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Enabling the Virtuous Cycle

Identifying and removing barriers to entrepreneurial activity by health and medical researchers in the higher education sector

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Ron Johnston
Mark Matthews
Mark Dodgson

Evaluations and Investigations Programme
Higher Education Division



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Training and Youth Affairs



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Executive summary

This study addresses the Wills Review's finding that there may be institutional barriers to the involvement of university researchers in new business enterprises, specifically in relation to holding equity, directorships and moving between academia and industry.

This study finds that policies towards research commercialisation are largely common across Australian universities, and in general, any formal institutional barriers to research commercialisation are few, and in practice can usually be bypassed:

- while holding equity is still relatively rare, there are few if any formal prescriptions against it;
- the holding of Directorships generally requires the approval of the Vice-Chancellor, but is normally granted; policies however do not address the specific situation of start-up companies;
- there is little explicit consideration of facilitating mobility between academia and industry to support research commercialisation, though general policies permit this;
- the financial incentives for commercialisation activities largely rest in the prescribed royalty return to the inventor;
- intellectual property policies are largely based on the assumption that the predominant mode of commercialisation will be via licensing; they do not specifically address the issues of start-up companies; and
- there is a paucity of information available to university staff about opportunities for involvement in business enterprises and the detailed business processes involved.

However there are significant variations in the *practice* of research commercialisation, leading to serious impediments arising from *business process inefficiencies* in the way in which research commercialisation arrangements operate. A generic business process framework has been developed to provide a basis for universities to analyse their performance, and develop more appropriate approaches.

These business process inefficiencies can, to a large extent, be attributed to the relatively recent growth of research commercialisation activity in Australian universities—in other words to a lack of cumulative experience in handling these complex processes. As learning increases, particularly in launching start-up companies, the business process efficiency can be expected to increase, thus adding to the virtuous cycle sought in the Wills Review recommendations.

However, this study has revealed that the natural process of learning-by-doing is severely impeded by shortages of funding for 'proof-of-principle' and for subsequent investments that produce commercially viable propositions.

The government's announcement of the Biotechnology Innovation Fund specifically targeting the proof-of-principle funding problem in the bio-medical area is therefore an important step forward in enabling the virtuous cycle. The question is whether it needs to be supplemented by alternative schemes such as loans or an overdraft facility that reduce the level of uncertainty over funding for the commercialisation process.

In addition, the lack of time available for researchers to engage in research commercialisation is a major constraint. There is a challenge to Government to provide adequate resources to allow this crucial activity to proceed, and to universities to seek to arrange their constrained resources in ways that support those researchers capable and active in research commercialisation.

It is difficult to provide an adequate scorecard of Australian university performance in research commercialisation. With regard to start-up companies, it would appear that about one-third of technology start-ups in Australia in 1997 originated directly from universities. The only reliable conclusion is that the rate of formation of technology-based start-up companies arising from university research is increasing.

However, assessment of the performance of Australian universities in research commercialisation needs to recognise the very considerable extent of experimentation and change which has occurred over the past 1–2 years.

These can be seen as a response to the new conditions of the global knowledge economy, the emergence of global markets for research, the dramatically growing value of technology-based companies, and the greatly increased availability of venture and other forms of capital to invest in research-originated technologies and companies.

This experimentation includes:

- a greater emphasis on commercialisation through start-up companies;
- decentralised mechanisms for scanning, reporting and facilitating research commercialisation;
- transfer of ownership from the institution to the inventor;
- abolition of monopoly in university commercial arm operations; and
- direct provision of capital.

The outcomes of these various changes are yet to emerge. However, they clearly signal a recognition of the significance of new approaches to research commercialisation.

In order to address the issue of best practice, four different configurations of research commercialisation have been identified:

- isolation—the traditional historical model of universities;
- passive commercialisation—the model followed by most universities in Australia, until recently;
- technology transfer—a model more common in the US where there is a strong industrial base interested in research output and highly skilled personnel; and

- pro-active commercialisation—where the university actively seeks to encourage a higher level of internal research commercialisation and to modify its operating environment by creating a constituency of start-up companies able to interact more effectively with the university in the future.

The last of these is seen as particularly appropriate for the Australian situation, in which there is not a strong industry structure with which the universities can interact. Returns from a licensing strategy are ultimately limited by the dearth of potential licensors. Alternatively, a strategy to commercialise through new ventures, while carrying higher risk, offers the possibility of greater long-term returns **and** the gradual development of a cohort of young science-based firms able to interact far more effectively with the science base—the virtuous cycle in action.

1. Introduction

1.1 The policy context

The development of science and information-based industries is a long established, and increasingly important, driver of economic growth and job creation. This type of industrial development requires effective technology transfer between the public sector and the private sector, and associated enabling linkages, that translate academic research into commercial outcomes.

This translation of research into commercial outcomes can create a *virtuous cycle* involving universities, industry and government. This virtuous cycle is created by a mutually reinforcing process in which public sector investment in research is leveraged by industry through technology transfer and research commercialisation, leading to export growth, job creation and increased tax revenues for investment in key research areas—so reinforcing the nation's distinctive technological capabilities.

The creation of such a virtuous cycle was a major policy objective of the Health and Medical Research Strategic Review—the 'Wills Review' conducted in 1998 (Wills, 1998). Health and medical research is an area in which Australia performs relatively well in research terms and is also an area of growing economic importance globally due to the combination of advances in bio-science (such as genomics) and demographic trends. The opportunity therefore exists to create this type of virtuous cycle in Australia.

1.2 The problem

In order for this opportunity to be exploited it is necessary to identify and remove those barriers to technology transfer and research commercialisation that restrict the operation of this virtuous cycle. Whilst some of the impediments to creating a virtuous cycle are structural, and cannot be addressed directly through specific policy measures, other barriers are more easily dealt with. The Wills Review discussed a number of those barriers and they will not be repeated here.

One type of barrier noted in the Wills Review were the institutional policies and procedures in research performing organisations that limit entrepreneurial activity by researchers. The Wills Review noted that restrictions on researchers' ability to hold equity and directorships in enterprises resulting from their research could be a barrier to research commercialisation, as could barriers to personnel movements between academia and industry.

It was observed that these institutional barriers might be a particular problem in government research organisations and hospitals, which placed researchers in these sectors at a disadvantage relative to their peers in universities and institutes. The

Wills Review noted that the committee had been made aware of several cases in which such barriers existed, and illustrated this with the case of Biota.¹

The Commonwealth Departments of Education, Training and Youth Affairs (DETYA) and Health and Aged Care (DHAC) were subsequently tasked with investigating the existence and impact of such barriers. This Evaluation and Investigations Programme study was commissioned in order to assist DETYA and DHAC to respond to this request. Additional funding was subsequently obtained from the Department of Industry, Science and Resources (ISR).

Although this type of institutional barrier to entrepreneurial activity was noted to be a greater problem for researchers in government laboratories and hospitals, and less of a problem for university researchers, there is still a case for investigating this issue in the higher education sector.

This is because: (a) there is a lack of comprehensive information on the issue, and; (b) universities perform a much larger amount of the nation's health and medical research than is performed in government research organisations and hospitals.

With respect to the sectoral distribution of medical and health sciences R&D Commonwealth government organisations perform 2.5 per cent of total R&D, state government organisations 16.9 per cent and the higher education sector 50 per cent.²

An indication of research outcomes from this R&D *to industry* can be obtained by considering the academic papers cited in US patents held by Australian private entities (a measure of industry-science base inter-dependence). Australian government research organisations account for 19.4 per cent and Australian universities 42.3 per cent of these cited papers. (Narin, et al, 2000).

The proportional differences between R&D expenditure levels and these patent citations probably reflects the greater emphasis on applied research in government laboratories, often associated with contract and collaborative research arrangements. These figures are discussed in this report.

Due to the concentration of health and medical research in universities, the *overall* impact of institutional barriers in universities on national technological capabilities in the health and medical area may be greater than that of the relatively higher barriers in government research organisations.

The problem is therefore to identify the nature and extent of institutional barriers to research commercialisation in Australian universities and, in so doing, provide information that will allow DETYA, DHAC, ISR and the Wills Review Implementation Committee to explore possible solutions to these problems.

¹ Researchers in a government laboratory were prevented from receiving the same financial reward in the form of stock options that research collaborators in a non-government laboratory were able to receive.

² ABS 8112.0 1996-97 'All Sector Summary', page 15. The business sector performs 18.1 per cent and the private non-profit sector 12.4 per cent of the national R&D effort in medical and health sciences.

1.3 Methodology

To this end, this study has involved research on both the nature and extent of institutional and other barriers to research commercialisation in the health and medical areas and international practices and arrangements for handling technology transfer and research commercialisation. The terms of reference for the study are reproduced in Appendix A.

This study differs from many previous studies of research commercialisation (covering a number of research fields) in that it has collected *both* informed anecdotal views obtained via interviews and a larger statistical sample of views obtained via an on-line survey form. These two methods were employed because of the need to capture the views of senior university staff, and other well informed people, *and* of the researchers who face these problems in their day-to-day activities.

There have been a number of studies of the research commercialisation process in Australian universities over recent years. This study has attempted to make a significant contribution to this body of understanding by virtue of adopting a strong *analytical approach* combined with a *balanced* empirical investigation involving semi-structured interviews and a formal survey.

The specific components of the methodology are summarised below.

1.4 An analytical approach

The emphasis has been on distinguishing between significant and non-significant variations in the arrangements for handling research commercialisation between different universities. A *business process* framework based upon identifying generic stages and decision-points in the commercialisation process is used to draw these distinctions. This framework is augmented by considering the nature and significance of *learning-by-doing* (experiential) effects, and of the different *national circumstances* that impact upon research commercialisation effectiveness.

1.5 Balanced empirical investigation

The web-sites of every university were accessed to identify formal policies on commercialisation of research, management of intellectual property, external earnings, promotion and mobility.³ In addition, information provided to university researchers about opportunities for involvement in business enterprises was extracted. The accuracy of this information was checked in the interviews described below.

Extended, semi-structured, face-to-face and telephone interviews were conducted with more than 40 senior respondents (Appendix C) capable of providing an informed view of the state of, and structural constraints on the commercialisation of university research in Australia.

³ A small number of universities restrict external access to what are defined as 'personnel policies'.

Interview-derived and survey-derived information were compared in order to calibrate the views expressed by senior university staff, university researchers, and the views of other informed observers about the commercialisation of university research.

Researchers do not necessarily share the same views of a university's effectiveness in handling research commercialisation as the senior university staff who set university policies and procedures. Such differences in views are the natural consequence of differences in motives, knowledge and experience.

The analytical framework used is designed to help to draw policy conclusions about the implications of any such perception gap by combining the results obtained from semi-structured interviews with the data obtained from a structured on-line submission process linked to a specially created web site:
www.policyintelligence.com/Willsimplem.html

This contained background information on the study and links to relevant material both within Australia and overseas. We also sought unstructured submissions expressing views on the effectiveness of university research commercialisation arrangements. (see Appendix B for details)

Other aspects of the balanced investigation were an assessment of practices in a sample of leading overseas universities, carried out largely by accessing and analysing the policies and procedures posted to their web sites, backed up by the results of a literature review. In addition, a number of comparative and national reports on research commercialisation overseas were considered.

The study also involved carrying out four in-depth case studies of the arrangements for handling research commercialisation in Australian universities (the Universities of Melbourne, Queensland, Sydney and Curtin University of Technology).

The Australian and the overseas case studies were designed to inform *both* the collation of factual information on university policies and procedures and the *analytical framework* for analysing this information.

The use of this balanced analytical approach has allowed us to generate new information on the nature and extent of the barriers to research commercialisation in the health and medical area and to suggest an appropriate policy framework for moving forward in Australia.

1.6 Structure of the report

Chapter Two of the Report explores a range of issues which are regarded as central to identifying and removing barriers to entrepreneurial activity by health and medical researchers in the higher education sector.

Chapter Three reports on the current structures, strategies, policies and practices of Australian universities with respect to research commercialisation and explores the extent to which these operate to facilitate or impede the processes. It identifies current preferred commercialisation avenues, and the extent and impact of impediments to these avenues, from the perspective of the researcher. It also provides a preliminary assessment of the performance of the universities in commercialising research.

During our study, it has become evident that the organisation of research commercialisation within the universities has been the subject of considerable experiment and change over the past 12–18 months, and that the change is continuing. At this stage firm patterns, or 'best practice' models, have yet to emerge. We have therefore examined these emerging practices, on the basis of a number of case studies, and in comparison with overseas practice, separately in Chapter Four. On this basis a generic business process framework has been developed and tested.

Chapter Five provides conclusions.

The terms of reference, methodology and details of the data collected are presented in accompanying Appendices.

2. Issues for consideration

The following background issues require consideration in a study of institutional barriers to research commercialisation.

2.1 Technology transfer, research commercialisation and the public interest

The term 'technology transfer' is widely used in the US to refer to the process via which university and federal laboratory research results and capabilities are transferred to the business sector. The term 'research commercialisation' tends to be used in Australia. The difference between these two terms is, however, more than a choice of terminology. Technology transfer is a more generic term that covers transfers that do not necessarily involve commercial gains to the transferor. Research commercialisation is more specific and relates to situations in which there is a commercial gain to the transferor.

One reason why the elite US universities refer to *technology transfer* is that their strategies are based upon an over-arching *public interest* motivation. Technology transfers are not, in the first instance carried out for direct financial gain to the university, but are carried out to meet the institution's *public interest* obligations. As a 1998 mission of Vice-Chancellors and Principals of the Universities from the United Kingdom observed in a report on a study trip to the US:

We were struck by the way US universities (including those with strong income streams) saw their work in technology transfer primarily as a contribution to the public interest or civic role of the university, rather than to the generation of income. In this respect technology transfer is seen as part of a broader commitment to incentives staff and to knowledge transfer, in which the production of trained minds is a crucial output. These universities have well-developed strategies for links with business...Income was welcome and desirable, but it was not seen as the sole or a sufficient measure of effective technology transfer policy.

(CVCP, 1999)

These public interest obligations allow universities to secure a not-for-profit tax status and to focus on core research and teaching activities. Many of the elite universities are private bodies; some such as MIT were established with direct industry support explicitly in order to provide the sort of teaching and research required by industry.⁴

In the elite element of the US system the availability of business sector funding, through various channels, and high student enrolment fees, lead to a very different

⁴ US universities were originally modelled on the German system. Industrial dissatisfaction with the skills and unsuitable 'professorial' aspirations of their graduate intake eventually led to the business sector intervening in the higher education sector and establishing private colleges and a private-sector operated university entrance examination system that is still used today.

financial climate in which a public interest-driven emphasis on technology transfer is an attractive option. The financial gain to these universities is *indirect* and manifested in large corporate gifts, endowments and high levels of alumni contributions.

By comparison, the trend in other countries such as the United Kingdom in which universities are far more dependent upon government funding sees revenue from commercial activities being used to compensate for cutbacks in public sector funding.

