. It must support investment in the TTO, the employment of good quality staff, it must remunerate and motivate the staff, it must establish and maintain an environment that encourages and recognises researchers and students and, most importantly, it has to be prepared to do this for several years if necessary so that TT&C becomes part of the culture of the university and not a mere fashion statement that does little more than conform to government expectations. Things typically done by some of the superior universities include: have the TTO reporting to the university President or next most senior executive; encouraging engagement with industry through activities such as affiliations and consortia; establishing entrepreneur-in-residence programs; conducting business planning competitions for students; providing and encouraging funding for early-stage development of promising ideas; offering particular recognition to faculty members and students of achievements in commercialisation; and offering flexible remuneration to researchers (in terms of income or equity) to participate in TT&C.

### 11.2.5 Access to Early-Stage Capital

Proposition: *In order to succeed at TT&C universities must have access to early-stage capital to provide funding for proof-of-concept development and to undertake detailed market evaluation.*

There is little doubt that early-stage capital is usually important in allowing nascent ideas to be developed to a technically acceptable stage before intellectual property can be licensed or assigned either to industry or a spin-off company. Universities, where they have the resources, generally provide funds at two levels: for initial proof-of-concept, typically in the range up to $100,000; and to develop the idea to a level where technical risk is minimised,
typically in the range $500,000 to $2 million. Further funds for full development to marketability are supplied, when needed, by venture capital.

The usual issue facing universities is where these early-stage funds should come from. There is some strong sentiment in the US that funds at this level should come from the private sector, from not-for-profit foundations, or from university funds (most usually comprising retained earnings from earlier commercialisations). Where US universities are near large sources of capital, such as California and Massachusetts this appears not to raise an issue, as sophisticated private investors are more commonly available. In Australia some pension funds, such as Westscheme, and some university-inspired common funds, like UniSeed, are sources of early-stage funding.

The case studies show that overseas best practice in TT&C involves funding from retained earnings, private investors (where the market is sufficiently mature) and, increasingly, not-for-profit foundations (most commonly in life sciences and pharmaceuticals) and patient capital like pension funds. Many Australian and international universities report that there are more ideas worthy of funding than they are able to find early-stage funding to support. While there is a continuing need for more funding in this area, there is no major difference apparent among the Australian case study universities as a result of the presence or absence of funding – they are all largely in the same circumstances.

The government is often seen as the lender of last resort for nascent ideas that cannot get funding elsewhere but, because government rarely provides the full funding needed, researchers are usually obliged to obtain matching funding from an industry partner or elsewhere. Australia has an extensive program of support for early-stage development (DITR 2003) available to universities and others.

11.2.6 Industry Linkages

Proposition: Linkages between universities and industry are the vital element in successful TT&C.

The literature and published investigations indicate that personal relationships spanning the university-industry gap are the key ingredient in TT&C success, and the data from this project are consistent with and reinforce this proposition. This strongly suggests that, of all the things that could be done by any entity – government, university, industry association – the one thing that is likely to achieve the greatest improvement in TT&C results is facilitating opportunities for personal interaction among the principal participants in TT&C – researchers, business managers and capitalists.
11.2.7 Intellectual Property

Proposition: *A workable intellectual property regime is a necessary pre-requisite to successful university TT&C*

Australia, along with the UK, probably has the best general regime for intellectual property for university TT&C among advanced economies: it is non-prescriptive; allows universities to choose whether to own and exploit intellectual property; permits universities to choose whether to license or assign intellectual property; provides guidance to universities through their representative organs on intellectual property policy and practice; provides incentives for researchers to engage in TT&C; and is generally consistent with international best practice. The contrast here is with the US, which has rather prescriptive rules on the use of intellectual property arising from federally-funded research; while in Canada and New Zealand, where there is no guidance given to universities on intellectual property rules leading to a diversity of practices.

Because each jurisdiction provides examples of universities succeeding in TT&C, each national intellectual property regime arguably forms part of a workable common infrastructure. Nonetheless, on balance, the guidance provided by the UK and Australian approach appears preferable to the prescriptive approach adopted by the United States or the *laissez-faire* approach of Canada and New Zealand by providing a measure of consistency among universities’ intellectual property policies, while still allowing the flexibility desirable to accommodate differing university cultures and experience.

11.2.8 Co-operative Research Centres

Proposition: *Co-operative Research Centres improve TT&C performance.*

Case studies show that from the point of view of university TTOs and electronics industry SMEs, Co-operative Research Centres do not aid TT&C. TTOs saw them as likely to divide the university’s TT&C efforts, while SMEs perceived them as an exclusive club that benefits only the participants in the CRC.

Venture capitalists indicated a preference for dealing with CRCs over universities for reasons such as the more commercial nature of the research, the more focused activities of a CRC and the commercial attitudes of CRCs; but while this helps venture capitalists, it is not directed towards assisting universities in TT&C.

CRCs may result in universities obtaining some additional funding to support particular research or research students that may not be otherwise available, but both the primary and
secondary data support the conclusion that CRCs are of limited value in assisting university TT&C.

### 11.2.9 Characteristics of Local Industry

Proposition: *Local industry has to be capable of absorbing university research outputs if TT&C is to flourish.*

This proposition requires an answer in two parts: as it concerns intellectual property licensing and spin-off company formation on the one hand, and all other interactions with industry on the other. When it comes to licensing intellectual property out of universities and universities starting spin-off companies, the evidence shows that universities are placing their knowledge into the global environment. University TTOs want to deal with companies that are able to take leading-edge university knowledge global – this desire was found in almost every case study. And, just as clearly, successful university spin-off companies have to compete in the global marketplace, as the likes of case study Company B made clear: it was “born” a global company. Thus, it does not matter whether the licensee company is Australian or otherwise, what matters is that it has global reach or ambition. Australian companies can license university intellectual property or spin-out of universities if they have this quality. If they do not, university TTOs will look beyond Australia to seek the best receptor company in the world.

As to the second part, Australian-based companies are the natural receptors for university knowledge in categories such as consulting, contract research and personnel exchanges that form so much of the university-industry interaction. UniQuest figures show that over half its income is derived from the prosaic activities of consulting and contract research. Comments by Australian case study companies make it very clear that they value university interaction greatly in the areas of consulting, contract research personnel exchange and other personal dealings.

### 11.2.10 Industry Clusters

Proposition: *Industry clusters aid universities and industry in TT&C performance.*

There is evidence in the literature that clusters in life sciences and some other fields have evolved in Australia over many decades. But the data in this research offered no cogent evidence of industry clusters having any tangible impact on the high-technology electronics industry in Australia. Where companies with similar characteristics co-exist it appears to have come about through historical factors rather than design, and there was no evidence of any high-technology business clusters identified, rather there was a strong degree of scepticism about their worth. It is noteworthy that even among the SMEs interviewed there was a strong
tendency to look and interact with a number of universities based on the perceived abilities of the faculty members with little regard to either institutional reputation or location. Australian companies appear to deal with universities and complementary businesses irrespective of geographical limitations with no clusters discernible among the case studies. Company D's work with Barcelona University is clear evidence of this behaviour, with most case study companies interacting with multiple universities throughout Australia.