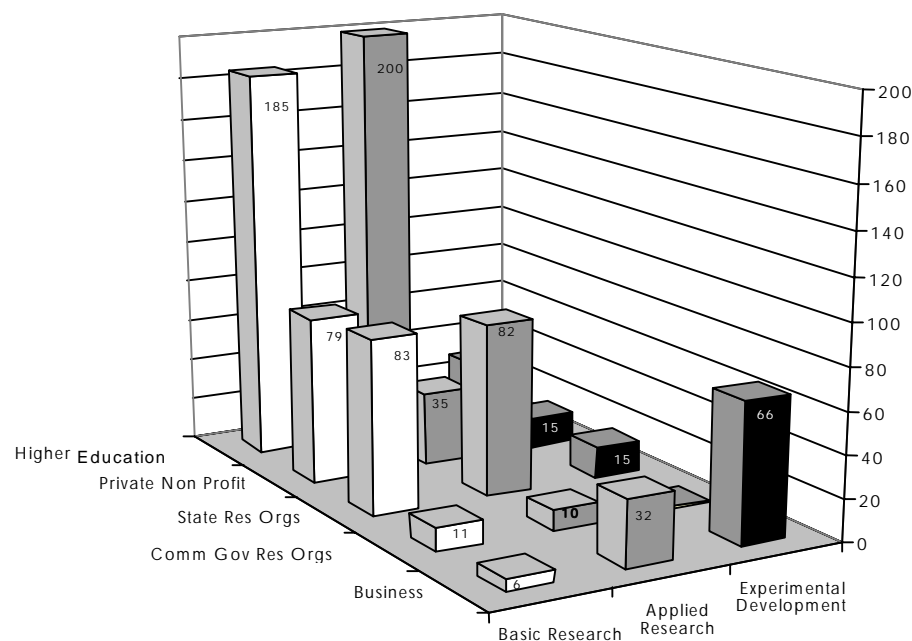
This structural difference between US and Australian universities must be born in mind when discussing international best practice in technology transfer and research commercialisation. *It is not appropriate to recommend that Australian universities emulate the policies and procedures supporting research 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.*

2.2 The balance of scientific and technological capabilities between universities and industry

Another issue that is relevant to any consideration of commercialisation of research performed in universities is the absorptive capability and orientation of the relevant industry. The greater the difference in capability, or interest, between universities and business firms, the more difficult it will be to establish the shared understanding necessary to effective research commercialisation.

One measure of scientific and technological capability is the level of investment in, and type of, R&D. Figure 1 provides a breakdown of health and medical R&D by performing sector and socio-economic objective for 1996–97. The figures are presented in Table 1.

Figure 1 Total health and medical R&D (classified by socio-economic objectives)



Source: Calculated by Policy Intelligence using unpublished data specially provided by the ABS.

Table 1 Total health and medical R&D in Australia by performing sector and type of R&D, 1996–97

\$m	All health and Medical Research					Total
	Higher Education	Private Non Profit	State Research Organisations	Comm Govt. Research Organisations	Business Sector	
Pure Basic	62.52	32.44	30.70	1.19	0.59	127.46
Strategic Basic	122.03	46.59	52.06	9.92	5.50	236.10
Applied	199.76	35.18	81.81	9.58	31.60	357.94
Exp. Dev.	29.14	14.52	15.02	1.41	66.30	126.39
Total	413.46	128.73	179.59	22.11	104.00	847.88

Source: Calculated by Policy Intelligence using unpublished data specially provided by the ABS.

The dominance of the higher education sector in health and medical R&D is clear, as is the significant role played by the state government and private non-profit sectors.⁵ What also stands out, however, is the relatively low level of business sector R&D expenditure. It should be noted that there is also a modest degree of contracting of industry R&D to the public sector.

Nevertheless, this low level of commitment of the health and medical industry in Australia to R&D suggests that its technological capability may be not at all well matched with that of the public sector. This, together with the recognised dominance of much of this industry in Australia by major foreign-origin multinational companies, which conduct much of their R&D at their home laboratories, presents a substantial structural barrier to more effective commercialisation of public sector research in Australia. This situation is very different from that of the US.

What is also apparent from the data in Table 1 is the low level of expenditure on experimental development.

In general terms basic research generates knowledge of fundamental properties, applied research translates this fundamental understanding into options for possible exploitation and experimental development determines which of these options are practically and commercially viable.

Experimental development is of critical importance because it covers the activities required to translate laboratory findings into real applications in the form of drugs, instruments and materials. The key stage in the development of a new product, 'proof of principle', is conducted largely through the experimental development phase of R&D.

This low level of expenditure on experimental development can be regarded as *prima facie* evidence of a very distinct progression gap, or constraint, to the effective commercialisation of health and medical research in Australia.

2.3 The role of 'learning-by-doing' in building the Virtuous Cycle

Research commercialisation is a risky process. As such, cumulative experience, or 'learning-by-doing', tends to lead to an improved capacity to appraise and manage these risks.

If it is accepted that the research commercialisation process is strongly influenced by learning-by-doing, institutional impediments to moving along this learning curve can potentially have dramatic long-term consequences for the aggregate efficiency of research commercialisation activity. This learning effect does not just apply to individual knowledge and skills—there is also the 'positive externality' associated with general flows of information and transfers of knowledge between individuals that collectively decreases technical and business risks. Indeed, the existence of

⁵ This is a characteristic specific to health and medical R&D, mainly due to the high level of charitable donations made for health and medical research and the role of state governments in funding public hospitals.

these positive externalities is a major reason for the success of industrial clusters such as Silicon Valley.

Considering the specific issues addressed in this study—commercialising university research in the health and medical area—cumulative experience affects the capacity of researchers to:

- appraise technical and business risks;
- develop strategies and tactics for mitigating these risks; and
- execute these plans competently.

This cumulative experience is the product of individual experience, collective experience *and its dissemination*. It is for this reason that the involvement of individuals with previous commercialisation experience can significantly affect the risks faced in the new business venture.

Many new businesses fail because the risks are poorly estimated and, consequently, insufficient attention is paid to ‘engineering’ a more attractive cost-risk-return relationship. The ‘innovation progression gap’ can be treated, partly, as the combined effect of poor capabilities to estimate cost-risk-return relationships and to shift these relationships into more favourable regions.⁶

This perspective is compatible with *business process*-based approaches—examining the research commercialisation problem partly as a problem of the waiting periods, ‘re-work’ cycles⁷ and other factors that influence the time and cost involved in making decisions concerning research commercialisation. As experience of handling research commercialisation grows the business process efficiency in handling this process will also tend to improve.

In this study, the learning-by-doing perspective, grounded on the capacity to appraise and modify cost-risk-return relationships, has been treated as a *hypothesis* about the most appropriate means of explaining both the nature and extent of impediments to research commercialisation and the policy implications of these impediments. As a result of adopting this analytical approach, the study has the potential to contribute to our understanding of research commercialisation behaviour both on a more generic level than the health and medical area per se, and as a longer-term contribution to policy analysis.

⁶ Although there are significant funding availability issues as well.

⁷ One or more iterations at a task or decision caused, for example, by inadequate information and/or poor capabilities to execute a task effectively.

3. Commercialisation of research in Australian universities—policies, practices, performance

3.1 Introduction

Improving the level and effectiveness of commercialisation of research performed in the public sector has been a matter of concern and analysis in Australia over at least the past twenty years.⁸

This preoccupation can be readily understood given the comparatively high levels of public investment in and performance of R&D in Australia compared with other countries. A second component was the widely held view, backed up by numerous anecdotes, that Australia performs excellent research, but is poor in translating it into wealth generation for the nation. Too many 'inventions' escape overseas.

The Australian Research Council (ARC) has published two reports addressing this issue in the past twelve months. The first report, entitled 'University Research: Technology Transfer and Commercialisation Practices' (Cripps et al, 1999), provides a detailed picture of current practice and achievement. It notes a lack of entrepreneurship, and emphasises that the processes are more an outcome of people than of procedures or university practices.

The second report, entitled 'Research in the National Interest: Commercialising Research in Australia' (ARC, 2000) reviews structural and cultural barriers to the commercialisation of university research, and commercialisation mechanisms.

The universities have responded quite substantially to the above concerns over the past decade or more. As their role has changed, and Commonwealth funding per student declined, linkages with industry and business have become the norm rather than the exception, and much higher levels of collaborative and contracted research are now performed.

The changed basis of Commonwealth Government funding for research, primarily through the Research Quantum mechanism, has also required a much more precise accounting of R&D expenditures, and a clear distinction between contract R&D and consulting.

During the late 1980's, there was an efflorescence of university 'business arms', designed to encourage and exploit the intellectual property (IP) of the university. Their performance was decidedly mixed, and the notion that universities were a goldmine of IP just waiting to be tapped declined in influence. Moreover, in some

⁸ See for example Twomey, 1993; NBEET, 1995, BHERT, 1996; OECD, 1997; FASTS, 1998; Matthews and Johnston, 1998.

cases these intermediary bodies acted as a barrier to university researchers gaining more direct experience of the challenges of commercialisation. In others, researchers inexperienced at commercialisation over-valued their discoveries and blamed the business arm for its inability to deliver to their unrealistic expectations. This led to disillusionment of some researchers with research commercialisation.

Nevertheless, considerable learning resulted, and there developed a greater awareness and interest in the commercialisation of research among at least a growing minority of university researchers. A number of evident successes, such as Cochlear Ltd and ResMed Inc (though 30 and 20 years in gestation, respectively), provided models of the considerable returns that could be achieved in the long-term through commercialisation of health research developments.

Under the changed conditions of the late 1990s, with the considerable promise of the knowledge economy, the rewards to be obtained from knowledge-intensive products and services, and the easier availability of capital to support new ventures, there is a renewed interest in the potential return to universities, and the nation, through new business formation. This will be examined in Chapter Four.

3.2 Current policies for research commercialisation

3.2.1 Institutional structures and processes

Few if any universities present a single coherent set of policies addressing the various issues of research commercialisation. Typically, aspects are treated under such various policies as employment conditions, promotion, intellectual property management, outside earnings, code of conduct (re confidentiality and conflict of interest), cost recovery, delegation of authority, consultancy and contract research, involvement of students and risk management.

This is not a matter for criticism. The recent growth of university involvement in commercialisation of research makes it likely that policies will have evolved over time as issues present themselves. Nor is it necessarily inefficient. However, in most cases it would make it difficult for a new staff member, or an outsider, to rapidly gain a clear picture of a university's set of policies and practices with regard to research commercialisation.

It should also be acknowledged that, as in much of university life, everyday practice may in some areas depart considerably from those prescribed by formal regulations and policies. However accountability requirements are steadily reducing this gap, if at times at the cost of rapid decision-making and increased procedural workload.

A survey of published policies and procedures for research management and commercialisation across Australian universities reveals most strongly their similarity. Most address the same issues in the same terms, with differences mostly only at the margin. This has resulted in part through the role of the AVCC in developing guidelines from its members, partly from a high level of shared learning between institutions, and partly from the fact that, by and large, they address issues common to all universities. Differentiation of strategies with regard to policies for

the commercialisation of research have only started to emerge very recently (see Chapter Four).

In the main, the research commercialisation operations of universities are managed through an 'arms length' organisation with direct responsibility to manage the university's commercial activities, including research contracts and consultancies, registering and exploiting IP, establishment of spin-off companies, and sales of products and other services.

The great majority of these organisations are incorporated, though with a few notable exceptions, such as the Business Liaison Office at the University of Sydney. While comprehensive data are not available⁹, the evidence is that about two-thirds of these organisations operate with a monopoly, or first right-of-refusal, within their universities. The remainder have in principle to compete for the research commercialisation business in the university, but in practice being located on campus provides such an advantage that they are still the first port-of-call.

The forms of commercialisation of research, which receive the most attention are consulting and contract research. These are relatively straightforward for researchers and the university, involve little direct risk, a fairly immediate revenue return, and little or no influence over the subsequent use of the research results. Thus:

Appropriate consulting and contract research, involving the application of the knowledge and expertise of staff and postgraduate students, results in important benefits to the university and to the community. These benefits include:

- *enriching the skills and knowledge base of University staff and postgraduate students;*
- *making specialised knowledge, skills and facilities available to the wider community;*
- *facilitating collaborative research with industry and government departments; and*
- *providing the University with additional financial resources and with access to specialist facilities.¹⁰*

In general, the formal policies and regulations, with a few exceptions, provide little encouragement for researchers to become directly involved in managing the commercialisation of their own research. Rather, they largely emphasise appropriate arrangements for others to exploit their research output. Thus:

Although they are important downstream outcomes of research, development and the production and marketing of goods and services is not, in general, something for which universities are well suited or adequately resourced... The university looks rather to commerce and industry to commercialise its intellectual property.¹¹

⁹ Based on a 1999 survey conducted by the Australasian Tertiary Institutions Commercial Companies Association (ATICCA) of their membership to which they had 20 responses.

¹⁰ An example taken from the University of New England's Policies for Consultancies and Contract Research

¹¹ Monash University's Research Policy

The most common model is to provide protection for IP only through the relatively inexpensive provisional patent phase, and to use the twelve months of protection to seek to establish a licence with an external party with an appropriate royalty return. If an industry partner cannot be found within the twelve months, the application is usually allowed to lapse, and the ownership of the IP reverts to the inventor.

These commercial arms play a considerable role in facilitating commercialisation of research and in providing the important legal and contractual support services. However, in practice, they rely on researchers to play a very significant role in the various stages involved with the commercialisation of research.

Based on the procedures at the University of Sydney a typical process might have the following stages and responsibilities:

Table 2 Typical research commercialisation stages

Stage	Responsibility
Research	Researcher
Report of possible IP	Researcher
Supply of Record of Invention Form	BLO
Completion of Record of Invention Form	Researcher
Scientific Literature Search	Researcher
Patent Database Search	Researcher
Review of Commercial Potential	BLO
Evaluation of Patentability	Patent Attorney
Provisional Patent	BLO
Search for Licensee	BLO, with assistance of Researcher

Only the most general guidelines are commonly provided about a start-up company route to commercialisation. For example, in what has been described as one of the most detailed guidelines for researchers¹²:

... when commercialisation of research outcomes may be best achieved by the establishment of a company or joint venture with parties outside the University, the merits and commercial viability of an external entity must be evaluated and approvals sought in accordance with University procedures.

(BLO, 1999)

With regard to the **right or ability to hold equity**, there are no restrictions on individuals investing their own finances as they see fit. With regard to companies based on IP arising from university research, there is little explicit consideration in formal policy, perhaps not surprisingly because it is a relatively recent occurrence. Precedent established in a number of universities is of a negotiated allocation of equity, generally in proportion to the guidelines established for royalty allocation.

¹² Cripps et al., 1999.

This equity is commonly diluted very quickly as a result of new equity provisions for major investors.

With regard to **the acceptance of Directorships**, there is commonly only a standard requirement for approval by senior authority, such as the Vice-Chancellor or the Senate before accepting any Directorship. This directive is generally designed to address the general issue of invitations to join an established Board, rather than the special case of a researcher taking equity in a start-up company based on the products of their own research.

However, evidence of the general practice across many universities is that this approval is normally given, almost automatically, and on many occasions is not closely enforced.

Finally, while regulations are largely common, practice varies considerably. This can largely be attributed to different levels of expertise, customer orientation, and empathy with researchers on the part of staff of the commercial arms. In addition, there is great variation in the extent to which the executive of universities provide 'space' and active encouragement for entrepreneurialism, and the cultures of universities, Faculties and Departments support research commercialisation. Finally of course, the resources to support research commercialisation vary considerably between universities.

3.2.2 Financial and other incentives

The primary incentives, by way of reward, for successful involvement of researchers in commercialisation are the financial returns through a share of royalty payments, as outlined above. However, the response of interviewees was almost universal in stating that these funds, together with the regular flow of finance via contract research and consultancies, were pursued and used to maintain their research programs. They were not seen as a mechanism for achieving personal wealth.

If this perspective reflects a commonly held view among university researchers, (and it is widely believed to be so), then financial incentives directed towards the achievement of personal wealth may have only a limited effect.

Other forms of financial incentive which operate within the university system are provided through promotion. Some universities have changed their promotion criteria to include performance in the commercialisation of research, though they are in a minority. There is also still a widespread view among academics that performance in peer-reviewed research through winning grants and publications in high quality journals remains by far the most important criterion for promotion, and perhaps more importantly for researchers, peer recognition.

3.2.3 Impact on mobility

No evidence was found of special provisions for encouraging or allowing the movement of researchers into industry, either as part of new or existing companies. Within general provisions, researchers are permitted to take a limited amount of outside work (usually up to 20 per cent of their time), to work on contracts with

industry, to supervise students working in a company, and to take secondment for some agreed period to work in industry (usually with a three-year limit).

Nor was support found for special provisions of this kind. Commercial managers expressed the view that investors would always want to see key personnel deeply committed (and exposed) to the fortunes of the venture they are involved in. Researchers consider that three years away from the research front could never be 'caught up' and hence a decision to move into an industrial environment for that length of time was, in practice, a one-way decision.

This is quite different from the situation reported in Europe by Howells and McKinlay (1999) who argue that an important component of best practice should be that:

Prospective entrepreneurs who want to leave the university employ should be offered a transition employment period, starting with continuation of the payment of a full university salary and gradually shifting to self-employment as the company takes-off and with an option to return to an academic at a later stage.

It is apparent that issues concerned with mobility of staff from the university into start-up companies appear to have received almost no consideration in policy terms. However, as we discuss in chapter four, one emerging strategy is to create a constituency of science-based companies associated with the university with which staff can rotate more effectively in the future.

3.2.4 Intellectual property

Almost all Australian universities have in place well developed IP policies and practices¹³ that are substantially similar, apparently based on an Australian Vice-Chancellor's Committee (AVCC) Discussion Paper published in 1995. (AVCC, 1995). However they vary considerably in matters of detail.

The major common features of IP policy are:

Definition (including copyright, patents, plant varieties, trademarks, registered designs, circuit layouts, trade secrets, and other rights resulting from intellectual activity).

- Claim of ownership of all IP produced by staff, excepting publications and other special categories.
- Student ownership of any IP produced (though some universities claim ownership of student IP also), but with strong inducements for students to vest their IP in the university, with returns similar to that of staff.
- Obligations on 'originators' to report potential IP as soon as identified, and to follow appropriate non-disclosure requirements.

¹³ A detailed review of current IP practices has been conducted by Monotti (1997)

- Distribution of revenue resulting from IP exploitation, after costs are covered, on a formula basis (which is highly variable¹⁴) which acknowledges the appropriateness of a significant, but in most cases, minority, return to the individual originator(s).
- A Code of Conduct to govern matters such as conflict of interest and confidentiality agreements.
- Requirement that staff obtain approval of Vice-Chancellor or delegated authority to take up a Directorship of an incorporated body.

These IP policies are largely based on the assumption that the predominant mode of commercialisation, after consultancy and contract research, will be via licensing. They do not address the issues of start-up companies, which are beginning to emerge as an increasingly important form of research commercialisation (Chapter Four).

3.2.5 Information about opportunities for involvement in business enterprises

There is relatively little information of any great detail made generally available to university staff about opportunities for involvement in business enterprises. The highly rated BLO Manual provides substantial information about contacts and procedures once a researcher has made the decision to investigate the possibilities of commercialisation. Researchers who approach their commercial arm will normally be assisted, but on the basis of variable expertise.

It would seem reasonable to infer that there is no well-publicised path to, or collection of experience in, research commercialisation. Opportunities for learning are few, and experience difficult to, and only rarely, shared.

To conclude, formal institutional barriers to research commercialisation in Australian universities are few, and in practice can be bypassed. However, that does not imply that there is a well-developed path to research commercialisation, where the researcher is actively assisted and guided to overcome each hurdle along the way.

3.3 Impediments to research commercialisation from the researcher's perspective

The findings reported in this Section are drawn from a Web-based survey to which 113 useable responses were obtained. Respondents were predominantly university staff and students. Full details of the methodology, responses and data analysis are provided in Appendix B.

Of this sample, it is worth noting that 25 per cent had considerable experience in research commercialisation (more than five 'commercialisation relationships') and

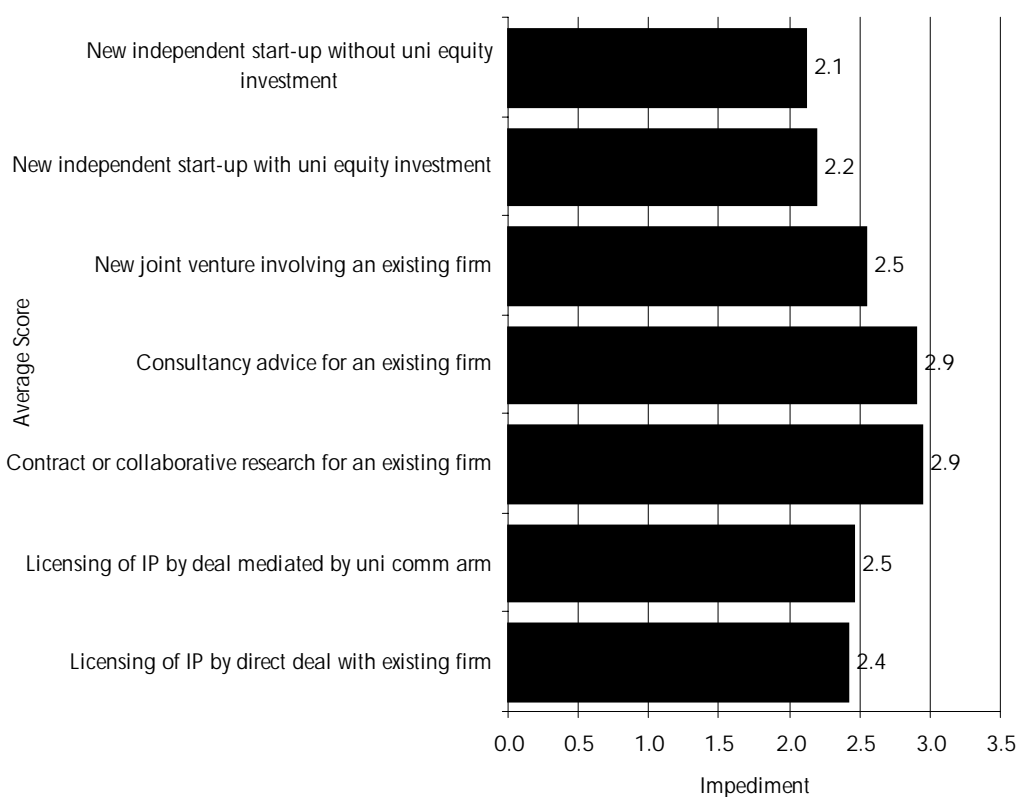
¹⁴ Formulae vary from a simple 3-way equal split between inventor, Department and University, to more complex schemes, which include a return to the University commercial company, and a sliding scale to allow a higher return to the inventor when the revenue to be distributed is small.

30 per cent reported cumulative returns to the research team in the range of \$0.1–1million, and 36 per cent in excess of \$10 million. Clearly, the sample included many who had been quite successful in the research commercialisation game.

3.3.1 Preferred research commercialisation avenues

The following graph shows how the total sample of respondents collectively rated each of the research commercialisation avenues specified *with current research commercialisation impediments in place*. A score of zero to five was used.

Figure 2 Preferred research commercialisation avenues



These results indicate that the most preferred commercialisation avenues are the traditional contract or collaborative research and consultancy for an existing firm. This is in line with the emphasis noted in policies and practice in universities.

These can be very effective mechanisms for technology transfer and collaboration when there are adequate industry *'receptors'* for the technology. These avenues are usually associated with incremental innovation as distinct from more radical scientific and technological advances. As noted they are characterised by low risk, and modest but rapid revenue flows.

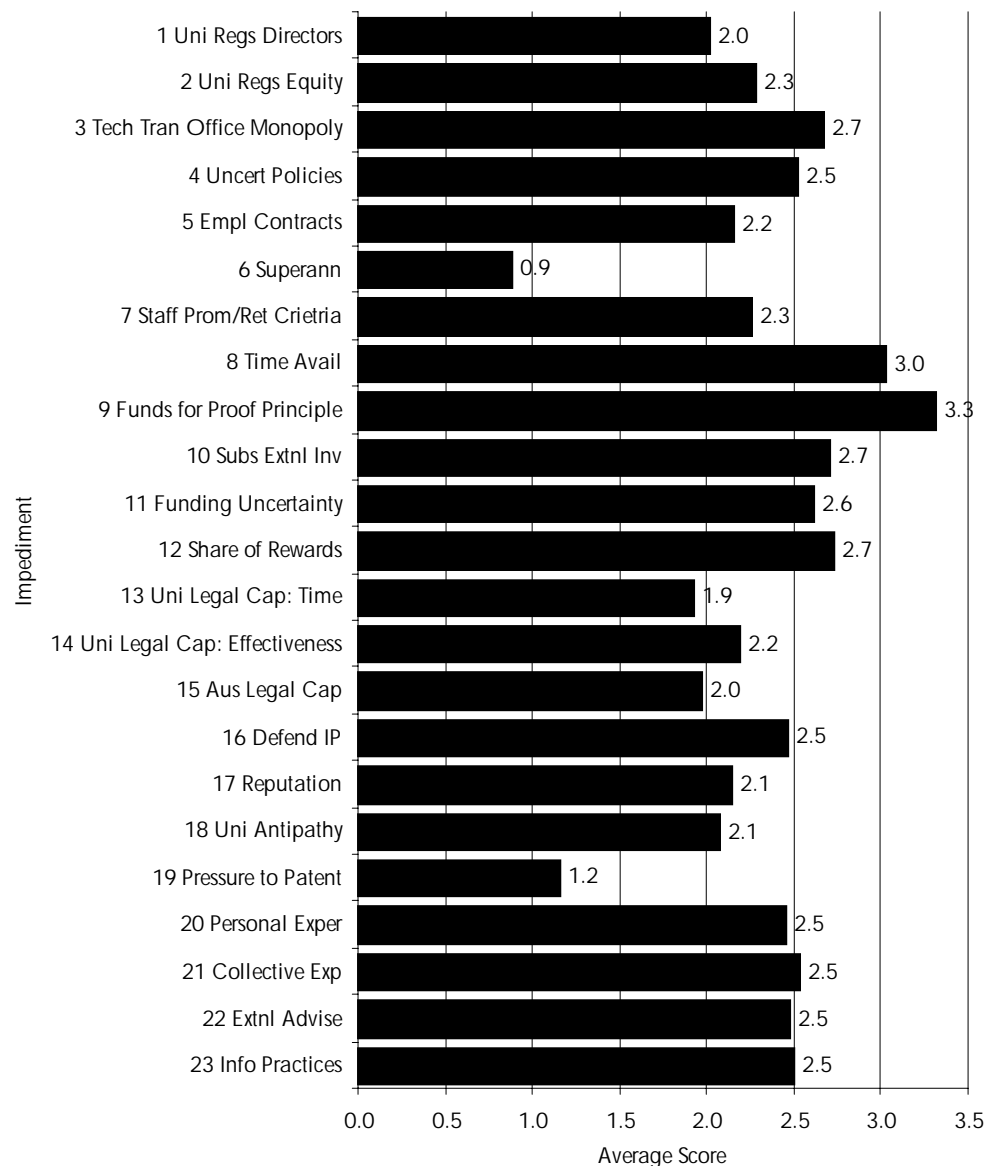
The least preferred avenues are new business start-ups, and that the general pattern of these results. However, the difference in response rating is not sufficiently large

to allow any substantial conclusions to be drawn. The data suggest that the avenues with the lowest risk-to-effort ratio are preferred. Technology transfer via research and consulting linkages is relatively risk-free and does not attract the 'overhead time', effort and stress that licensing arrangements, still less start-ups, tend to require.

3.3.2 Impediments to research commercialisation

Next, the relative strength of a number of key impediments to research commercialisation was examined. Figure 3 shows how these impediments were rated. Respondents were asked to rate impediments in terms of relative severity of impact on levels of commercialisation activity. Appendix B contains a more detailed description of these impediments.

Figure 3 Rating of impediments to research commercialisation activity



On the basis of these data the most severe impediment to research commercialisation is funding for the 'proof of principle' process. This finding is in accord with the earlier recognition (Chapter Two) of the low level of investment in the experimental development component of R&D, and with the opinions of many of the interviewees. Proof-of-principle is essentially a sequential process of increasingly expensive experimental activities.

Available mechanisms through ARC large and SPIRT grants, plus contracted research, are seen as largely adequate for advancing an idea to the initial proof of principle stage. However, the following stages where funds of the order of \$100,00–\$500,000 can be required, often under considerable time pressures, are not catered for either in the commercial market, or through Government schemes.

The second greatest impediment identified through the survey was the time available for research commercialisation. This reflects a common theme that academics are just too stretched by their teaching loads, their research, and the many administrative requirements, to find the time to engage in the demanding and time-intensive processes of research commercialisation.

Other 'above moderate' barriers are access to external investment for subsequent commercialisation activities (eg venture capital), the monopoly operations of the university commercial arm (a practice we will comment on in a later section), and the insufficient share of rewards resulting from university policies.

Most of the other impediments identified scored around 2.5 (moderate impediment), with the exceptions of superannuation policies and pressure to patent from the university, which are much lower.

We obtained further information from the respondents on why they had given moderately high scores to the university regulation-based impediments. It turns out that these impediments were given significant scores more because there is general dissatisfaction with the 'business process' efficiency with which universities handle a wide range of commercialisation matters than constraints caused by rules and regulations per se.

3.3.3 The Impact of impediments on preferred research commercialisation avenues

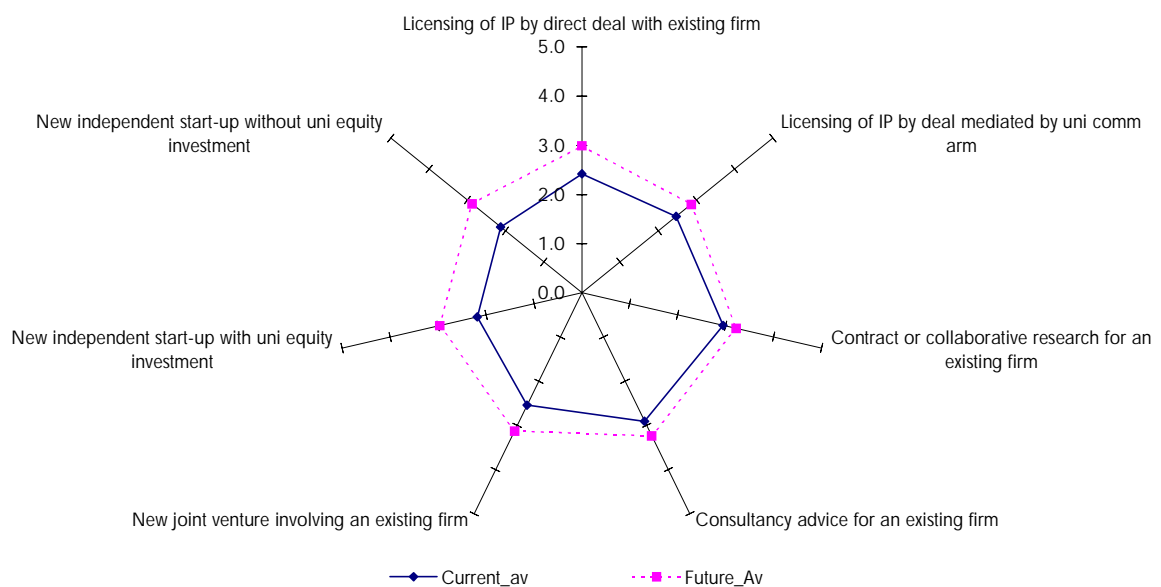
This question is pertinent to policy formulation because there is a view that a *broad spectrum* of university-industry interactions is more effective than a limited spectrum in closing the cultural gap between the two sectors - thereby facilitating the commercialisation process. A broad spectrum of interactions tends to involve beneficial 'interactive' and knock-on effects between the different channels that raise the overall effectiveness of the process.¹⁵

¹⁵ For example, doing consultancy work for a firm improves mutual understanding of each partner's research strategies, capabilities and modes of operation etc. This can facilitate subsequent research and commercial partnership building. Because these university-industry interactions involve learning-by-doing that 'de-bugs' these linkages and increases the probability of successful future linkages many governments now actively subsidise such linkage-building in order to generate a self-sustaining non-subsidised learning-by-doing process - effectively as 'launch aid'. (Matthews and Johnston, 2000)

Respondents were asked to provide a set of ratings of the appropriateness of the commercialisation *avenues assuming that current impediments have been removed*. This question was designed to allow us to test whether or not current impediments affect preferred commercialisation avenues.