11.2.11 Role of Intermediaries

Proposition: Intermediaries operating between universities and industry improve TT&C performance.

The evidence indicates that Australia presently has two quite small private company intermediaries, plus some, such as NICTA and AIC inspired by the government; the UK has at least six significant private companies acting as intermediaries plus some state-inspired intermediaries; and North America has numerous intermediaries, mainly from the not-for-profit sector, plus some such as the Fraunhofer Society from Europe. Almost certainly Australia is under-served in intermediaries capable of assisting universities exploit some areas of research. While the sentiment of one university that intermediaries should not be necessary when TTOs are operating efficiently is most likely true, the fact is that Australia has many universities that are not offering effective TT&C functions to their researchers and may need some impetus, such as the ability to substantially outsource some of the activity through an intermediary, to stimulate more effective TT&C.

11.2.12 Technology Parks and Incubators

Proposition: The presence of technology parks and incubators stimulate better TT&C performance.

Of the thirteen universities studied, only two had established anything in the nature of an incubator. One was a small regional Australian university which appears to use its associated technology park and incubator to encourage regional economic development more than to promote university commercialisation, while one private US university has an incubator, although its operation is tempered by cost realities – its costs are too high to encourage its use by off-campus companies.

Metropolitan universities, in particular, reported a greater reluctance to become involved with their own incubators and technology parks because of the high costs associated with their establishment and operation. Where they are perceived as being needed, universities generally prefer that they are provided by the state or private foundations and operated for the general good of the community and regional economy.
11.2.13 Regional and Smaller Universities

Proposition: Regional and smaller universities must satisfy different criteria to other universities if they are to succeed at TT&C.

Research-intensive universities (In Australia Group of 8 universities or, in the US, Carnegie Tier 1 universities) inevitably receive greater research funding and, as a result, usually have a greater proportion of world-class research being undertaken. This leads them to have more potential to achieve greater TT&C outcomes. However, not all Australian Group of 8 universities achieve superior TT&C results notwithstanding the quality of their research. On a like-for-like basis some of Australia’s smaller, regional and technical universities produce greater TT&C results than Group of 8 universities.

Evidence from the case studies shows that a Group of 8 university or a university situated in a metropolitan location is not a reliable indicator of TT&C performance. An essential criterion to achieving superior TT&C performance is undertaking world-class research. Some smaller and regional universities specialise in areas specifically as a result of their location (such as manufacturing, agriculture, mining, and environmental and veterinary science) and are equally as capable of producing outstanding TT&C results from smaller budgets as long as their research meets the quality benchmark. It is, however, true that universities that undertake a greater volume of good quality research, ceteris paribus, produce a greater volume of TT&C results\(^{200}\).

11.2.14 The Role of Government

Proposition: The role of government in stimulating TT&C is to establish an environment that encourages parties to participate

While government has a role in encouraging TT&C, the issue is: what should it do? The Australian Government has been subject to legitimate criticism from some scholars on particular deficiencies, but there was no obvious concern about present policies among the case study universities or companies. Indeed, there was more praise than concern. Australia’s existing TT&C common infrastructure has not prevented the rise of some successful university commercialisation regimes. The data suggest that universities can succeed in TT&C when the government’s settings are non-ideal, as long as they are benign and not inconsistent with general practices among advanced economies – NZ Uni in New Zealand being the premier example.

\(^{200}\) This is what Siegel et al. (2003a) refer to as a “return to scale”: namely, the greater the volume of research, the greater the volume of commercialisation.
US practice is generally to have the government establish a regime that encourages TT&C, and then let the market operate freely. The SBIR, a significant market intrusion by the US Government, has the character of a regime but may be properly considered as environmental (part of the US common infrastructure) rather than direct intervention. The US regime has been relatively stable for around twenty years, allowing participants to be able to plan with sufficient certainty. The key parts of the regime as it affects this topic have been legislative (Bayh-Dole and the SBIR), coupled with broad and deep financial markets willing to assume some degree of risk. Apart from an equivalent to the SBIR and some other fiscal issues (Rider, et al. 2006), Australia has a reasonably similar common infrastructure to that of the US in so far as the government is able to affect it. The arguable proposition is that Australia does not have the aggressive business culture of the US – and no government can provide this.

The role of government in Australia, and the other advanced economies, should probably be limited to that of providing the best common infrastructure that it reasonably can, and then to allow the market to operate. The Australian Government is doing this, and existing successful TTOs are evidence that this approach can and does work.

11.3 Factors Affecting an Australian University Commercialisation Model

11.3.1 The Australian Environment

Miles and Daniels (2007), in their essay on the UK innovation economy concluded that the UK is competing with two innovation powerhouses: North America, and South and East Asia. The factors working on the UK economy mean that it should accept that it is not in a position to meet these two regions head-on, rather to acknowledge the UK’s strengths and attempt to use these to its advantage. The probability of the UK creating “a ‘big gorilla’, such as Microsoft” is remote (although, maybe, not impossible) but, in their opinion (p.4):

“It is suggested that the way forward is to nurture smart ‘niche positions’ and collaboration within global innovation-industrial platforms. The UK doesn’t have to emulate the scale of the likes of Silicon Valley; it does have to focus on a policy regime which will support the development of strong and defensible niche positions. Further, the future gorillas that do grace the commercial landscape of the UK may not employ vast numbers in the UK; unbundling production and services across borders and the relatively small size of the UK market will lead to employment associated with the UK gorilla spread across its global markets, supplier homebases and R&D centers”

This conclusion is persuasive and equally valid for Australia. Australia has shown itself capable of world-class innovation in niches; it has a small home market and has to work constantly on global opportunities; and even the greatest of Australia’s innovations with global relevance are unlikely to employ directly vast numbers of people in Australia. The challenge Australia has is to ensure that it derives, as far as possible, the maximum benefit that it can from the research that it undertakes. This can be achieved by setting in place an
environment that meets two broad principles: a general structure established by the
government that is conducive to (indeed, encourages) the commercialisation of university
research; and specific university environments that encourage the individual initiative needed
to take ideas into the market.

In the first case, the general structure created by government in Australia, there is ample
evidence that, while it may be improved in certain particulars, is generally sound and has
permitted the development of some excellent outcomes in university research
commercialisation: the likes of UniQuest, in particular, being testament to what can be
achieved. There are certainly aspects of the structure that can be improved, but the
government has shown willingness to redress deficiencies when a suitable case can be
made. The fact that the current structure can and does permit good results is cogent
evidence that major changes to the common infrastructure are not presently essential to
enhance TT&C.