Figure 4 illustrates the impact of impediments on preferred commercialisation avenues by plotting both sets of scores on the 'spokes' defined by each commercialisation avenue. The unbroken line describes the current situation, the broken line the hypothetical impediment-free situation.

Figure 4 Effect on preferred research commercialisation avenues of removing current impediments



These results suggest that current impediments *are* perceived to affect preferred research commercialisation avenues. Assuming that preferences relate to actual activities, current impediments may have the effect of:

- limiting new firm start-up activity that involves university equity;
- limiting new firm start-up activity that *does not* involve universities making an equity investment;
- limiting activity that involves licensing IP via a direct deal with an existing firm; and
- limiting joint ventures with existing firms.

The differences for contract and collaborative research, consulting and licensing deals mediated by university commercialisation arms are less marked.

In general, current research commercialisation impediments appear to restrict the 'breadth' of commercialisation activity—producing a 'less rounded' commercialisation profile.

We conclude that researchers take a wide and considered view of the relative applicability of the various research commercialisation avenues that are available. In particular, they recognise that collaborative/contract research and consultancy work can be major channels for commercialisation.

This probably reflects the fact that many research results are too incremental to warrant commercialisation via a start-up company. This is an important point because it places Australia at something of a disadvantage vis-a-vis countries with more advanced innovation capabilities in the private sector because there is less scope for such university-industry interactions in Australia.

The funding based major impediments to research commercialisation are the availability of funding for proof-of-principle activities and the subsequent investments necessary to produce cost-risk-return probabilities that will attract external investors. This funding problem is exacerbated by factors such as insufficient time available for dealing with research commercialisation given other duties and responsibilities.

Perhaps most importantly, the findings from both the on-line submission form and (far more strongly) from personal communications and the textual submissions received point very strongly towards a single generic problem that affects all the universities covered. This is the low level of business process efficiency exhibited by many universities and their research commercialisation arms in handling these procedures and decisions. Chapter four comments further on this issue.

This finding complements that of the various detailed case studies in that it highlights the impact of learning-by-doing in handling research commercialisation matters. This aspect of business process efficiency is driven partly by the lack of cumulative experience gained from previous research commercialisation activities and partly by the tensions caused by the need for university administrators to operate in a new, more business-like environment than has been the case in the past.

These consultations have not revealed that there are 'internal' university policies and procedures that constitute direct barriers to research commercialisation. Instead, they have revealed that current impediments are, to a significant extent, driven simply by the need for more experience in research commercialisation on the part of both researchers and research commercialisers a process that will tend to improve business process efficiency within universities and their commercialisation arms.

If these current impediments were to be removed then a more rounded profile of research commercialisation activity would result, with more activity in all commercialisation avenues. This is likely to lead to beneficial flow-on effects that would play an important role in improving university-industry interactions in Australia.

3.4 Performance of universities in commercialising research

It is very difficult to provide anything like an adequate scorecard of Australian university performance in research commercialisation. Universities, for various

reasons, do not make these data readily available. Indeed, until recently, many did not collect such data and there was no pressure to report it.

Surveys have generally been limited by poor response rates, frequently justified on grounds of commercial secrecy - a claim that would bear only limited examination. However, the sense, and reality, of competition between universities, and university commercial companies, has probably provided the biggest obstacle to establishing better measures of performance.

On the basis of a very limited response, ATICCA identified a total of A\$31 million revenue generated by research commercialisation, out of a total income of \$240 million in 1998. On this basis, research commercialisation generated only 13 per cent of income, and hence might be regarded as not of particular importance. However, it did consume on average 29 per cent of time.

With regard to performance, the following figures were identified:

New inventions disclosed	274
New patent applications filed	161
New patents issued	103
New licences and option agreements	63
Current licences and option agreements	231

It is difficult to make an assessment of these data, given the limited response and lack of any clear benchmarks for comparison. What might be indicated by the figures for current and new licences and option agreements is an increase in the rate of new licensing.

With regard to start-up companies, 46 were reported for 1996–98. Again, it is difficult to provide an objective basis for assessment. Against US levels of spin-offs, this is a low figure—MIT alone, for example, spins off around 150 companies annually; but the environment for commercialisation is very different—see Chapter Four.

One benchmark is provided by a recent analysis which identified a total of 67 venture capital deals in technology start-up and early expansion companies in Australia in 1997¹⁶. On the basis of very crude assumptions that the rate of supported company formation was on average the same over the three years 1996–98, and that the limited sample of responses to the ATICCA survey led to under-reporting, it might be concluded that **about one-third of technology start-ups in Australia in this period originated directly from universities**. This might be viewed as quite a reasonable performance.

Perhaps the only strong conclusion that can be drawn is that the rate of formation of technology-based start-up companies arising from university research, and their visibility, is increasing.

It should be noted that medical and health-related research figures prominently in all reports. In the ATICCA survey they are responsible for 42 per cent of activity.

¹⁶ Australian Venture Capital Journal, reported in BRW, July 28, 2000, p.96.

On the basis of the web-based survey and interviews six key stages can be identified in the research commercialisation process. The following analysis presents a qualitative synthesis of the level of performance of Australian universities

1. *Commercialisation readiness*

There is considerable evidence that most universities do not employ procedures and protocols that provide the necessary information base for substantiating IP claims, and facilitating due diligence searches. County Investment Management recently withdrew from the development of a proposed Medical Research Investment Fund on the grounds that it was impractical. They particularly urged the need for:

... a commonly accredited mechanism for management of IP that would make early stage investment feasible. Such a mechanism might involve a credit rating system for research institutions which took into account their IP management procedures such as maintenance of laboratory record books, and procedures for identification and protection of commercialisable IP.¹⁷

2. *Scanning research activity to identify potential IP*

Most universities place responsibility on the researcher for identifying and reporting potentially commercialisable research. However, it is apparent from interviews that many researchers are not confident that they have the necessary knowledge to identify potential IP.

I think I know it's not a goer with the big pharma companies. But I just don't know about the smaller ones, or whether this might have veterinary or agricultural applications.

Still others, with perhaps less experience, don't even think of possible commercial applications.

Many commercial arms operate in essentially a passive mode, awaiting the researchers with their commercialisable ideas to come through the door (and complaining when they don't). Some provide courses to provide generic skills in identifying commercial opportunities. These may be valuable, but they suffer in attracting only those already interested, and generic skills are often insufficient in addressing a particular case.

Some carry out a 'trawl' through Departments from time to time, with mixed outcomes. However, such an approach is likely to be far more effective than the passive 'wait-and-see'. It should be noted that the establishment of effective long-term relationships between researchers and commercialisation staff seems to underpin most successful cases.

We conclude that the pool of potentially exploitable research in Australian universities is probably moderately, and perhaps even markedly, greater than that being disclosed. Howells et al report a similar situation in Europe. More effective and active scanning processes are required to increase this pool.

¹⁷ in Australian R&D Review, June 2000, p.16

3. *Option creation*

Some universities have codified their selection procedures, along the lines outlined for the University of Sydney in Table 2. Others rely on ad hoc procedures. Much of the responsibility lies with the researcher, or is conducted through dialogue between the researcher and the commercial arm personnel.

Best practice would appear to lie in establishing clear, codified procedures, like the 'commonly used technology evaluation protocols and manuals that appear to be employed in many Canadian and US universities'. (Howells et al, 1999)

4. *Option evaluation*

Establishing a comparative track record for success in picking winners in technology ventures by venture capitalists is possible. However, with a much smaller portfolio, generated by the various activities of their university, such an exercise for research commercialisation is notoriously difficult. However there is evidence of a relatively clear and shared 'pecking order' of performance by university commercial arms, which suggests, at least in some informal way, such judgments can be made.

One issue arising is that, for many universities, the pool of commercialisable research is probably not sufficiently large to be effectively managed using the averaging risk-compensating techniques that can be applied to an investment portfolio. Every case is unique, from which a return is expected. In addition, the financial and human resources that can be committed to research commercialisation are limited.

Under these circumstances, the arrangement, which has grown up, whereby every university has its own commercial arm, is probably far from efficient from a national perspective. Despite the level of competition between universities, there would seem to be a good case for encouraging the removal of effective or real monopoly rights of university commercial arms, and a degree of consolidation in the market place.

What also emerges clearly is that the performance of a university commercial arm is correlated strongly with the capabilities of the chief executive, particularly their industrial and commercialisation experience. The most important means of improving the 'hit rate' is selective recruitment of people with these skills, and in the longer term, development of a recognised career pathway in research commercialisation. This experience accords with the understanding of the world Science Park movement, where it is held that the major factor underlying the success of a Science Park is the quality of its CEO.

5. *Negotiation of appropriate commercialisation and protection regimes*

Considerable experience appears to have been developed in this area, though as it is a competitive field, the leading edge is continually advancing. There is a corpus of experienced IP evaluators and negotiators, though not sufficient to allow every university to have one.

One of the very significant challenges is that of balancing the needs and interest of the researcher/research team, with those of the university, and even the nation. With most researchers operating under extreme pressure on resources, and the

need to invest considerable time in raising what is required to continue their research, there is an inevitable demand for short-term funds. Thus the researcher is more interested in the near-term cash flow arising from licensing, or even sale, compared with the potential of much larger but highly uncertain returns over a longer period.

6. *Management of the commercial portfolio*

There is adequate evidence that the universities, to varying extents, have developed the capability to manage a portfolio of licences. However there are much less accumulated skills in managing the stages of development of start-up firms. Such firms go through a number of critical thresholds in their development, in management, marketing and technology, each of which can prove terminal. In particular, given the uncertainty and risk, there is a tendency for hierarchical universities to rely on the familiar command-control management mechanisms, and appoint a senior executive to guard the university's interests.

In contrast, what is most needed are directors whose interest is in the company succeeding. One such category is those with the necessary knowledge of the technology. In general, the university should see its return coming through the deal it negotiates, and the extent of its equity, rather than in engaging in hands-on management of start-up enterprises.

4. Emerging practices in selected universities and their wider implications

4.1 Introduction

The purpose of this chapter is to examine the nature and extent of the diversity in different universities' approaches to handling technology transfer and research commercialisation and to draw conclusions about the policy significance of this diversity.

We use a number of case studies of Australian and overseas universities' approaches to handling technology transfer and research commercialisation to achieve this objective. Case studies provide an excellent means of exploring how complex causal factors interact to produce different outcomes. Our aim is to use these case studies to:

- specify the key dimensions over which different universities' approaches differ; and
- use this specification to develop a generic framework for mapping different universities' approaches in the future.

The preceding chapter argued that Australian universities currently have broadly similar policies towards IP, following the AVCC's guidelines. Formal institutional barriers to research commercialisation are not strong, and where they do exist they can usually be by-passed in practice. However, there are not well developed *uniform* paths to commercialisation and different universities are exploring different strategies for facilitating research commercialisation. In short, the variance in formal institutional policies and procedures is low but the variance in the efficiency and effectiveness of the practical application of these procedures may be rather larger.

The case studies covered in this chapter will be used to examine this issue in greater detail. In so doing, it is necessary to develop and test a framework for analysing how universities differ with respect to their handling of technology transfer and research commercialisation. This framework will allow county-specific 'structural' factors to be covered in order to provide a basis for deciding upon the appropriateness of emulating specific aspects of overseas practice.

The case studies were selected in order to address the project requirement to 'examine existing and emerging practices, nationally and internationally, in order to identify best practice models'. Hence, for overseas universities, the emphasis was on those internationally regarded as representing best practice. The Australian universities were selected on the basis that they were strongly engaged in

reformulating their strategies and processes for research commercialisation, and/or which were recognised as performing strongly.¹⁸

The case studies selected were:

- MIT;
- Stanford University;
- UCLA;
- Oxford University;
- The University of Melbourne;
- The University of Queensland;
- The University of Sydney; and
- Curtin University of Technology.

Additional information about other universities' arrangements for handling research commercialisation was also used.

4.2 Changes in Australian universities approaches to research commercialisation

A number of policies and practices have begun to emerge over the past year or two which signal a significant shift about the perceived potential of commercialisation of university research under the new conditions of the global knowledge economy, and the emergence of global markets for research.

These include:

- **A greater emphasis on commercialisation through start-up or spin-off companies.**

The well-established evidence of the successful commercialisation of research through spin-off companies in the major US universities, and a growing view in Europe that generating new enterprises to exploit research developments can be more effective than licensing IP to existing companies, appears to be having an influence in Australia.

The advantages of such an approach to the nation are seen as:

- job creation (direct and indirect);
- increased likelihood of downstream operations in Australia;
- spawning of flow-on spin-offs, leading to a start-up agglomeration; and
- opportunity for gaining greater value multipliers through exit strategies such as public offerings and trade sales.¹⁹

¹⁸ These judgments were based on the web surveys and the extensive round of interviews.

¹⁹ Adapted from Cripps et al, 1999, p.155.

However, there is doubt whether arguments of national advantage were the prime drivers of this emerging shift in practice. Rather, it was likely to be the dramatically growing value of technology-based companies, the surge in the value of the US NASDAQ share list, and the greatly increased availability of venture and other forms of capital to invest in research-originated technologies and companies. These factors both raised the profile of the start-up commercialisation avenue and made it easier to pursue this strategy.

As yet, only a few universities have moved towards committing themselves to start-up company formation as a significant component of their research commercialisation strategies. None have established publicly available protocols to guide the process. Indeed it is a period of considerable experimentation and cautious learning. However, as our selected case studies will show there is a considerable burst of new spin-offs.

- **Decentralised mechanisms for research commercialisation**

The case studies of both the Universities of Melbourne and Queensland reveal a move to decentralisation of the scanning and screening component of the research commercialisation process. Staff of the commercial arm are being located within the Faculties with the explicit aim of improving the capture of research outputs with commercial potential i.e. to expand the number of candidates for the potential portfolio. At the same time, the stages of negotiation and management are being maintained within the central organisation, in order to ensure access to the necessary skills and judgment involved in commercial negotiation.

- **Transfer of ownership from the institution to the inventor**

The new regulations at the University of Melbourne include a transfer of ownership of IP from the university to the inventor/researcher. There is no longer a requirement to inform the university. Rather they are free to make their own commercialisation judgments, to invest in the necessary protection, and to reap substantial rewards. In this they can choose to go it alone, be assisted by the University's commercial arm (MEI), or to seek alternative commercialisation advice and assistance.

This shift constitutes a first in Australia, but is closer to the arrangements in some leading US universities (eg MIT) and UK universities (Cambridge, UMIST). The very considerable success of what is commonly referred to as the 'Cambridge phenomenon' is attributed to the quality of the researchers, and the relative autonomy under which they operate within the 'college system'.²⁰ As a consequence, the growth of a concentration of technology-based firms has been more a case of spin-out (companies with which the university has no ownership, legal ties, and occasionally, knowledge) than spin-off (companies in which the university has a continuing involvement or interest).

- **Abolition of monopoly in commercial arm operations**

An increasing number of universities are exposing their commercial arm, at least in principle to competition from other university commercial arms, and from the commercial investment industry. The extent of the real competition, or the time taken to establish genuine market conditions, is as yet unclear.

²⁰ For example, see ARC, 2000.

- **Direct provision of capital**

A number of universities (eg. ANU, Curtin) have decided, or are in the process of deciding, to adapt their investment strategies to permit a certain level of investment (of non-Commonwealth funds) in equity in university-originated start-up companies, or to enter joint venture capital raising with investment firms.

These findings will be explored further in the following case studies.

4.2.1 The University of Sydney

The University of Sydney provides a case study of a 'traditional' approach to research commercialisation. Responsibility for identification of potentially commercialisable research rests with the researcher. Indeed, they are bound by regulation to make such an identification and communicate it to the university's commercial arm—the Business Liaison Office (BLO). Intellectual property (IP) generated by employees is the property of the university.

The BLO is one of a small minority of commercial arms that has not been incorporated. Rather it works alongside the Research Office and reports to the Pro-Vice Chancellor (Research).

The major business of the BLO is managing the university's contract research and consultancy. With regard to the exploitation of IP, the preferred route, in which considerable experience has been gained, is to take out a provisional patent and seek to licence the IP during the 12 months of available cover. However there is an increasing use of the new venture mechanism to seek to gain a greater return to the university from equity holdings. (see Box)

There are mixed views among researchers at Sydney University about the performance of the BLO. Many regard it as doing a good job. Others see a centralised organisation as too remote from the actual research performance, and that such commercial arms should operate, and be located, in the Faculty. Other issues which attract criticism are the time delays in reaching decisions, the reluctance to pay for a full patent, the extent to which the researchers have to perform the various commercialisation stages, and the high proportion of any earnings that the university takes.

However, the performance appears to be reasonably strong, with steadily increasing revenue, and start-up companies (see box). The explanation would appear to lie in the commercial skill and experience of the BLO staff, a growing acceptance among researchers of their competence, and the very considerable portfolio of potentially commercialisable research that is generated in a university with the size and research orientation that Sydney has.

The overall approach of the University to research commercialisation might be described as 'laissez faire', based on the notorious difficulties of organising independent academic researchers. When the scale and the talent are sufficient, such an approach may be adequate to produce significant returns. However, with lesser scale and talent, it is unlikely to be very effective. Furthermore, it may serve to capture only a portion of the potential gains that could be realised through a more active, or strategic, approach.

This case study does serve to emphasise the difficulty of arriving at simple 'best practice' models. Best practice will vary considerably based on size, quality of staff, nature of research and the receptor community. We will develop these ideas further through the other case studies, and consideration of an appropriate conceptual framework.

Case Study 1 Traditional approaches—The University of Sydney's
Business Liaison Office

The commercial arm is the Business Liaison Office, which operates as part of the university and reports to the Pro-Vice Chancellor Research. The BLO is 'responsible for everything to do with commercialisation, contracts and consultancies' and has a staff of eight. It is organised into two groups: business development/contracts and the Intellectual Property and Licensing Unit.

Operations are highly centralised, though the Director and two Assistant Directors take responsibility for specific discipline areas. The Director is a bio-scientist with significant industry experience.

In the few years of its operation under the present Director, the BLO has come to be regarded as an effective and influential shaper of both policy and practice with regard to research commercialisation in the university. It has produced what is widely regarded among commercial arm managers as the best Manual in the country to guide researchers, which is updated every year. It also has produced a series of standard models for contracts, licences and other agreements. It also runs regular courses on IP and legal contracts.

New patent applications were made for 48 new inventions in 1999 compared with 14 in 1996. Licensing income has increased from \$300,000 to \$1.1 million over the same period, and will exceed \$1.8 million in 2000. These are very substantial increases. However this increased licence income still accounts for only 3 per cent of the total value of all research agreements. Research contracts are still by far the greatest source of industry revenue.

Perhaps the best known of Sydney University's spin-off companies is ResMed Inc, now recognised as one of Australia's leading successes in taking a health-related product to the global market. It originated in research to develop non-invasive treatment for obstructive sleep apnoea at the University of Sydney in the 1980s. It now has net revenue in excess of US\$80 million, and distributes to more than 80 countries.

Between 1996–99, nine spin-off companies based on university research were formed. The University has equity in three of these—eBioInformatics Inc., Benthic Geotech Pty Ltd and Australian Photonics Pty Ltd.

In 2000, four companies have been formed to commercialise medical related technologies developed within the university. In addition, in the last two months, two separate companies have been formed to commercialise the University intellectual property relating to eye disease and diagnosis. One of these has received approval for a Comet grant. Two other new companies have been formed in the last month, one to develop and commercialise a health product and one to commercialise plant varieties, both of which have approved Comet funding.

4.2.2 The University of Melbourne

The University of Melbourne has recently embarked on what is possibly the most radical reformulation of its strategy and approach to research commercialisation ever seen in an Australian university. (see Box below)

In accord with the strong drive to internationalise the university, and establish it in the top rank of international universities, a new approach has been developed which shifts the emphasis away from short-term direct returns from research commercialisation, towards a position designed to produce more substantial, long-term and indirect returns.

This is to be achieved by moving more towards the position of the elite US universities (see next Section) where exploitation of intellectual property is seen as part of the university's charter, and where the benefits flow from the formation of long-term, and even generational relationships with commerce and industry.

The central element of the new policy sees IP, the responsibility to exploit it, and the rewards from it, largely vested in the individual researcher or research team. This is supported by removal of the monopoly of the university commercial arm (MEI), linked with a commitment of funds (\$30 million) to MEI to establish offices in the Faculties to identify and pursue commercial opportunities, with the requirement of producing a significant return on the investment.

The expectation is that this will lead to a substantially larger IP portfolio, associated with, rather than owned by, the university and a stronger commitment to commercialisation among academic researchers.

There is a significant level of concern among university researchers about possible risks associated with such a radical change. Some consider that the new arrangements, with responsibility falling to researchers to pursue commercialisation, may deter some staff. 'we simply don't have the experience, or the time, to negotiate good commercial arrangements'. There is a fear that commercially naive researchers may be 'taken to the cleaners' by sharp commercial operators. Furthermore, without the backing of the University 'brand name', it may be difficult to attract and negotiate good deals.

It will be some time before the new approach to research commercialisation can be evaluated. However, it certainly represents a benchmark in Australia in re-thinking the role of research commercialisation in university activities, and moving it to the heart of development strategy.

Case Study 2 Re-thinking commercialisation arrangements—the University of Melbourne

There has been considerable upheaval and restructuring of arrangements for commercialisation of research in the past five years at the University of Melbourne. This has involved successive granting of prime responsibility to UniMelb Ltd, MRE Ltd and MEI Ltd. This has produced a climate of instability. Staff generally found little assistance from these previous arrangements.

From January 2000, new organisational arrangements for managing a programme of professional services designed to foster innovation, protect and manage IP and

facilitate contract and collaborative R&D were introduced. These involved separating the responsibilities of:

- A Research Innovation and Development Group, within Melbourne Research and Innovation Office, responsible for negotiation of R&D contracts, facilitating a culture of innovation (including through advice and training on IP), and advising staff about avenue for development and commercialisation of IP, including referral to MEI or alternative external commercial specialists; and
- Melbourne Enterprises International (MEI) Ltd, through its Business Development Division, responsible for managing existing IP portfolio, consulting management, facilitation of new business development opportunities and commercialisation of IP in strategic areas.

MEI has been provided with a budget of \$30 million (proceeds of the Melbourne IT float), with a requirement to produce a return of 6–8 per cent pa, to be used to fund salary increases. MEI has no exclusivity, and has placed a Business Development Office in most Faculties to pursue business. Recognising the limited financial resources of staff and Departments, these services will be predominantly provided in return for an agreed percentage of the potential outcome.

A new IP Statute was approved by Council in December 1999 and implemented in May 2000. Under this arrangement IP rights and responsibilities reside with staff, not the University. Returns, after payment of direct costs incurred by the University, are 95 per cent to the staff member(s) and 5 per cent to the University for less than \$1million and 85 per cent/15 per cent for more than \$1million.

4.2.3 The University of Queensland

The key features of The University of Queensland's (UQ) approach have evolved in response to the learning-by-doing process that has taken place since the formation of UniQuest in the mid 1980s and especially since 1994. The university invested equity in UniQuest in 1995 for the purpose of the company building a professional team and implementing a research commercialisation strategy that had a ten-year horizon. In making this investment, the University accepted that such investment is unlikely to start to produce returns for five years.

This recognition was an important milestone in the development of a culture supportive of research commercialisation in UQ. This growth and learning-by-doing process is now poised to generate major financial yields that will provide investment funds for expanding the university's *capacity* and *capability* to facilitate research commercialisation.

Expanding *capacity* is important because there are limits to the size of the deal flow that can be handled at critical points in the process of generating deal flow, adding value to it, packaging it and negotiating a deal. An essential requirement for handling this deal flow is a critical mass of highly skilled professionals in technology commercialisation. This critical mass cannot be achieved without a substantial deal flow, a recognition of the time delay between investment and returns, and the funding and corporate strategy to keep the commercialising unit on the air while this process works its way through to making returns.

UniQuest has assembled the required critical mass of skilled staff and is able to handle a large portfolio of deals. Still, as they move through the commercialisation 'life cycle' the demands on human resources required to close deals (a sub-set of the wider portfolio) increases dramatically and, even in UniQuest's case, restricts the number that can be brought to satisfactory conclusion. UniQuest's strategy is to create a Seed Fund of \$10–\$20 million and to accelerate the process of generating revenue from previous commercialisation deals, as the means to expand its capacity to handle deal flow and as a result, to negotiate and successfully implement more and better quality deals.

It is important for a commercialisation company like UniQuest to meet the expectations of its researcher-clients. If capacity expansion does not take place, and capacity expansion plans are not communicated, then this capacity constraint can, itself, constitute a major impediment to research commercialisation. This is because researchers will expect that the critical stages in negotiations will be drawn-out, time-consuming and stressful and, as a result, impose major opportunity costs that will impact upon their research performance—particularly in terms of publications. Given that a decision made *now* to initiate the exploration of commercialisation opportunities may bring with it this future *opportunity cost* researchers will tend to avoid this pathway if they do not anticipate capacity constraints being reduced.

As UniQuest notes, the capacity to close commercialisation deals has strong critical mass elements and therefore warrants a degree of *centralisation* of this function. In UniQuest's approach, a strong central capability works closely and in a 'hand-shake' with its appointments in the Faculties, to create a high-capacity service. It is seen as far more efficient, and therefore effective in generating outcomes, to retain a core critical mass of skills in a central unit working closely with devolved functions throughout the University as the means to maximise the capacity to generate, add value to and close deals, than to devolve all of this capacity throughout the university.

The second issue concerns *capabilities*. The high levels of tacit knowledge required for successful research commercialisation mean that investment in upgrading these capabilities is required in order to address this expectations problem—for closely related reasons. If the expectation is that the decision to explore commercialisation opportunities may bring with it serious problems due to capability constraints in the business processes involved (appraising commercial potential, securing patents etc) then the decision may be made to avoid opening up this option in the first place.

The University of Queensland's approach appears to recognise the importance of managing expectations by striving to create a virtuous cycle of learning-by-doing and re-investment in capacity and capability expansion. The move to *distributed and integrated* commercialisation capabilities—a move designed to increase the rate of *generation/capture* of commercialisation options—is a clear manifestation of this approach.

This strategy was initiated by the University's core commercialisation company, UniQuest, reaching an agreement with the Executive Deans of the Faculties and the DVC (Research) to appoint a Manager, Innovation and Business Development to work closely with each Dean, in the Faculties, on business development, sourcing deals and interfacing with UniQuest's 'headquarter's' specialist staff in technology commercialisation. These senior appointments are currently operational in four Faculties, with a fifth coming on stream shortly and the prospect for a

second appointment in the three largest Faculties soon. They work from an office adjacent from the Dean's office in each Faculty and liaise closely with the Dean and academic staff and post-graduate students over the dissemination and commercialisation potential of current and planned research.

The formation of IMBcom as a virtual company in UniQuest, to be spun off later this year as a separate commercialisation company is a significant move. IMBcom will be the Institute of Molecular Bioscience (IMB) 'own UniQuest'. It will commercialise research outcomes from the IMB and also exemplifies the University's strategy of devolving and integrating commercialisation with teaching and research. Staff performance in the IMB is to be appraised on the basis of equal weighting for all three activities IMBcom will facilitate this integrated process.

Unlike the capacity to close commercialisation deals, much of the capability to generate commercialisation options (ideas, concepts etc) can be devolved. Indeed, the increase in communication effectiveness achieved between researchers and commercialisation professionals alone is likely to generate a large increase in commercialisation opportunities. Comprehensive management of the whole process—from idea generation to closure of deals—is required to ensure that it is balanced from beginning to end. This ensures that an increase in capability at one end of the process does not result in a bottleneck at the other. UniQuest seeks to achieve this comprehensive 'life cycle' management of the commercialisation process.

What is particularly interesting in the University of Queensland's approach is that it seeks to maximise the advantages, in *commercialisation option generation*. This is done by developing a distributed commercialisation function within the university whilst also maximising *business process efficiency* in crucial stages of the commercialisation through centralised 'critical mass' *capacity* to close deals. The rationale for this is that either centralising or devolving overall responsibility for both capabilities and capacity would be far less effective than developing the two-phases of decentralised option generation and centralised negotiation.

The evolution of the university's model is, however, at a relatively early stage and it remains to be determined just how effective such a model is. On the basis of the analysis in this study the anticipated outcome for the university is very positive.

Case Study 3 Consolidating commercialisation effectiveness—the University of Queensland

As with most, if not all, Australian universities the main motive for facilitating research commercialisation is to generate external private income to augment public sector income sources. A particular emphasis is placed upon forming start-up companies. An important, explicit co-objective is to enhance the process of making the outcomes of Australian research useful to the Australian and international community and to generate economic benefit for Australia.

The University's research commercialisation firm, UniQuest Pty Ltd, does not have a monopoly over intellectual property protection arrangements and their exploitation. UniQuest does not have a formal first right of refusal over commercialisation rights of UQ's IP, it relies on its *competence* for making it the first port of call for researchers who wish to commercialise the outcomes of their

research. However, there is an implied obligation through the University asserting its right of ownership of IP created by its employees, for researchers to use UniQuest as a matter of course. UniQuest uses an array of commercialisation pathways on a horses-for-courses basis, including start-up and spin-off companies, whose formation is strongly encouraged by the University's culture and policies. In most cases UniQuest holds equity in these companies on behalf of UQ, its Departments and Centres that host the research and the researchers/inventors. UniQuest also holds equity in some start-ups and spin-offs on its own behalf, as a result of making seed investments using its own resources. UniQuest maintains an active involvement in many of these start-ups and spin-off companies at both Board and management levels during the early stages of their life cycles. UniQuest's strategy is for these companies to operate autonomously through their own management and Boards at the earliest possible date.

UniQuest has a particularly aggressive start-up company formation strategy and has formed 25 of these companies to date.

Collaborative research and funding arrangements are handled by the Research Office. A 'Clearing House' exists, involving meetings of the DVC (Research), Research Office and UniQuest to resolve disputes as to whether UniQuest or the Research Office has jurisdiction over a particular research contract. These disputes seldom arise.

Consultancy work is encouraged. UniQuest offers a service to assist academic staff members manage consulting projects, but an individual member of the academic staff may carry out consultancy work directly, without using UniQuest. This is on condition that no university equipment or infrastructure are used, or, if they are used, for an agreed payment subject to constraints that balance consulting with existing teaching and research loads. This agreement is made between the individual and the Head of School or Centre Director. One day per week may be spent on such external work. Professional liability insurance is provided as a part of UniQuest's service.

A convention has been adopted such that net commercial returns from the exploitation of IP are distributed on the basis on 1/3 to the inventor/researchers, 1/3 to the Centre or Department that hosts the research and 1/3 to UniQuest acting on behalf of the corporate University.

The most notable feature of the University of Queensland's arrangements for handling technology transfer and research commercialisation (TT-RC) is its recently developed strategy of distributing the TT-RC capability throughout the university. This strategy is based upon recognising the importance of *integrating* research, teaching and TT-RC activities in order to achieve stronger interactions between the three functions.

4.2.4 Curtin University of Technology

Curtin University, with its origin as an Institute of Technology, has always had strong links with industry, and acknowledged the need to develop substantial revenue flows that are not dependent on the Commonwealth Government. Its major emphasis has been on developing revenue through international student programs, and in this it has been very successful (of the order of \$100 million).

As a smaller university, with acknowledged weaknesses in such key research indicators as proportion of research higher degrees, staff with PhDs, and proportion of research active staff, the challenge is to determine an appropriate IP and research commercialisation policy. The present policy is substantially modelled along the common pattern described in Chapter 3, and produces a modest income through licensing, and has seen the formation of two spin-off companies.

The key questions posed are:

- Can we have an entrepreneurial university without supporting entrepreneurial staff activity?
- Can existing structures accommodate entrepreneurial activity, and if not, how should they be changed?