It is also reasonably clear from the earlier analysis that the broad environments established
by individual Australian universities, as they affect research commercialisation, are not vastly
different _inter se_, and have become more alike over time (for example, the change by the
University of Melbourne to institutional ownership of intellectual property, thus making all
Australian universities but one uniform in this regard). All universities offer a financial
incentive to researchers to participate in TT&C; they all allow time for academic faculty
members to participate in TT&C; they all have largely similar general rules relevant to TT&C;
and they all work into the same global marketplace. The analysis here shows that the
difference in their relative performance is largely defined by differing cultures within individual
universities and the character and abilities of their individual TTOs. The culture of a university
is not generally something that can be changed quickly, but it inevitably starts with the
attitude and principles espoused and practised by the Council and senior executives of the
university and, in terms of TT&C, can be profoundly affected by the performance of the
university in TT&C – success will breed success, while indifferent performance can breed
researcher indifference. Similarly, the performance of the TTO in assisting the university
attain superior TT&C performance is affected by the attitude, principles and practises of a
university’s Council and senior executives – they must select a TTO leader (who, in turn
selects staff) capable of meeting the university’s objectives. And, ultimately, academic
researchers have to wish to participate in TT&C. Under present rules universities cannot
oblige them to engage in TT&C and are never likely to attempt to do so because this runs
counter to the fundamental ethos of academia. It is, largely, a matter of leading by example.
11.3.2 Universities

The evidence makes it sufficiently clear that universities themselves are unlikely ever to obtain significant financial benefit from the commercial exploitation of ideas arising from their research. There are many reasons universities engage in TT&C, but making money for the university from this activity should be an incidental one. Using the data from this project, a model that summarises university commercialisation practice can be described in the following terms:

- universities undertake research that provides benefits and contributes to the welfare of the community;
- one of the mechanisms by which value is returned to the community is through the commercial exploitation of ideas with commercial potential;
- such ideas may be exploited commercially through the production and sale by industry of innovations derived from these ideas (allowing that universities are a poor medium to exploit commercial ideas all the way through to market);
- it is preferred that local industry (which, in Australia, means Australian industry, however it may be defined) exploits the ideas with commercial potential so that the economic benefits may be retained, as far as possible, locally;
- in some cases, most notably in life sciences, industry will be more willing to exploit ideas with commercial potential if it is able to do so through the exercise of monopoly rights arising from protection granted through patents and other forms of intellectual property rights; and
- universities may obtain a return from industry’s exploitation of these ideas, but universities are unlikely to (or otherwise should not expect to) obtain monetary returns from this exploitation in excess of the costs universities incur in providing industry with the benefit of the ideas (such as identifying, protecting and disseminating the ideas). Universities will rarely recover any significant portion of the costs associated with the research involved in creating the ideas with commercial potential.

This model suggests that Australian universities should be doing the following things if outcomes from their research are to be maximised (enhanced):

- encourage regular and deep interactions between university researchers and industry;
- provide industry, preferably Australian industry, with ready access to all ideas with commercial potential at the earliest appropriate time;
register, under the intellectual property rights regime, only those ideas with commercial potential that need a monopoly to permit their commercial exploitation;

provide industry with access to ideas with commercial potential at the lowest possible cost (that is, universities should not expect to receive financial benefits in excess of the costs of identifying, protecting, disseminating, etc, the ideas). Income in excess of that needed to cover the university’s costs is a bonus; and

provide industry with such continuing assistance as industry needs to ensure that the idea can be transformed into a commercial innovation.

What are the implications of this model?

Universities should not expect to do more than recover their costs of identifying, protecting, etc the ideas to be exploited. They are, in fact, continuing their historical task of disseminating ideas for the public good, and should continue to do so for two reasons: to attempt to permit Australian industry to have the best prospects of benefiting from the ideas; and to ensure that good ideas are taken up by industry at the earliest possible time;

The mode of identifying, capturing, protecting, disseminating and exploiting the ideas created through research (such as through TTOs), is less important than the support of the purpose behind commercialisation: thus public benefit is the prime motivation, not income to the university;

There needs to be a range of appropriate media through which the ideas generated by universities are made known to potential users;

Support for industry innovation is more important than trying to identify the next big idea that represents a “disruptive” innovation – that is, an innovation that changes businesses or industries, or creates new ones (after (Howard 2006));

There are probably five broad models capable of adoption by Australian universities according to their individual culture and circumstances:

The do nothing option: allow knowledge diffusion to continue in the way it always has;

The small TTO option: establish a small TTO which undertakes some specified tasks and buys-in additional resources as needed;

The large TTO option: establish, capitalise and support a TTO with organic skills to undertake most TT&C;

Outsourcing option: engage an external supplier to undertake most or all of the TT&C functions; or
• Co-operative model: where universities co-operate in some or all of their TT&C functions and, possibly, establish a common TTO or procedures.

Traditional modes of linkage such as learned papers and conferences remain far and away the pre-eminent mechanism linking university researchers with industry and will do so for the foreseeable future.

Most TTOs in Australia and elsewhere are presently of the second type: small offices with limited resources. The risk with a small TTO is that it suffers from limited resources to undertake the tasks necessary for the university; it has a limited skill base – it simply cannot possess the range of skills present in a larger office; it may concentrate on a few areas or inventions that have good prospects with the risk that other areas of research are compromised and made to feel unimportant or that their needs will not be met in a timely fashion. The result of this may be that most faculty members will seek mechanisms to bypass the TTO and establish private links with industry where they wish to do so (Owen-Smith and Powell 2001). A small TTO can either be: a nominal office established to satisfy the dictates of research funding agencies; as a transitional step to the development of a larger and better-resourced office; or as a strategic decision to undertake only limited TT&C activities directly.

The third model has been adopted generally by larger universities to meet the spectrum of TT&C activities. Aust Go8 Uni2 and Canadian Uni1 are examples. TTOs like these can only be established if the three criteria for success are met: institutional support; superior TTO leadership; and high-quality research with global application.

The fourth model has not been adopted to any great degree in Australia, but has been embraced by a number of eminent UK universities. As the Australian market develops and matures this option may prove suitable for a number of universities.

The fifth model has been used by a regional Australian university in conjunction with UniQuest, but the evidence suggests that it is unlikely to prove workable among institutions generally, particularly where they are likely to be in competition for researchers.

11.3.3 Technology Transfer Offices

Depending on the TT&C model adopted by a university, TTOs are likely to adopt one of three general models of commercialisation office. These are:

• Hands-on management of commercialisation;
• Acting more as facilitator of commercialisation than hands-on; or
• Outsourcing most of the function while maintaining only the essential skills in-house.
Whichever TTO model is selected, the evidence suggests that the TTO will not meet the objectives of TT&C if it acts as gatekeeper rather than facilitator. Better-performing TTOs see their role as the facilitator of industry interaction, not the guardian of knowledge to be sold at the highest price.

11.3.4 Industry

Evidence suggests that there are two principal types of interaction with universities that industry values: those involving long-established and more informal relationships that include such activities as consulting, advice, research contracts, exchange of personnel and co-publications; and the rather more recent and more formal activities involving intellectual property licensing and company spin-offs.

The first of these has been chronicled in the SME case studies developed in this research, but this form of interaction is not limited to SMEs but is typical across the spectrum of industry. The evidence shows that this interaction is particularly important to SMEs to help them innovate in high-technology industries such as electronics. However, SMEs (spin-off companies excepted) do not generally have the same ability to exploit discoveries with global potential largely due to their limitations of capital and resources. But because these are the areas of greatest interest to TTOs, there is an evident disconnect between the expectations of SMEs and the ambitions of TTOs.

Australian universities are almost always undertaking research at the forefront of technology, which means that, if they invent, discover or create something new, it will have potential implications throughout the world. Australian universities are not “inventing” for Australian industry or the Australian market. The evidence found in this research makes a strong case that the market for ideas emanating from Australian universities is a global market. Added to this are a number of other facts, including:

- Australia is a small market in itself; and
- Australia has research strengths in a number of niche areas.

While it may be preferable for a company to have a strong presence in its local market, often this simply may not be possible. The likelihood is that an idea emanating from an Australian university will require exploitation by a company that has global reach. Such a company may be Australian, but it could equally be foreign owned or based. Alternatively, where no company can be found as a suitable medium to take an idea to market, or where it is assessed that there may be other benefits arising, an idea can be taken to market by creating a company for that purpose: a spin-off company.
If it becomes Australian Government policy that SMEs should be given greater ability to exploit university research results with global potential, programs similar to the US SBIR and STTR may need to be considered. This, along with the use of State and Territory Departments of State Development may be the most practical ways in which SMEs are likely to be drawn in any meaningful way into engaging with universities on potentially larger prospects.

A particular mention was made by more than one SME that access to the huge range of journals held by universities would be very useful given that the cost of access by SMEs is otherwise prohibitive.

11.3.5 Government

The role of government is essentially to establish an environment that facilitates interaction between industry and universities. As argued earlier it does this through a number of mechanisms and, while not perfect, the Australian Government has established a common infrastructure under which university TT&C can succeed. The one thing that governments in Australia have not done, but which may assist TT&C, is funding the establishment of university TTOs or intermediaries.

Hatakenaka (2005, p.17) suggested that there are three rationales for public funding of third stream activities:

- to achieve cultural change;
- to overcome market failure; or
- to provide pump priming.

She argued that the first of these, to achieve cultural change, is needed so as to ensure that commercial income is not the prime rationale for third-stream activities (because she takes a broad interpretation of what constitutes third stream activities). This rationale does not apply to TT&C. The second, to overcome market failure, is to stimulate demand from users, especially SMEs, who may otherwise be reluctant to pay for knowledge transfer activities. This may well be appropriate in some circumstances, but has to be very carefully devised so as to be effective. It may well be that a structural arrangement like the US SBIR (as it concerns SMEs, at least) could be more effective than merely providing cash for this purpose to universities. Pump priming in this context means providing funds to universities to kick-start the activity or engage in new commercialisation activities. If government funding were to

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201 Just as giving the cash or its equivalent to SMEs in order to acquire knowledge services from universities may also be less than ideal. A program in Holland along these lines was only partially successful: (Cornet, et al. 2006).
be provided to Australian universities for research commercialisation activities it would most likely be under this rubric.

Government funding to pump prime research commercialisation activities at universities is superficially attractive. Serious money is needed to start the function - $10 million or so being invested by the University of Queensland in UniQuest. But even amounts of this magnitude are no guarantee of success when funded from internal university sources, as the experience of Canadian Uni2 attests. Providing money to pump prime a TTO is not likely to be any predictor of success. And the ability of any government to determine a priori whether a university has established the right settings to achieve success is all but impossible, so it may possibly fund a few winners but also a number of losers. Anything less than a serious amount of money to establish a TTO (in the order of $10 million appears typical at a large university) may end up being money poorly spent in any event, and the likelihood that a government would risk $390 million ($10 million on each of Australia’s thirty-nine universities) is remote in the extreme. At the other end of the spectrum, where the university has supported research commercialisation with the right settings, motivation and staff, government assistance has been minimal – NZ Uni being an excellent example.

While the view of the Australian Government on knowledge transfer funding in general and TTOs in particular has not been published, the Productivity Commission (2007), an influential agency, asserts that additional funding for third stream activities is not warranted save in two circumstances (p.295):

- Some additional funding may be required on a case-by-case basis to help facilitate the development of more flexible arrangements; and
- There may be a case for providing some additional support for taking research through to ‘proof-of-concept’.

The greatest support that government can provide to university TT&C is to construct the common infrastructure that encourages the commercialisation of university research. While some direct financial assistance to establish individual university TTOs and support early-stage development may be helpful, it is not a long-term solution. The long-term aim of government should be to encourage the involvement of two particular business groups. First, the involvement of patient and/or expert capital such as not-for-profit foundations, pension funds and expert venture capitalists. Second, the establishment in Australia of intermediaries of the for-profit and not-for-profit type.
11.3.6 Regional and Smaller Universities

Australian regional universities are not recognised as prime research universities – in 2004 they were responsible for university research expenditure of only $333.2 million of the national total of $3,389.8 million, or a little under 10%\(^{202}\). Yet the evidence from this research shows that regional and smaller universities can achieve significant TT&C results providing they meet the same criteria as metropolitan universities: institutional support for TT&C; high-quality TTO leadership; and world-leading research. The challenge for these universities may be compounded by their relatively small research budgets – they have fewer resources to conduct world-leading research – and their ability to attract suitable candidates to lead TT&C, but the evidence shows that it can be done providing institutional leadership is there.

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\(^{202}\) Calculated from DEST (2007), Table 30, not including LaTrobe university as a regional university.
12 Areas for Further Research

Technology transfer and commercialisation remains a fertile field for research in many scholarly areas including management, economics, government policy, education, law and technology as shown in the journals listed in footnote 25ff. Governments have a continuing economic interest in the field because of the significant financial support they provide to university research and the potential such research holds for economic development. Some areas for future research identified during this project are listed in Table 12.1.

<table>
<thead>
<tr>
<th></th>
<th>Further Research</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The extent to which involvement in commercialisation affects academic promotion</td>
<td>4.6</td>
</tr>
<tr>
<td>2.</td>
<td>Metrics used to assess the performance of university TT&amp;C</td>
<td>4.7.3</td>
</tr>
<tr>
<td>3.</td>
<td>Analyse the performance of intermediaries in the commercialisation of university research</td>
<td>8.3.4</td>
</tr>
<tr>
<td>4.</td>
<td>The potential role in TT&amp;C that could be undertaken by intermediaries in Australia</td>
<td>8.3.4</td>
</tr>
<tr>
<td>5.</td>
<td>The use made of time made available to academic faculty members by universities to undertake private commercial activities</td>
<td>9.3.12(b)</td>
</tr>
<tr>
<td>6.</td>
<td>Determining the generalisability of the conclusions reached about Australian SMEs from data on companies in the electronics industry.</td>
<td>10.3</td>
</tr>
<tr>
<td>7.</td>
<td>The potential for Australian State Government State Development agencies to work with universities on TT&amp;C</td>
<td>10.7.12</td>
</tr>
<tr>
<td>8.</td>
<td>Assessing the suite of skills and personal attributes possessed by university TTO chief executives in order to understand their particular abilities</td>
<td>11.1.1</td>
</tr>
<tr>
<td>9.</td>
<td>Assessing the potential for Australian State and Territory Governments to act as a link and bridge between university research outputs and local industry</td>
<td>11.3.5</td>
</tr>
</tbody>
</table>

Table 12.1 – Areas for Further Research

Technology transfer and commercialisation involves the conjunction of so many areas of scholarly investigation (management, economics, government policy, education, law and technology, to name the most obvious) that it poses a challenge for any investigator. Yet the importance of ensuring that university research results diffuse efficiently into the community is of such immense significance to the continuing creation of wealth and better human
existence that investigative work to understand better the processes involved remains an important task. It is a field replete with the need for investigators to work, as far as possible, across many fields of knowledge, and constitutes one of the best examples of the need for cross-disciplinary academic appreciation that it may be possible to identify. In some small way this project should add to an understanding of one aspect of this field.
APPENDIX 1 – Interviews and Visits

In completing this project the following people were interviewed and activities undertaken on the dates and at the locations shown here.