A number of components of a new approach have been proposed:

- a greater incentive for the limited number of researchers capable of generating commercialisable research output by a greater personal incentive/reward—up to two-thirds of the net return;
- appointment of a person with the relevant experience to manage the IP commercialisation portfolio;
- establishment of a small fund by the University Investments Committee to support the taking of equity in entities commercialising university IP;
- mechanisms to facilitate the establishment of business units primarily concerned with managing consultancy and commercial development opportunities in areas of significant commercial opportunity; they will not be concerned with normal academic activities but will be expected to operate in close association with an academic unit.

Under this new model, Curtin University is not so much focussed on extracting the maximum value from the research activities of its academics, recruited for quite different purposes and according to quite different criteria. Rather, it is seeking to establish linked capabilities in areas identified as having high promise, with the explicit intention of generating and exploiting IP.

Such a proactive approach inevitably carries risks, but is probably the only way that a smaller university could ever be more than a marginal player in research commercialisation, and the revenue it can generate.

4.3 Case studies of international universities

US universities and the elite UK universities operate under significantly different conditions than Australian universities with respect to research commercialisation. In general, US universities' linkages with industry, and the business sector in general, are highly *symbiotic*, i.e. inter-dependent and based upon a strong public interest motive.²¹ Their perspective towards universities' role in the national

²¹ Background research on overseas approaches was carried out by Craig Meer of Policy Intelligence Pty Ltd.

innovation system is illustrated by the following hypothetical example from the US that shows how a chemistry professor's invention of a novel liquid crystal might set in train a chain of diverse technology transfers.

The crystal is licensed to a manufacturer of computer display screens, one of which is attached to a computer purchased by an undergraduate student. The student writes a computer program to display and manipulate chemical models, publishes a paper based upon research done using this program, and upon graduation, receives two job offers: one from a pharmaceutical company to join their drug discovery team, and the other from a software applications developer to write more programs for 3D modelling. The student decides to pursue graduate studies in cell biology, and the pharmaceutical company funds the student's doctoral research, which results in a new invention.

(AUTM, 1999, p3)

This hypothetical example illustrates how the 'broad spectrum' of linkages between universities and industry takes place. In this symbiotic relationship, (business process) effectiveness in securing IP over inventions plays *the* key role. As the US-based Association of University Technology Managers Inc states:

Universities...recognize that their research activities yield results that have the potential of contributing to new products that could improve the quality of life for the general public. However, for the public to benefit, those results must be transferred effectively to the commercial sector for development into useful products. Because the development of early stage inventions into products is often a lengthy undertaking requiring considerable investment, patent protection can be extremely important in providing the incentive for companies to make that investment. The academic research community in its commitment to facilitating effective technology transfer invests heavily in patent protection so that its research discoveries can be commercialised to benefit the public.

(AUTM, 1999, p3)

Moreover, the US universities are very clear about the functional role that they play in this public interest-based symbiotic relationship. They stress the *market failure* based argument that academic institutions

... are not constrained by a need to both generate and accurately predict profits for shareholders. Therefore, academic licensing programs can take a longer-term view of technology development than for-profit organizations, which do have a responsibility to provide a consistent and predictable return on investment for shareholders.

(AUTM, 1999, p3)

US best practice is therefore characterised by a strong emphasis on business process effectiveness in obtaining ownership of IP over academic inventions, but mainly in order to facilitate universities' *public interest* based role in complementing private sector technological capabilities via a wide spectrum of interactions. The existence of uncertainty over potential research outcomes combined with close academic-business linkages are the key components of the rationale for the US approach.

The major difference between US universities and universities in Australia is that US universities do not face the challenge of *creating* an industrial constituency that

would allow them to play a more symbiotic public interest role. Our Australian cases studies have clearly identified this effort to create an environment within which universities could operate in a more symbiotic role in the future.

This difference in strategic aims, albeit for a shared purpose, is critical to understanding best practice in technology transfer and research commercialisation. US universities' stronger financial input from business via donations and targeted research funding reflects the business sectors' clear recognition of the key role played by universities in addressing the market failures which would otherwise constrain industrial innovation.

To be specific, these *indirect* financial contributions to universities mean that universities' role in compensating for market failures is enhanced rather than damaged. This is because universities' distinctive contribution to the national innovation system is based upon:

- overcoming the restrictions that pure 'commercial' resource allocations produce (in terms of the need to accurately predict and maximise the short-term returns to investment in R&D), whilst;
- maximising the benefits to be obtained from efficient and 'business-like' processes for handling the securing of IP over inventions in order to enable technology transfer to take place.

If this distinction is lost, and resource allocation for university research is based upon commercial principles then the inherent uncertainty in the research process, and hence risk associated with investment in research, will reduce the effectiveness of universities' role in the national innovation system.

From a best practice perspective it is therefore essential that this distinction between maximising business process effectiveness in securing IP (and closing technology transfer/commercialisation deals) and *maintaining commercially de-linked* research resource allocations is maintained. This can be a delicate balancing act because it is easy to confuse a move towards a more business like handling of IP with the setting of research resource allocations on quasi-commercial grounds. The message from US universities arrangements for handling technology transfer is that these two functions need to be distinct in order to maintain the university sector's role in the national innovation system.

Our case studies of three leading US universities, and of Oxford University provide clear illustrations of this strategy. Key aspects of their arrangements for handling technology transfer and research commercialisation are summarised in the following table.

Table 3 Summary of administrative, regulatory and legal approaches at MIT, UCLA, Stanford and Oxford

Administrative Arrangements		Regulatory Provisions				Restrictions & Divided Rights			
<i>Name of Responsible Agency or Department</i>	<i>Distinctive Features of Arrangements</i>	<i>Details of Institutional Learning</i>	<i>Copyright & Intellectual Property Policies</i>	<i>Appointment & Enrolment Procedures</i>	<i>Guaranteed Freedoms (of research, etc.)</i>	<i>Business and Consulting Activities of Researchers</i>	<i>University Claims on Spinoffs and Consultancies</i>	<i>Division of Income Stream</i>	
Stanford	Office of Technology Licensing.	OTL staffed with project, management and technical personnel, not bureaucrats or lawyers.	History of institutional design dating back to early 1970s.	Stanford claims right, title, and interest in IP & copyright produced by academic staff and students.	All University personnel required to sign SU-18: obliges full research disclosure.	Domaining right guaranteed, but unclear as to when this may be exercised.	No direct restrictions on B&C activities but may be included in individual work contracts.	University claims right to hold equity in any spin-off arising from Stanford research.	15% off the top for the OTL, and one third each for the researcher, department & school.
UCLA	Office of Technology Transfer	OTT not geared for performing incubator-style operations; does not pursue start-ups. Emphasis is on facilitation.	Current arrangements based on suggestions forwarded in 1994 review of practices.	UCLA claims right, title and interest in those inventions which <i>might be readily patentable</i> .	Paid staff required to sign Patent Acknowledgement Form: obliges partial disclosure.	University privacy policy may override disclosure requisites.	No evidence of strictures on business activities, but confirmation of right to do consultancies.	Not directly mentioned in University policies. Possibly N/A.	35% to the researcher, 15% to the department or faculty, and the rest to the University
MIT	Technology Licensing Office & Industry Liaison Office	TLO & ILO operate alongside dedicated technology transfer programs designed to build lasting alliances.	MIT pioneered the concept of industry liaison in 1948 with the founding of the ILO.	MIT affirms copyright law, & only claims IP from targeted or sponsored research, and 'work for hire.'	Personnel must sign Inventions and Proprietary Information Agreement: has limited application	MIT policy affirms state and federal laws in the US which secure trade and professional secrets.	No direct strictures on B&C activities, but employee contracts may specify.	University claims equity in all start-ups using patents on-file at the TLO.	15% off the top for the TLO, and one-third each for MIT, research school and researcher
Oxford	Research Services Office & Isis Innovation	Some overlap between RSO & Isis, and confederate nature of Oxford complicates procedures.	Mixed: spin-offs started as early as 1950s, but Isis Innovation only established in the late 1980s.	Oxford claims all IP created by staff and students. Defines copyright very narrowly.	All personnel must sign Form INV/2 <i>after</i> creating patentable inventions.	Extensive freedom of research & privacy policies; includes full domaining rights.	Business activities strongly restricted, & consultancies subject to approval.	University claims exclusive right to majority interest in all spin-offs.	Sliding scale based on level of revenue. Recipients are Oxford, Isis, Department, & researcher.

Notes: Domaining is the practice of giving up copyright and IP rights to the public domain. Copyright is generally understood to be the right to authorship and exchange of knowledge created in the form of books, articles, film, sound recording, digital storage, etc. Intellectual Property usually refers to claims over the income stream generated by an item of copyright. There is wide variation across universities, however, in how the two concepts are understood, and not all interpretations appear in accord with basic statutory provisions. Finally, research disclosure refers to the practice of declaring a research breakthrough or invention to the relevant university authority.

In all three of the US universities the emphasis is on putting in place an organisational structure that *both* facilitates the scanning of research activity for inventions that should be protected commercially and facilitates industry awareness of the universities' research and teaching capabilities.

What stands out in the US cases examined is the strong formal emphasis placed upon notifying the relevant university office of a possible opportunity for technology transfer. New staff, and even visitors must agree to making this commitment.

The reason for this strong emphasis on notification is to ensure that the university is aware of discoveries that may have practical application outside of the university in order that appropriate IP over that knowledge advance is secured.²² In general, the securing of IP is prioritised because *not* to do so would restrict, or even prohibit, the application of that knowledge advance via commercial means. The chance of being able to transfer a technology for practical application without IP being held by the university is low because the transferee would have little advantage in this transaction.

For example, upon appointment to MIT—whether as a member of staff, a student, or a visitor—all researchers are required to sign a so-called 'Inventions and Proprietary Information Agreement.' This contractual agreement obliges all MIT personnel to: (1) promptly disclose to the Technology Licensing Office any new invention or research breakthrough, (2) promptly complete all documentation required by MIT authorities pertaining to intellectual property developed at the University, (3) prepare and maintain accurate written records of intellectual property developed at the University, and (4) promptly supply any written records as required by various MIT authorities. These requirements *only* pertain to work for hire arrangements, sponsored research agreements, and any targeted research funded by the University.

Similarly, at Stanford, all personnel are required to sign SU-18, the 'Patent and Copyright Agreement for Personnel at Stanford.' This document obliges all staff and students at the University to: (1) disclose to Stanford in a timely fashion—usually 12 months—all potentially patentable inventions and research, and; (2) recognize and abide by all official University policies regarding inventions, patents, licensing, and copyright.

Prior to taking up employment at UCLA, all staff are required to sign a so-called 'Patent Acknowledgment Form.' This form obliges the signatory to: (1) acknowledge potential University title over inventions and research breakthroughs that are made in the course of employment at UCLA, or while using UCLA research facilities, and (2) 'to promptly report and fully disclose the conception and/or reduction to practice of potentially patentable inventions to the Office of Technology Transfer.' Employees' salaries and conditions are linked to fulfilments of these obligations, and non-fulfilment could lead to a loss of privileges and renegotiation of employment contracts.

We could find no evidence comparable disclosure condition at Oxford—although this may exist.

²² This is re-enforced by the provisions of the Bayh-Dole Act, see ARC (2000).

Whilst the US universities studied were very strict about the need for disclosure, they also allowed staff and students to invoke some form of 'free speech' clause or process which allowed the free disclosure of the advance via normal academic channels. The availability of this option supports the proposition that the rationale for strong disclosure conditions is not to directly maximise the revenue to the university—but to ensure that the option exists to engage in technology transfer via commercial channels should this be an appropriate mechanism for technology transfer.

This strategy is therefore compatible with traditional academic activities because it does not restrict technology transfer to commercial avenues. One very interesting feature of US approaches is the emphasis placed upon managing the commercial portfolio as a technology transfer mechanism by ensuring that licenses are being actively exploited. As AUTM stress

To ensure transfer of technology for the public good, nonprofits licensing professionals spend at least as much effort negotiating technology utilization, i.e., diligence terms in the licenses, as they spend negotiating financial terms. Thus, if a technology is not being commercially developed or used, the license may be terminated, freeing up the technology to be licensed to another commercialisation partner.

(AUTM, 1999, p19).

Details of these universities' institutional arrangements can be found on the following pages.

Case Study 4 MIT

At MIT, ultimate responsibility for the commercialisation of research lies with the Office of the Vice President for Research and Dean for Graduate Education, although this office appears to function largely as a formal clearing house for decisions made by well-staffed and well-funded agencies at lower levels. Key decisions on commercialisation generally fall to two main agencies under the Office of the Vice President: the Technology Licensing Office (TLO), and the Industry Liaison Office (ILO). The function of TLO is to oversee the process of technology transfer from MIT to the private sector—largely via licensing and patent sales. The purpose of the ILO is to provide the private sector with the most 'cost-effective and productive way to mine the rich resources at MIT.' In addition to these formal institutions there are a cluster of dedicated commercialisation programs which function to build lasting strategic alliances between the MIT centres of research and outside organisations. The Technology Licensing Office is primarily, although not exclusively geared towards getting MIT researchers up to speed on their copyright and patent entitlements as a prelude to research commercialisation.

The ILO provides a range of services that are the opposite of those offered by TLO. Through the Liaison Office, outside companies can obtain information, step-by-step guidance, and legal advice on the research conducted at MIT, and best to use it.

MIT claims ownership of all IP developed by faculty, students, staff, visitors, and other participants where such IP has resulted from 'the significant use of funds or facilities administered by MIT'. Generally speaking, MIT *does not* construe the use of offices, libraries, machine shops and the like as constituting significant use of MIT

facilities, nor does it construe the payment of salary from unrestricted accounts as constituting significant use of MIT funds.

Disclosure to the TLO is required of all new inventions and breakthrough research which is the outcome of: (1) 'work for hire' type arrangements, (2) sponsored research agreements with organisations outside MIT, and (3) targeted research funds within MIT. On an individual case basis, personnel may seek to challenge these stipulations by applying for a TLO 'waiver.' Any income generated from inventions and research disclosed to the TLO is split as follows: 15 per cent off the top for the Office, and then one-third each for the MIT central administration, research school or department, and researcher(s).

Upon appointment to MIT—whether as a member of staff, a student, or a visitor—all researchers are required to sign a so-called 'Inventions and Proprietary Information Agreement.' This contractual agreement obliges all MIT personnel to: (1) promptly disclose to the TLO any new invention or research breakthrough, (2) promptly complete all documentation required by MIT authorities pertaining to intellectual property developed at the University, (3) prepare and maintain accurate written records of intellectual property developed at the University, and (4) promptly supply any written records as required by various MIT authorities. These requirements *only* pertain to work for hire arrangements, sponsored research agreements, and any targeted research funded by the University. The University *does* claim the right to have equity in all companies established to commercialise those inventions and research breakthroughs on-file at the TLO.

Case Study 5 Oxford University

Institutional arrangements for research commercialisation at Oxford are somewhat opaque because of the loose confederate nature of the University. Oxford colleges and halls are largely self-governing corporations with their own constitutions, property, and sources of income. The central administration acts largely as a coordinating organisation performing a small number of 'public good' type functions.

These arrangements notwithstanding, most commercialisation work generally falls to two central agencies responsible to Oxford University Council. The first of these is the Research Services Office, which is 'responsible for the negotiation and administration of all research grants and contracts held by the University' and functions as 'the University's central administrative structure for all research-related matters.' The other agency is Isis Innovation, a wholly owned subsidiary of the University of Oxford, which aims 'to promote the commercialisation of research ideas generated by Oxford academics and owned by the University.' There is some overlap between these two agencies, but the former has institutional seniority by virtue of its IP screening role (RSO approves assignment of intellectual property to Isis). Day-by-day responsibilities for commercialisation, however, fall to Isis.

Isis Innovation pursues the commercialisation task via two main strategies. On the one hand, it seeks to patent University inventions and find suitable private sector licensees. Isis helps researchers with advice on patenting and exploitation, and provides funding to cover patent applications and legal costs. Licensees are sought using alumni contacts, the 'Oxford Innovation Society,' Oxford Research Online (a

web-based catalogue of University research), press releases, and regular contributions to conferences.