Australian Interviewees

For the purposes of confidentiality the list contained here does not contain details sufficient to identify any interviewee. Full details are held by the author.

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Affiliation</th>
<th>Date</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTO Director</td>
<td>Aust Go8 Uni1</td>
<td>30 October 2006</td>
<td>In person at the university</td>
</tr>
<tr>
<td>Vice-Principal, Commercialisation</td>
<td>Aust Go8 Uni1</td>
<td>31 July 2006</td>
<td>In person at the university</td>
</tr>
<tr>
<td>TTO Director</td>
<td>Aust Go8 Uni2</td>
<td>19 September 2006</td>
<td>In person at the university</td>
</tr>
<tr>
<td>TTO Director</td>
<td>Aust ATN Uni1</td>
<td>14 August 2006</td>
<td>In person at the university</td>
</tr>
<tr>
<td>TTO Director</td>
<td>Aust ATN Uni2</td>
<td>21 August 2006</td>
<td>In person at the university</td>
</tr>
<tr>
<td>TTO Deputy Director</td>
<td>Aust IRU Uni</td>
<td>5 March 2007</td>
<td>In person at the university</td>
</tr>
<tr>
<td>TTO Director</td>
<td>Aust Small Uni</td>
<td>22 August 2006</td>
<td>In person at the university</td>
</tr>
<tr>
<td>TTO Director</td>
<td>Aust Regional Uni1</td>
<td>15 February 2007</td>
<td>In person, by telephone</td>
</tr>
<tr>
<td>TTO Director</td>
<td>Aust Regional Uni2</td>
<td>16 June 2006</td>
<td>In person at the university</td>
</tr>
<tr>
<td>Aust Venture Capitalist</td>
<td>Aust VC1</td>
<td>11 October 2006</td>
<td>In person, Sydney</td>
</tr>
<tr>
<td>Aust Venture Capitalist</td>
<td>Aust VC2</td>
<td>31 October 2006</td>
<td>In person, Melbourne</td>
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<td>Aust Electronics SME</td>
<td>Company A</td>
<td>15 October 2007</td>
<td>In person, Brisbane</td>
</tr>
<tr>
<td>Aust Electronics SME</td>
<td>Company B</td>
<td>19 October 2007</td>
<td>In person, Brisbane</td>
</tr>
<tr>
<td>Aust Electronics SME</td>
<td>Company C</td>
<td>2 October 2007</td>
<td>In person, Brisbane</td>
</tr>
<tr>
<td>Aust Electronics SME</td>
<td>Company D</td>
<td>3 October 2007</td>
<td>In person, Brisbane</td>
</tr>
<tr>
<td>Aust Electronics SME</td>
<td>Company E</td>
<td>21 September 2007</td>
<td>In person, Brisbane</td>
</tr>
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</table>
### Non-Australian Interviewees

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Affiliation</th>
<th>Date</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director, Office of Technology Transfer</td>
<td>US Private University</td>
<td>16 March 2007</td>
<td>In person at the university</td>
</tr>
<tr>
<td>Senior Licensing Officer, Office of Technology Licensing</td>
<td>US Public University</td>
<td>12 March 2007</td>
<td>In person at the university</td>
</tr>
<tr>
<td>TTO Director</td>
<td>Canadian Uni1</td>
<td>22 May 2007</td>
<td>In person at the university</td>
</tr>
<tr>
<td>TTO Director and Director Commercialization – Physical Sciences &amp; Engineering</td>
<td>Canadian Uni2</td>
<td>19 March 2007</td>
<td>In person at the university</td>
</tr>
<tr>
<td>TTO Director</td>
<td>NZ Uni</td>
<td>31 May 2007</td>
<td>In person, by telephone</td>
</tr>
<tr>
<td>Venture Capital Director and General Partner</td>
<td>US VC</td>
<td>13 March 2007</td>
<td>New Jersey, USA</td>
</tr>
<tr>
<td>Strategic planning firm, CEO and Principal</td>
<td>US Strategist</td>
<td>14 March 2007</td>
<td>Washington DC, USA</td>
</tr>
</tbody>
</table>

### Discussions

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Position</th>
<th>Affiliation</th>
<th>Date</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Russell Ayres</td>
<td>Director, Commercialisation and Collaboration Team</td>
<td>Department of Education, Science and Training (Australian Government)</td>
<td>25 August 2005</td>
<td>Canberra</td>
</tr>
<tr>
<td>Neil Finlayson</td>
<td>Deputy Director</td>
<td>Knowledge Commercialisation Australia</td>
<td>30 January 2006</td>
<td>Griffith University, Brisbane</td>
</tr>
<tr>
<td>Dr Peter Burn and Gillian Gribble</td>
<td>Associate Director, Public Policy; and Senior National Industry and Policy Advisor</td>
<td>Australian Industry Group</td>
<td>11 October 2006</td>
<td>Sydney</td>
</tr>
<tr>
<td>Patrick Coleman</td>
<td>Director, Policy</td>
<td>Business Council of Australia</td>
<td>31 October 2006</td>
<td>Melbourne</td>
</tr>
<tr>
<td>Dr Jeremy Burdon</td>
<td>Director of Intellectual Assets, Health Science Venture, Arizona Technology Enterprises</td>
<td>University of Arizona</td>
<td>10 March 2007</td>
<td>San Francisco CA, USA</td>
</tr>
<tr>
<td>Dr Nicholas Miles</td>
<td>Executive Director</td>
<td>Oxford to Cambridge Arc</td>
<td>22-23 May 2007</td>
<td>Toronto, Canada</td>
</tr>
</tbody>
</table>
## Conferences Attended

<table>
<thead>
<tr>
<th>Conference</th>
<th>Convenor</th>
<th>Date</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercialisation 2006</td>
<td>Knowledge Commercialisation Australia and the Australian Institute for Commercialisation</td>
<td>June 2006</td>
<td>Melbourne, Australia</td>
</tr>
<tr>
<td>AUTM 2007</td>
<td>Association of University Technology Managers</td>
<td>March 2007</td>
<td>San Francisco CA, USA</td>
</tr>
<tr>
<td>5th AGSE International Entrepreneurship Research Exchange</td>
<td>Australian Graduate School of Entrepreneurship, Swinburne University of Technology, Australia</td>
<td>February 2008</td>
<td>Melbourne, Australia</td>
</tr>
<tr>
<td>AUTM 2008</td>
<td>Association of University Technology Managers</td>
<td>February 2008</td>
<td>San Diego CA, USA</td>
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</table>

## Presentations Given

<table>
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<th>Conference</th>
<th>Convenor</th>
<th>Role</th>
<th>Date</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>University Commercialisation Environment</td>
<td>Australian Institute for Commercialisation</td>
<td>Presentation to staff</td>
<td>26 September 2006</td>
<td>Brisbane</td>
</tr>
<tr>
<td>Adherence by Universities to National IP Policies</td>
<td>Australian Institute for Commercialisation</td>
<td>Presentation to staff</td>
<td>2 March 2007</td>
<td>Brisbane</td>
</tr>
<tr>
<td>Commercializing University Research Symposium</td>
<td>University of Toronto on behalf of the Council of Ontario Universities, the University of Toronto, and MaRS</td>
<td>Invited Speaker at Symposium – topic: the Australian university commercialisation environment</td>
<td>24 May 2007</td>
<td>Toronto, Canada</td>
</tr>
<tr>
<td>5th AGSE International Entrepreneurship Research Exchange</td>
<td>Australian Graduate School of Entrepreneurship, Swinburne University of Technology, Australia</td>
<td>Presentation – topic: University TTOs and their Role in Entrepreneurism</td>
<td>8 February 2008</td>
<td>Melbourne, Australia</td>
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<tr>
<td>University-Industry Interaction</td>
<td>Australian Institute for Commercialisation</td>
<td>Presentation to staff</td>
<td>18 April 2008</td>
<td>Brisbane</td>
</tr>
<tr>
<td>Australian University Commercialisation Performance</td>
<td>Australian Institute for Commercialisation</td>
<td>Presentation to staff</td>
<td>13 May 2008</td>
<td>Brisbane</td>
</tr>
<tr>
<td>Commercialisation Masterclass</td>
<td>Australian Institute for Commercialisation</td>
<td>Presentation on University of WA – Gray</td>
<td>16 May 2008</td>
<td>Brisbane</td>
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## Papers Published

<table>
<thead>
<tr>
<th>Name of Paper</th>
<th>Author(s)</th>
<th>Journal</th>
<th>Citation</th>
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<tbody>
<tr>
<td>Australian Framework for the Commercialisation of University Scientific Research</td>
<td>Alan Collier</td>
<td>Prometheus</td>
<td>Volume 25, Number 1, March 2007, pp. 51-68</td>
</tr>
<tr>
<td>Compliance with the National Principles of the Intellectual Property Regime by Australian Universities</td>
<td>Alan Collier</td>
<td>Commercialize, The Journal</td>
<td>forthcoming</td>
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</table>
### Exhibit A – University Interview Outline

<table>
<thead>
<tr>
<th>Issue</th>
<th>Closed Questions</th>
<th>Open Questions</th>
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<tbody>
<tr>
<td>Information about the University</td>
<td>- Name, position and contact details of interviewee; name and details about the university (number of students; areas of research).&lt;br&gt;  - Does the university have a statement in relation to its philosophy (vision, mission, etc) concerning the role of commercialisation; and how will the university pursue commercialisation in the future?</td>
<td>- Why does the university undertake commercialisation activities? What is its motivation?</td>
</tr>
<tr>
<td>University Commercialisation Environment</td>
<td>- Does the university have an <em>innovation policy</em> – one that is directed to stating what the university seeks to achieve from its research and its commercialisation?&lt;br&gt;  - Does the university have a strategic research plan? Is commercialisation part of the institutional strategic plan or strategic research plan?&lt;br&gt;  - Does the university have any goals, particularly financial goals, that it has set in relation to commercialisation results (for example: to achieve income equivalent to 5% of research income from commercialisation)?&lt;br&gt;  - How and on what terms does the university share income from commercialisation activities with academic staff?&lt;br&gt;  - Does the university provide any entrepreneurial or commercialisation training for academic staff, particularly research staff?&lt;br&gt;  - Does the university have or promote any particular schemes to encourage commercialisation (for example: providing access to pre-seed funding; provide time off for academic staff to pursue commercialisation activities)?</td>
<td>- Is the university regulatory environment conducive to commercialisation (such as statutes, policies and procedures)? What, if anything, should be changed?&lt;br&gt;  - What could the university do to support commercialisation of research better? For example: give time off for academic staff to undertake commercialisation; promotion on the basis of commercialisation results; give staff more financial benefits?&lt;br&gt;  - Some universities, such as the Group of 8, appear to achieve greater commercialisation outcomes than the average. Why is this? What could be done to improve the results for universities generally, regional and smaller universities in particular, and your university?</td>
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<tr>
<td>Issue</td>
<td>Closed Questions</td>
<td>Open Questions</td>
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| Management of Commercialisation Activities | • What is the university’s process for establishing research commercialisation policy and goals?  
• What is the university’s mechanism, if any, for determining what research may be commercialised and on what terms?  
• Does the university have written statutes, regulations, policies and/or procedures dealing with risk management; and handling conflicts of interest? | • Does the university apply sufficient management resources to commercialisation activities? Does it possess relevant skills? What could it do better?  
• What, if any, risk management strategies are applied by the university to its involvement in commercialisation? Are these policies effective? How should they be changed?  
• What is the university policy on handling research (and commercialisation) conflicts of interest? Are these policies effective? How should they be changed?  
• Is training in entrepreneurship and commercialisation for research staff adequate? How could it be improved? If the university does not provide training; has it ever done so (and with what result); has it ever contemplated doing so; why has it elected not to do so?  
• When the university is involved in commercialisation activities, who undertakes the commercial negotiations? Is this the appropriate office to do so? What, if anything, should be changed in relation to this practice? |
| Intellectual Property                     | • Does the university have written statutes, regulations, policies and/or procedures dealing with intellectual property?  
• Does the university comply with the National Principles of Intellectual Property Management for Publicly Funded Research published by ARC and the Ownership of Intellectual Property in Universities Policy and Good Practice Guide published by the AVCC?  
• Does the university have in place any mechanism by which research with commercial potential can be identified and packaged to make it attractive to | • Is the intellectual property policy and practice of the university conducive to commercialisation? Do the IP policies of bodies such as ARC and AVCC promote or impede commercialisation? How could the university’s IP policies be improved?  
• Should there be a legislated IP policy like the US Bayh-Dole Act applicable to universities? Who should own IP: universities, researchers, or another party? |
<table>
<thead>
<tr>
<th>Issue</th>
<th>Closed Questions</th>
<th>Open Questions</th>
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<tr>
<td></td>
<td>industry?</td>
<td>o  What does the commercialisation office actually do? What does it become engaged in? For example: identifying candidate technologies; obtaining patent protection and managing patents; spin-off companies; licensing, options and agreements; managing consulting assignments; compiling commercialisation metrics; what else? o  Should the university have a commercialisation office, or is there a better model (say co-operation amongst particular universities)? o  What should be done, if anything, to improve the commercialisation office’s performance or, more generally, to improve connections with industry?</td>
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<td>Are you aware of any mechanism used by the university that permits IP from separate sources to be aggregated in order to form more attractive packages?</td>
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<td></td>
<td>How many patents has the university sought and obtained annually over a period of, say, 10 years? How many of these have been licensed to industry?</td>
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<td></td>
<td>In relation to the university commercialisation office: when did the university start the office; is there a written policy governing the role, management and operations of the office; how many people are employed in the office (what are their qualifications; how long have they been employed); what turnover goes through the office; are statistics kept in relation to the performance of the office (number of contracts; type of contract); are there financial accounts kept in relation to the office (profit and loss, balance sheet, costs of running the office); what is the annual running cost of the office and what is the source of its funding?</td>
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<td></td>
<td>o  Are existing linkages with industry effective? How could it be improved? For example: are CRCs effective; does the university promote industry linkages? Would, say, not-for-profit intermediaries such as Battelle Corp in the US assist here? How were existing industry linkages created?</td>
</tr>
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<td></td>
<td>Does the university seek to have standing relationships with industry or government as a means of raising research funds or effecting commercialisation? How does it do this? Who manages this relationship?</td>
<td>o  Does the university require researchers, at any point, to consider whether particular research is capable of commercialisation? How does it encourage this?</td>
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<td></td>
<td>How does the university ensure that research capable of commercialisation becomes known to industry?</td>
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<td></td>
<td>Does the university have any program to provide linkages between industry and the university to promote commercialisation of research outcomes (for example: exchanges of staff between industry and the university; time off for staff to work in industry without loss of seniority; student placements in industry,</td>
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<td></td>
<td></td>
<td>o  Is Australian industry capable (by virtue of size, capabilities, disposition, or whatever) of absorbing the research output of the university that could be commercialised? How does the university make</td>
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<td>Issue</td>
<td>Closed Questions</td>
<td>Open Questions</td>
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|                       | industry people on university boards and councils)?  
|                       | • How many start-up companies has the university created annually over the last, say, 10 years?  
|                       | • Does the university offer industry any particular programs to meet specific needs such as: technical assistance; short courses; or industry extension?                                                  | decisions about which companies with which to be involved in commercialisation?  
<p>| Commercial Issues     | Are details about the number, value, business area, and other information available about university LOAs?                                                                                                      | SMEs are often referred to as suitable receptors for university research. How does the university encourage SMEs to learn about and exploit university research?                                                     |
| Technology Parks and  | Does the university run, or is it associated with, any technology parks or incubators? Who manages these? Are any details available about the results derived from these facilities, especially any information on their financial results and economic impact? | Which commercialisation route is preferred (start-up -vs- licence) and why?                                                                                                                                                                                                     |
| Incubators            |                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                         |
| Funding and Venture   | Does the university provide any funding for development, such as proof-of-concept or pre-seed, or seed?                                                                                                           | Is there sufficient capital available at each stage of development to permit research results to be proven and taken to commercialisation? What could be done better?                                                                                               |
| Capital               | Does the university access any such funds?                                                                                                                                                                         | Do existing programs such as pre-seed funding do enough to support university research commercialisation? Is the taxation regime a disincentive to commercialisation? Should they be altered – if so, how?                               |
|                       |                                                                                                                                                                                                                 | Was there any government subsidy or other support provided to the research, to the development of the product, or for any other purpose (such as market research, consultants)? Details.                                                               |</p>
<table>
<thead>
<tr>
<th>Issue</th>
<th>Closed Questions</th>
<th>Open Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Views</td>
<td></td>
<td>• What strengths and weaknesses did you observe in the university’s commercialisation policies and practice?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• What do you believe should be done differently in the university’s commercialisation policies and practices?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• What innovations are planned that will increase the ability of the university to exploit research outcomes through commercialisation?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• What would inspire universities to participate more vigorously in commercialisation of research?</td>
</tr>
</tbody>
</table>
Exhibit B – Information Provided to Individual Informants