On the other hand, Isis also seeks to exploit the intellectual property of the University by establishing start-up companies using University development capital or drawing on external venture capital funds. This incubator role involves a range of services, including the provision of financial and managerial expertise, office facilities, and the development of business strategies. Isis is currently managing about 100 patents and patent applications and has signed over 25 license or option deals since 1997.

Oxford claims ownership of all intellectual property devised, made, or created by staff in the course of their employment at the University, by persons engaged by the University under contracts for services, and by all students. Where any of the above persons creates intellectual property that is capable of commercial exploitation, he or she must report its existence to the Oxford Research Services Office.

Third, University staff are not allowed to take a proprietorial interest in any spin-off company that arises from their invention or research breakthrough. Further, they are not permitted to have more than 50 per cent equity in any such firm. On both counts the University claims exclusive rights. Finally, subject to the approval of their head of department, academic staff may hold consultancies.

Case Study 6 Stanford University

Facilitating the commercialisation of research at Stanford occurs under the auspices of the Office of the Vice-Provost and Dean of Research and Graduate Policy. Within the Office of the Vice-Provost are three agencies of importance to the commercialisation process: the Office for Sponsored Research, the Office of Technology Licensing, and the Internal Audit Department. The Office for Sponsored Research assists faculty and students to locate research funding from the public and private sectors. The Office of Technology Licensing is responsible for 'managing the intellectual property assets of Stanford University' and technology transfer from the University to private industry. The Internal Audit Department is responsible for financial and managerial oversight across the University, taking a special interest in matters involving contractual obligations between the University and outside collaborators.

Representatives of the Office of Technology Licensing argue that the commercialisation strategy adopted by their agency is unique in the US. There are two facets to this strategy. On the one hand, the Office contracts-out all the routine and/or procedural functions associated with technology licensing and patent applications. While the contractors conduct their work on campus within the Office of the Vice-Provost, the functions they perform are done on a fee-for-service and case-by-case basis by external lawyers and administrators. On the other hand, the Office of Technology Licensing concentrates its effort on marketing Stanford research, liaison with potential and established clients, evaluating collaborative projects upon completion, assessment of new technologies and inventions, and negotiating the best deal for University researchers.

The Office takes a ‘cradle to grave’ approach in its management of licensing deals or collaborative projects and has in excess of 1000 ‘active’ cases on its books at any point in time. It is Stanford’s policy that all rights in copyright remain with the creator unless: the research is a work-for-hire; is supported by a direct allocation of funds through the University for the pursuit of a specific project; is commissioned by the University; makes significant use of University resources or personnel, or is otherwise subject to contractual obligations.

All University personnel are under a ‘timely disclosure obligation’ which requires them to inform the Office of Technology Licensing of any new invention or research breakthrough which might be patentable. The OTL will then proceed to assess the item for patent worthiness, and seek a suitable transfer partner in the private sector if appropriate. Any income stream generated by a successful transfer will be divided as follows: 15 per cent off the top for the Office of Technology Licensing, and of the remaining funds, one third each for the researcher, his/her Department, and the research school.

As a precursor of taking-up employment at Stanford, enrolling in a research degree (or coursework degree with a research component) or taking-up a post-Doc, all personnel are required to sign SU-18, the ‘Patent and Copyright Agreement for Personnel at Stanford.’ This document obliges all staff and students at the University to: (1) disclose to Stanford in a timely fashion—usually 12 months—all potentially patentable inventions and research, and; (2) recognize and abide by all official University policies regarding inventions, patents, licensing, and copyright. Staff and students at Stanford are not subject to the provisions of SU-18 and associated University policies if they choose to exercise a basic right of open public disclosure. This is a free-speech caveat in the University’s regulations which means that personnel can publish or present their findings at a conference with the express intent of giving up their copyright and IP privileges to the public domain.

Case Study 7 University of California at Los Angeles

Research commercialisation at UCLA broadly falls under the purview of the Office of Research Administration, which is directly responsible to the President of the University. Beneath the Office of Research Administration are two offices with linked functions; they are the Office of Contract and Grant Administration and the Office of Technology Transfer. The former is responsible for all matters germane to the income and expenditure of research funds at UCLA.

The Office of Technology Transfer (OTT) is responsible for ‘assisting members of the faculty and staff in patenting and licensing inventions and in working with industry in support of the University’s education, research, and public service mission.’ It is the UCLA’s gatekeeper for University-corporate collaboration and the real focus of research commercialisation. The OTT has a dual-pronged strategy for achieving its primary organizational task. On the one hand, it targets Faculty members with a multifaceted toolkit offering suggestions on: how to acquire industry involvement and funding for research projects, how to apply for patents and copyrights, and how to broadly manage the commercialisation process. Advice ranges from hands-on practical advice to more technical and legal concerns.

The OTT also seeks to reach out to the private sector with: information on the UCLA’s research strengths, advice on how to find and communicate with relevant

University staff and students, and advice on how to manage a variety of industry-University interactions (from complex joint projects to simple purchases of technology). Office consultants are on-hand to deal with any major query. The Office for Technology does not seem to be designed for directly establishing a start-up company or performing incubator-type operations. The emphasis is on facilitation.

While patent and licensing procedures at UCLA have a long history dating back to the early 1940s, the current OTT is the outcome of a UCLA administrative report handed down in 1994. Based on a variety of experiences with industry liaison, the report recommended that technology transfer activities be researcher/faculty/laboratory centred, and that central University administration only maintain control of policy development, legal oversight, and advisory functions. It was felt that this would facilitate a more flexible and appropriate response to TT projects, and free-up the Office to concentrate on strategic issues.

The university claims exclusive rights, title and interest in those inventions and research breakthroughs which *might be readily patentable* (i.e. not all research outputs). UCLA researchers who suspect their invention or research breakthrough might qualify for a patent are obliged to disclose the item to the Office of Technology Transfer within a reasonable period. If, thereafter, the item is successfully commercialised and generates an income stream, income is divided as follows: 35 per cent to the researcher(s), 15 per cent to the researcher's department/centre/faculty, and the rest to the University.

Prior to taking up employment at UCLA, all staff are required to sign a so-called 'Patent Acknowledgment Form.' This form obliges the signatory to: (1) acknowledge potential University title over inventions and research breakthroughs that are made in the course of employment at UCLA, or while using UCLA research facilities, and (2) 'to promptly report and fully disclose the conception and/or reduction to practice of potentially patentable inventions to the Office of Technology Transfer.' Employees' salaries and conditions are linked to fulfilments of these obligations, and non-fulfilment could lead to a loss of privileges and renegotiation of employment contracts.

The US universities have developed policies and procedures for handling research commercialisation that reflect a long history of close industry-academic associations, relative freedom to move between academia and industry over a professional career, and a strong public interest motive that prioritises technology transfer over research commercialisation.

The approach in US universities is therefore an outcome of a long history of co-evolution in which universities and industry have interacted and learned, via trial and error, to work to mutual advantage across a broad spectrum of commercialisation activities. This process has been taking place since the early years of the twentieth century (and in some cases prior to that).

The emphasis on start-up firms in the US, unlike in Australia, is the consequence of recognising the special circumstances under which start-ups are the best means of research commercialisation. This is demonstrated by the better balance between start-up activity and other forms of research commercialisation.

In Australia, the emphasis on start-up firms tends to reflect a more complex situation in which the narrower spectrum of research commercialisation activity,

particularly in the form of interactions between existing firms and researchers, is partly driven by low industrial R&D investment levels and associated S&T capabilities. There are fewer opportunities to build links with existing firms and for staff to move between these firms and academia, hence the greater reliance on start-ups for research commercialisation.

In the following sub-section we consider the lessons derived from these case studies for organising research commercialisation business processes.

4.4 A generic business process framework for research commercialisation

The preceding discussion of arrangements for handling technology transfer and research commercialisation in this and the previous chapter have highlighted the importance of effective business processes within universities. These case studies examined have also revealed that different universities approach these arrangements in different ways and with different motives. Given this diversity, and the underlying importance of business process effectiveness in handling research commercialisation we have developed a prototype generic business process framework via which universities can calibrate their own processes.

Key elements of this framework have already been identified in our discussion of current policies, practices and procedures in Australian universities in Chapter Three. These are:

- Commercialisation readiness;
- Scanning research activity to identify potential IP;
- Option selection;
- Option evaluation;
- Negotiation of appropriate commercialisation and protection regimes;
- Management of the commercial portfolio.

We have translated these concepts into a general business process framework based upon the identification, evaluation and selection of *options* for possible commercial exploitation. This framework is loosely based upon the 'stage-gate' approach used very effectively to manage industrial innovation processes, (Cooper, 1990). The rationale for the stage-gate process is that a sequential series of risk-reduction investments are required in which clear option selection decisions are made. These selection processes are essential to the effective commercialisation of research because they involve weighing up the *relative* commercial potential of the different options under consideration within the context of the organisation's capability to finance the commercialisation process and exploit its rewards.

The following table identifies these key activities involved in research commercialisation from this business process perspective. The larger table on the following page provides more detail on the inputs, outputs and constraints relevant to these business processes. The commercialisation process is treated as a flexible process of scanning for options, developing these options and selecting the most

promising options for commercial exploitation. The framework has two basic phases, an option development phase and an option exploitation phase.

Table 4 Business process framework—summary view

Phase	Stage
OPTION DEVELOPMENT PHASE	COMMERCIALISATION READINESS: Maintaining records that are compliant with possible future IP requirements
	SCANNING & REPORTING: Identifying commercialisation opportunities arising from research and/or external business requirements.
	OPTION CREATION & PROVISIONAL OWNERSHIP: Selecting commercialisation opportunities for formal evaluation as options.
	<i>COMPARATIVE OPTION EVALUATION: Evaluating options in terms of cost-risk-return probabilities.</i>
OPTION EXPLOITATION PHASE	OPTION SELECTION: Selecting options with the best return on investment probabilities
	FULL OPTION OWNERSHIP: Securing intellectual property over the commercial options (includes secrecy-based forms of IP).
	OPTION EXECUTION: Translating an option into a closed deal
	MANAGEMENT OF THE COMMERCIAL PORTFOLIO: Maintaining the commercial exploitation of university-developed IP

The option development phase involves four main business processes: commercialisation readiness; scanning and reporting; option creation and provisional ownership, and, comparative option evaluation. Of these, comparative option evaluation, in which different options are assessed in relative terms with respect to their commercialisation potential does not currently feature in Australia. This is because the small scale commercialisation activity limits the need for such a selection process. As the number of commercialisation options increases the need to select between them on a basis of cost-risk-return relationships will be expected to increase.

The option exploitation phase has four processes: option selection; full option ownership; option execution and the management of the commercial portfolio. As the commentary on US approaches stressed, the management of the commercial portfolio includes diligence activities aimed at ensuring that university developed IP is exploited in practice.

This framework is offered as a potentially useful device for understanding the problems and constraints faced by universities and the strategies that they are developing to deal with these problems. It also provides a checklist against which universities can assess their own performance in research commercialisation in business process terms, and thereby develop the basis of benchmarking.

Table 5 A Generic business process framework for the university research commercialisation process

Phase	Stage	Inputs	Activities	Outputs	Resource Requirements	Constraints
OPTION DEVELOPMENT PHASE	COMMERCIALISATION READINESS Maintaining records that are compliant with possible future IP requirements	Day-to-day research activities	Time spent on routine documentation of the research process - records to be compliant with possible future IP requirements	Records of invention sequences, lab books, data files etc.	Minimal - mainly a question of researchers' time allocation and degree of organisation	Cultural hostility to 'managerialism' and 'commercialism' by researchers.
	SCANNING & REPORTING: Identifying commercialisation opportunities arising from research and/or external business requirements.	Research findings matched to either new or existing commercial opportunities	Voluntary or compulsory notification on inventions with commercial potential. Plus, less formal communications externally.	Invention disclosure documents and/or tacit knowledge of emerging commercial opportunities	Minimal, main emphasis is on intra-university communication and communication with external organisations	Antipathy towards engagement in commercial activity. Poor information on market opportunities.
	OPTION CREATION & PROVISIONAL OWNERSHIP: Selecting commercialisation opportunities for formal evaluation as options.	Commercialisation opportunities from SCANNING process	Assessments of patentability, including patent database searches. Provisional patent protection. Experimental development & proof-of-principle development	Qualitative information on relative suitability for exploitation. Provisional patents.	Low but significant. Effectiveness rests strongly on nature and extent of previous experience of subsequent stages. Funding for provision patenting.	Funding for proof-of-principle. Poor knowledge of competitive market intelligence.
	<i>COMPARATIVE OPTION EVALUATION: Evaluating options in terms of cost-risk-return probabilities.</i>	<i>Preliminary business case from option creation stage.</i>	<i>Development of quantitative formal business case proposals involving technical feasibility studies, market research, industrial partner identification etc.</i>	<i>Quantitative cost-risk-return estimates &/or supporting qualitative information</i>	<i>Significant to major funding required to generate technical risk assessments, market forecasts etc.</i>	<i>Technical expertise and funding for developing a formal business case for investment.</i>
OPTION EXPLOITATION PHASE	OPTION SELECTION: Selecting options with the best return on investment probabilities	Formal business case from option evaluation stage.	Decisions about which business cases to proceed with.	Comparative investment evaluations	Minimal	Lack of experience in decision-making and of long term outcomes of previous decisions (i.e. feedback)
	FULL OPTION OWNERSHIP: Securing intellectual property over the commercial options (includes secrecy-based forms of IP).	Records of invention sequences, lab books, data files etc from COMMERCIAL READINESS	Securing of IP (if not already achieved)	Full patents.	Significant to major funding for legal and technical expertise & patent fees etc.	Funding for full patent protection.
	OPTION EXECUTION: Translating an option into a closed deal	Long-term IP protection from option ownership stage.	Execution of partnership/licensing deals or new business formation processes	Legally binding agreements, new legal entities.	Significant funding for legal and commercial expertise.	Capacity of expert commercialisation professionals to work on deals given other commitments
	MANAGEMENT OF THE COMMERCIAL PORTFOLIO Maintaining the commercial exploitation of university-developed IP	Commercial activity	Defence of IP, life-cycle support for start-up firms etc	Patent infringement prosecutions etc	Substantial financial resources required	Difficulties in financing the protection of IP.

4.5 Approaches to research commercialisation—a basis for best practice

A review of the existing on university research commercialisation arrangements literature, notably Howells and McKinlay (1999) and CVCP (1999), has allowed us to develop the following four archetypal *configurations* based upon university *motives*, *business process organisation* and degree of *engagement* (i.e. linkages) with the business sector.

Isolation configuration

This configuration involves a mix of deliberate and unintentional impediments to technology transfer and research commercialisation that result in little or no linkages between university activities and the business sector. As Howells and McKinlay (1999) stress many old European universities were restricted by governments from involvement with industry and other 'outside interests'.

Technology-transfer configuration

This configuration is dominated by public interest-driven motives for technology transfer and research commercialisation. These motives are under-pinned and enabled by strong *indirect* private sector financial support via donations. This gives universities discretionary control over the private sector funding. Direct revenue generation for the university is not the prime motive for research commercialisation, although long-run indirect revenue generation may well be a motive for technology transfer.

Passive commercialisation configuration

This configuration is dominated by licensing activity and a passive attitude to exploiting commercial opportunities. If commercial opportunities arise from research then the university has procedures for facilitating this. However, the university does not actively seek to either encourage a greater incidence of opportunities or to modify the universities operating environment in order to facilitate technology transfer and research commercialisation.

Pro-active commercialisation configuration

In this configuration the university actively seeks to both encourage a higher level of research commercialisation via internal business processes and can actively seek to modify its operating environment via creating a constituency of start-up companies able to inter-act more effectively with the university in the future.

In practice any university will comprise a 'fuzzy' mix of all four configurations, particularly when considered at departmental and faculty levels. However, there is compelling evidence that strong biases exist across universities in the configuration that they seek to place themselves in.