RMIT HUMAN RESEARCH ETHICS COMMITTEE

Prescribed Consent Form for Persons Participating In Research Projects Involving Interviews, Questionnaires, Focus Groups or Disclosure of Personal Information

PORTFOLIO OF

SCHOOL/CENTRE OF

Name of Participant:

Dr ABC, Vice-Principal (Research), University of Australia

Project Title:

Enhancing Australian Universities’ Research Commercialisation Performance

Name(s) of Investigators:

(1) Mr Alan Collier Phone: (07) 3868 1177

(2) Dr Fang Zhao Phone: (03) 9925 1392

1. I have received a statement explaining the interview/questionnaire involved in this project.
2. I consent to participate in the above project, the particulars of which - including details of the interviews or questionnaires - have been explained to me.
3. I authorise the investigator or his or her assistant to interview me or administer a questionnaire.
4. I give my permission to be audio taped: ☐ Yes ☐ No
5. I give my permission for my name or identity to be used: ☐ Yes ☐ No
6. I acknowledge that:
   (a) Having read the Plain Language Statement, I agree to the general purpose, methods and demands of the study.
   (b) I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied.
   (c) The project is for the purpose of research. It may not be of direct benefit to me.
   (d) The privacy of the information I provide will be safeguarded. However should information of a private nature need to be disclosed for moral, clinical or legal reasons, I will be given an opportunity to negotiate the terms of this disclosure.
   (e) The security of the research data is assured during and after completion of the study. The data collected during the study may be published, and a report of the project outcomes will be published in a thesis. Any information which may be used to identify me will not be used unless I have given my permission (see point 5).

Participant’s Consent

Name: _____________________________ Date: _____________________________

(Participant)

Name: _____________________________ Date: _____________________________

(Witness to signature)
Dr ABC
Vice-Principal (Research)
University of Australia

Date: 17 July 2006
Author: Alan Collier
Direct tel: (07) 3868 1177
Direct fax: (07) 3268 3316
Direct email: acollier@corplink.com.au

Dear Dr Smith

Research Project: *Enhancing Australian Universities’ Research Commercialisation Performance*

Summary

- I would like to visit the university and conduct an interview not exceeding two hours with you or your nominee
- I would like to record the interview
- A summary of the issues I would like to cover is attached
- I will provide you with feedback if you wish
- A backgrounder on me is attached
- It is intended that 8 universities will be approached to assist
- I will call you or your assistant to ascertain your availability.

Investigators: Mr Alan Collier, School of Management, Doctoral Candidate

Dr Fang Zhao, Project Supervisor, Senior Lecturer in the School of Management, RMIT University: (03) 9925 1392; fang.zhao@rmit.edu.au

You are invited to participate in a research project being conducted by RMIT University entitled *Enhancing Australian Universities’ Research Commercialisation Performance*. This information sheet describes the project. Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please ask one of the investigators.

**Who is involved in this research project? Why is it being conducted?**

This project is my work towards the degree of Doctor of Philosophy in the School of Management at RMIT University. My work is being supported by a scholarship with an industry partner, the Australian Institute for Commercialisation.

This project has been approved by the RMIT Human Ethics Committee.
**What is the project about? What are the questions being addressed?**

The research project aims to:

- Identify the systematic barriers to research commercialisation within Australian universities;
- Identify and describe commercialisation models and practices that can overcome the systematic barriers to commercialisation of Australian university research;
- Develop effective strategies that will enhance the research commercialisation capacity and performance of Australia’s smaller and regional universities; and
- Identify strategies to promote the uptake by industry of Australian university research outcomes.

The main outcome of the project is to identify leading research commercialisation practices and to make recommendations on how these can be implemented in the Australian university context for the purpose of enhancing Australian university performance in research commercialisation.

The research plan involves interviewing and obtaining information from up to 55 people involved in the process of commercialising university research, including people in universities, business, industry associations, venture capitalists and overseas commercialisation associations. This survey is the first step in the research process.

**Why have you been approached?**

The purpose of asking you to complete a survey is to obtain information from you pertaining to your experience in research commercialisation. This will permit me, when your information is combined that from other sources, to answer the questions arising from the aims of the project described above.

The information you provide will be collated with other information in order to form general conclusions concerning research commercialisation. Any information that you provide can be disclosed only if (1) it is to protect you or others from harm, (2) a court order is produced, or (3) you provide the researchers with written permission.

**If I agree to participate, what will I be required to do?**

I am requesting that you participate in a recorded interview that is expected to last no longer than two hours. As a result of this interview I will prepare written notes that will be given to you for amendment as you see fit.

**What will happen to the information I provide?**

The survey data will be held securely at RMIT for a minimum of five years after the completion of the project so that it is possible for other researchers to verify and extend the research. After five years after the completion of the project, the data will be destroyed.

**Why should I participate?**

Participation in this project will assist in improving our understanding of the process of university research commercialisation in Australia which, it is hoped, will lead to better outcomes for universities and Australian society.

**What are my rights as a participant?**

Participation in this research is voluntary and you may withdraw at any time without prejudice to you. You also have the right to have any unprocessed data withdrawn and destroyed, provided it can be reliably identified, and to ask questions of the investigators at any time.

I will prepare a thesis for my PhD based, among other things, on the interviews I conduct, and this thesis will be published. If you wish, I could provide you with details about my thesis as soon as it is published.

It is assumed that, by returning the survey form, you consent to providing the information requested.
Who should I contact if I have any questions?

If you have any queries regarding this project and/or any complaints about your participation in this project, please contact either of the investigators mentioned at the start of this letter (Mr Alan Collier, or Dr Fang Zhao), or the Chair, Portfolio Human Research Ethics Sub Committee, phone (03) 9925 5594, or email: rdu@rmit.edu.au.

Thank you very much for your assistance.

Yours faithfully,

Alan Collier
Exhibit C – Industry Interview Outline

COMPANY Pty Limited

The Firm
Description of the Firm:
- History
- Principal activities
- Number of employees
- Approximate turnover
- Source of main ideas
- Competition/growth areas/changing environment

Key Themes from the Interview
- A
- B
- C

Outline of University Interaction
Description of the interaction between the company and universities:
- Consulting
- Contract research
- IP licensing

Remuneration
How universities are remunerated for the work they do:
- One-off fee
- Royalties
- Equity

Intellectual Property
- Sources of IP
- Whether IP registered or know-how
- How transferred – licence/assignment
- Description of any difficulties

Dealings with the TTO
Any dealings that the company has had with the university commercialisation office and the results of the dealings.

CRCs and other Interfaces
The experience of the company with any CRCs or other entities associated with the university.

Market
What is the market being addressed by the company?

Incubators
Does the company have any experience of technology incubators? What is its view?
Government Funding

Have they used government funding in R&D or product development? Was it successful? How could it be improved?

Public Databases

Has the company ever used public databases designed to exchange technology, such as InnovationXchange? How does it find its idea from universities?

Intermediaries

Has the company ever worked with a technology intermediary? Outcomes?

Work with other PFROs

Has the company ever worked with any publicly-funded research organisations (like the CSIRO, ANSTO, DSTO)? In what way, and what was the outcome?

Industry Associations

Is the company a member of any industry associations? Have these been of help in R&D or locating technology?

Work with Government

Has the company used the services of government agencies, like AusIndustry or Queensland Department of State Development and Innovation? Was it useful? What could be improved?

Inducements to Use University Research

What would be likely to induce the company to work with universities:

- Taxation incentives?
- Financial incentives?
- Better university procedures?
- Better ways of advising industry of what universities are doing?
- Anything else?

References and Notes

All references and quotes are attributable to a record of interview with NAME, Managing Director, COMPANY on DATE. Amended and approved by NAME on DATE.
APPENDIX 2 – Case Descriptions

A total of twenty-two case descriptions have been prepared by the author – one for each case study. These range between seven and twenty-two pages in length. For reasons of confidentiality copies are not attached here but are held by the author.
### APPENDIX 3 – Australian Government and Other Publications since 1995

This Appendix contains a list of publications produced by the Australian Government and other Australian entities relevant to the topic and which have been consulted by the author in this research. Copies of each publication are held by the author.

<table>
<thead>
<tr>
<th>Agency</th>
<th>Title</th>
<th>Author</th>
<th>Publisher</th>
<th>Pages</th>
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</thead>
<tbody>
<tr>
<td>Industry Commission</td>
<td>Research and Development</td>
<td>Industry Commission</td>
<td>AGPS</td>
<td>3 vols</td>
<td>1995</td>
</tr>
<tr>
<td>ARC</td>
<td>University Research: Technology Transfer and Commercialisation Practices</td>
<td>The Melbourne Consulting Group</td>
<td>ARC</td>
<td>252</td>
<td>1999</td>
</tr>
<tr>
<td>DETYA</td>
<td>Enabling the Virtuous Cycle – Identifying and removing the barriers to entrepreneurial activity by health and medical researchers in the higher education sector</td>
<td>Hohnston R, Matthews M and Dodgson M</td>
<td>Australian Government</td>
<td>84</td>
<td>1999</td>
</tr>
<tr>
<td>Australian Government</td>
<td>Knowledge and Innovation: A Policy Statement on Research and Research Training</td>
<td>Hon Dr D.A. Kemp, Minister for Education, Training and Youth Affairs</td>
<td>Australian Government</td>
<td>33</td>
<td>1999</td>
</tr>
<tr>
<td>Agency</td>
<td>Title</td>
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<td>Publisher</td>
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<tr>
<td>DETYA</td>
<td>Engaging Universities and Regions: Knowledge contribution to regional economic development in Australia</td>
<td>Garlick S</td>
<td>Australian Government</td>
<td>174</td>
<td>2000</td>
</tr>
<tr>
<td>DISR</td>
<td>A Study of Government R&amp;D Expenditure by Sector and Technology</td>
<td>Howard Partners: Mark Matthews and John Howard</td>
<td>Australian Government</td>
<td>89</td>
<td>2000</td>
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<td>Plan for the Future</td>
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<td>ABS</td>
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