Universities traditionally pursued an isolation configuration based upon European principles dating back to the Middle Ages. Industry dis-satisfaction with the isolation paradigm during the 19th century and early years of the 20th century, notably in the USA, led to both new types of university being created, e.g. MIT in the US and Manchester in the UK.

In addition, existing universities being subjected to, often subtle sometimes less subtle, industrial pressures to provide technology transfer via significant financial donations. The eventually led to the formation of the technology transfer paradigm—most clearly expressed in the USA because of the prevalence of private universities in the elite echelon of the higher education system.

The transition from the *isolation configuration* to the *passive commercialisation configuration* is more a feature of state-funded and controlled universities in Europe, and the UK in particular, again as a result of industrial dis-satisfaction with the *isolation configuration*. The reliance upon (declining) government funding is, more recently, leading to the evolution of the *pro-active commercialisation configuration* via a recognition of the nature and significance of the impediments that exist in *the passive commercialisation configuration*.

The account that we propose consequently identifies two evolutionary paths stemming from the same source—the isolation configuration—and paths largely determined by the role of government in the higher education sector. If this interpretation is correct, and it should be treated as a hypothesis at this stage, then those Australian universities in the passive commercialisation paradigm would be expected to migrate to the pro-active commercialisation paradigm due to well-understood financial pressures and the need to create a business environment in which they can operate in a symbiotic way.

'Best practice' in arrangements for research commercialisation cannot ignore these contextual factors—including differing national circumstances. Consequently it is logical to treat best practice as a *match* between national circumstances and university motives, policies and procedures in the sense that the two sets of factors *co-evolve* over time. Co-evolution is an interactive process in which developmental trajectories impact upon each other *via learning-by-doing*

In effect, to use the basic approach recommended in the Wills Review, creating a *virtuous cycle* of academic-industry-government interaction, is a crucial policy objective. However, there is more than one type of virtuous cycle that can be created and the appropriate type of virtuous cycle is largely determined by national circumstances.

It follows that best practice should be treated as the extent to which university policies and procedures *match* national circumstances at a given time (static effectiveness) *and* help to create a co-evolution dynamic that will improve the situation in the future (dynamic effectiveness). Recognising the dynamic effectiveness dimension is particularly important because optimising static effectiveness may, in some situations, harm dynamic effectiveness.

In this analytical context the implication is that Australian universities are better off migrating to, and developing, the *pro-active commercialisation configuration* because this configuration addresses weaknesses specific to Australia. Namely, a lack of learning-by-doing in research commercialisation and the lack of an external

industrial constituency with which the university is able to build a wide spectrum of linkages.

The elite US universities covered here (MIT, Stanford, UCLA) and Oxford in the UK do not prioritise the 'scanning' process because researchers are more likely to be attuned to identifying possible options for commercial exploitation. The type of integrated and distributed scanning capacity found in the University of Queensland and the University of Melbourne can be seen as a compensation mechanism for differing national circumstances. We have heard anecdotal evidence that several other Australian universities are exploring the distributed scanning capacity avenue.

The interesting policy question is: will some universities in the pro-active configuration eventually seek to shift into the technology transfer configuration, in effect substituting indirect commercial revenue for direct commercial revenue?

On the basis of our analysis such a shift could take place if the enabling conditions were to occur. To be specific, the development of an industry base able to link effectively with universities and which saw greater benefit in *indirectly funding* universities than in *direct funding* project-by-project funding.²³ Indeed, such a situation might be one, perhaps unanticipated, consequence of the virtuous cycle in effective operation.

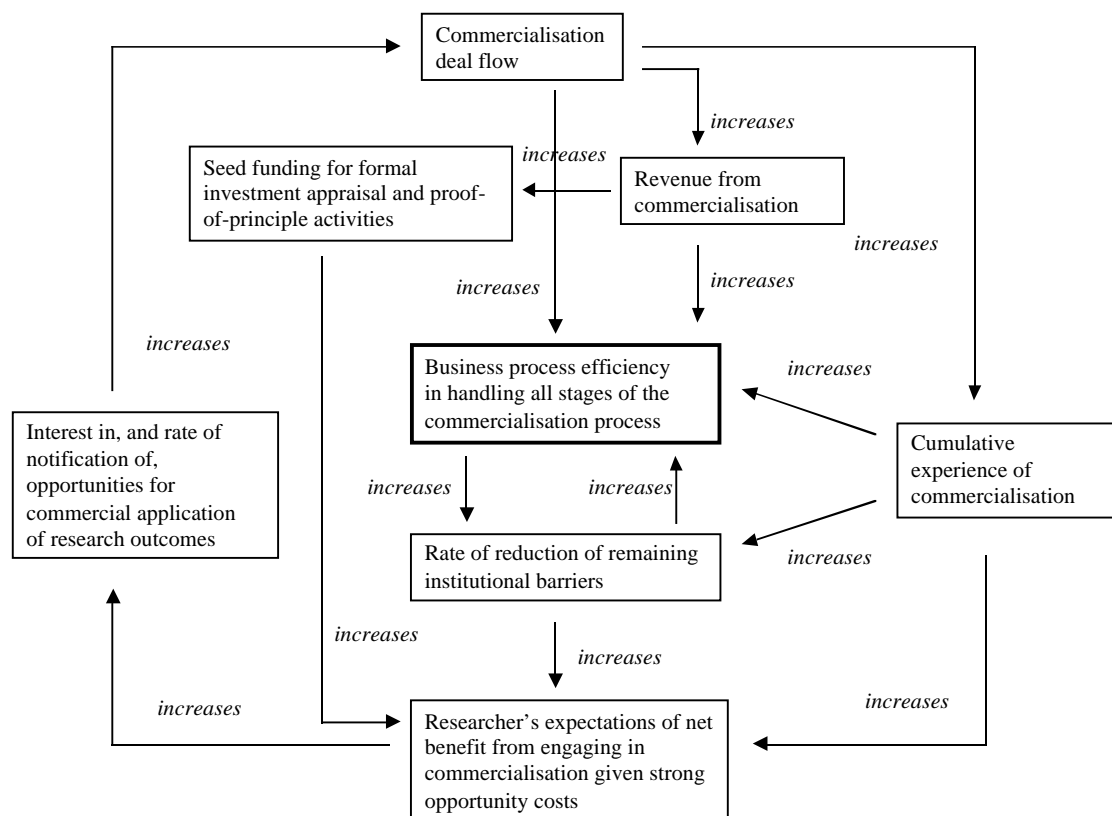
²³ From an industrial perspective there are benefits in supporting universities via general donations because the (often costless or low cost) technology transfer that occurs means that the business risk for specific commercialisation projects is reduced via a 'portfolio effect'. This is because the risks can partially cancel each other out when they are inter-dependent and not dealt with on a discrete basis. This portfolio effect can increase the amount of linkage activity to mutual benefit because each individual opportunity for technology transfer need not be scrutinised because it involves lower direct costs.

4.6 Learning-by-doing in research commercialisation

US universities have built up a substantial amount of organisational experience in handling technology transfer—reflected in their 'symbiotic' relationship with industry. The role of learning by doing in enabling universities to participate in the virtuous cycle is outlined in the figure below. This process incorporates the positive effects of using revenue from commercialisation activities to invest in key aspects of the commercialisation process—generating additional gains in efficiency and effectiveness.

Figure 5 The learning-by-doing and re-investment process

The role of learning-by-doing in enabling universities' participation in the virtuous cycle



This study has revealed that the process of learning-by-doing may be severely impeded by shortages of funding for 'proof-of-principle' and for subsequent investments that produce commercially viable propositions. Not only may this block specific ventures; it may also limit the beneficial learning-by-doing process that will eventually improve *business process efficiency*.

As we have already observed there is anecdotal evidence that there are serious impediments to research commercialisation arising from *business process inefficiencies*, i.e. the way in which research commercialisation arrangements are handled in practice. These business process inefficiencies can introduce an expectation

amongst researchers that the commercialisation process will be time-consuming, stressful, and 'not worth the candle'. As such, it may only damage their core research output. This fear can constitute a major barrier to research commercialisation.

This anecdotal evidence emerged both from interviews held when preparing the Australian case studies and from the on-line submissions process. Some selected, anonymous quotes from textual submissions are provided below. *These quotes should be read bearing in mind the 'health warning' that submissions were only made by people seeking to express negative views of the effectiveness of the current arrangements- though recognising that the positive aspects have been stressed in our case study profiles.*

Edited submissions from academic researchers:

I have had a small taste of the IP process at both an Australian and a US university. In both instances, the main outcome so far has been substantial setbacks to my research and to my career, with key publications delayed by substantial periods, significantly affecting my ability to attract grant funding. In both cases, the IP process was imposed upon me. At present, I would not choose to go the route of IP through a university if at all avoidable or recommend that anybody else did so. My experiences involved basic scientific research but discussions with clinicians suggest their experiences are similar and that many also choose to by pass university business offices wherever feasible. They are often better positioned to do this than basic science researchers.

In my experience with IP in an Australian university, the university's main interest has not appeared to be commercialization as the leading goal. Instead it has been to secure IP for the university, with endeavours towards subsequent commercialization virtually nonexistent, and amateurish and haphazard when they did occur.

Lack of initiative taken by technology transfer companies to make contact with researchers. For example, in the last 12 months, I would have had about 24 visits from salesmen who take time to make an appointment with me, turn up on time, and discuss their wares professionally. Even if they only make a small sale, they continue to keep in touch personally. In the same period, I have had no similar encounters with <deleted> apart from two or three newsletters encouraging me to 'get in touch if I think I have a good idea'. I have registered a broad range of skills in their consultancy register, but have heard nothing more. There needs to be more emphasis on technology transfer companies actively looking for opportunities to do research, and then bringing together a team of researchers who can tackle the problem. All this seems to argue for a different role of technology-transfer companies, and the like. The staff must have a good understanding both academic and commercial imperatives, the respect of both, and the ability to seek out and find the areas of common interest. The companies would need to be more active in identifying needs in the market, and in contacting researchers.

Edited submissions from an industrialist:

The biggest problem I have encountered within universities comes from the business offices rather than the researchers. Most researchers I talk with daily, wish to commercialise their research and are willing to learn how to do so. The Business offices are generally pretty good with the exception of a couple. I believe

the problems I see are mostly due to a lack of funding I think that they are often understaffed and cannot compete with commercial companies for good staff. The pay cuts to take a university appointment are prohibitive for most people working in industry. Problems I have encountered for example include; phone calls and emails that are not returned, requests for information where I was told in effect to get it myself. These less professional actions discourage commercial organisations. I believe that universities should establish specialised business units within schools that coordinate and provide a professional service. The units need to be funded adequately and need to employ highly experienced staff. Each school could then also hold equity with the university in a company designed to hold the IP developed from within the schools.

These inefficiencies can, to a large extent, be attributed to the relatively recent growth of research commercialisation activity in Australian universities—in other words to a lack of cumulative experience in handling these complex processes. As cumulative experience increases, particularly in launching start-up companies, the business process efficiency can be expected to increase, thus adding to the virtuous cycle sought in the Wills Review recommendations.

The government's recent announcement of the Biotechnology Innovation Fund specifically targeting the proof-of-principle funding problem in the bio-medical area is therefore an important step forward in enabling the virtuous cycle.

4.7 Summary and conclusions on emerging practices

This chapter has shown that the diversity evident in different Australian universities' approaches towards research commercialisation can be understood in the context of a period of experimentation over how best to approach the research commercialisation challenge. By examining the characteristic approaches in the US within the context of the different national circumstances we have been able to highlight a significant emerging trend in Australian approaches. This is to create the conditions under which the university can have a 'symbiotic' relationship with industry by the university creating the necessary constituency of high-tech start up firms with which it can have such a relationship in the future.

Universities in other countries are pursuing a similar strategy, particularly in the UK. What appears to be distinctive about the approach in Australia is that the scanning and reporting of commercialisation options is being actively facilitated by universities distributing experienced professionals throughout Faculties. This is an effective means of compensating for a lack of learning-by-doing in commercialisation amongst Australian researchers—and may constitute a best practice approach for facilitating research commercialisation in Australia that directly addresses Australian problems.

5. Summary and conclusions

The starting point for this study was the Wills Review's finding that there may be institutional barriers to the involvement of researchers in new business enterprises, specifically in relation to holding equity, directorships and moving between academia and industry.

Such barriers generally appear to be less of an issue in universities than for government research organisations. However, the dominance of universities in performing health and medical research in Australia is so great that the overall national impact of such barriers in the health and medical area may be greater than that of government research organisations.

Australian universities face a relatively unique challenge when attempting to facilitate research commercialisation in the medical area because their world-class science coexists with a less technically capable domestic industrial base. This is a very different situation than in the United States and in the leading European economies, which possess technically sophisticated multi-national firms able to interact more easily with university researchers.

By far the dominant form of research commercialisation in Australian universities is via contracted research and consultancies, for which there are well-developed management processes. However many institutions are increasingly keen to generate revenue via other avenues for research commercialisation, and are putting in place processes, and targeted funding, to facilitate them. As a consequence performance and revenues are undoubtedly rising.

5.1 Structural constraints

This study has found that, in general, the policies and procedures in Australian universities do not constitute direct barriers to researcher involvement in research commercialisation:

- while holding equity is still relatively rare, there are few if any formal prescriptions against it; however some universities are, in practice, cautious given bad experiences;
- the holding of Directorships generally requires the approval of the Vice-Chancellor, but is normally granted; however policies do not address the specific situation of start-up companies;
- there is little explicit consideration of mobility between academia and industry to support research commercialisation, though general policies do provide for such possibilities;
- the financial incentives for commercialisation activities largely rest in the prescribed royalty return to the inventor, which varies somewhat between universities; university promotion policies allow such performance to be taken into account, though the evidence is that the weighting attached is often small;

- intellectual property policies are largely common across universities, based on the assumption that the predominant mode of commercialisation, after consultancy and contract research, will be via licensing. They do not address the issues of start-up companies;
- there is, in general, a paucity of information of any great detail made generally available to university staff about opportunities for involvement in business enterprises. Researchers who approach their commercial arm will normally be assisted, but on the basis of variable expertise.

To conclude, across the university sector, regulations concerning research commercialisation are largely common. However practice varies considerably. This can largely be attributed to different levels of expertise, the extent of encouragement for entrepreneurialism, and resources available to support research commercialisation.

Formal institutional barriers to research commercialisation are few, and in practice can be bypassed. However, that does not imply that there is a well-developed path to research commercialisation, where the researcher is actively assisted and guided to overcome each hurdle along the way. Other substantial impediments exist.

5.2 Other impediments

The most severe impediments to research commercialisation are funding for 'proof of principle' and the availability of time to engage in research commercialisation given research, teaching and administrative burdens.

The finding on proof-of-principle finding is in accord with the earlier recognition of the low level of investment in the experimental development component of R&D. Available mechanisms are largely adequate for advancing an idea through the proof of principle process. The key investment stages where funds of the order of \$100-500 thousand can be required, often under considerable time pressures, are not catered for either in the commercial market, or through Government schemes.

With regards to the time available to devote to research commercialisation, this reflects a common theme that academics are too stretched by their teaching loads, their research, and the many administrative requirements, to find the time to engage in the demanding and time-intensive processes of research commercialisation.

Other substantial barriers are access to external investment for subsequent commercialisation activities (eg venture capital), the monopoly operations of the university commercial arm and the insufficient share of rewards resulting from university policies.

The removal of these impediments would apparently have the effect of encouraging a more 'rounded profile' of research commercialisation activity, with more activity in all commercialisation avenues, particularly through new ventures. This would be likely to lead to beneficial flow-on effects that would play an important role in improving university-industry interactions in Australia.

5.3 Business process efficiencies

One constraint that appears to operate in all universities is the low level of business process efficiency in handling research commercialisation procedures and decisions. This is driven partly by the lack of cumulative experience gained from previous research commercialisation activities and partly by the tensions caused by the need for university administrators to operate in a new, more business-like environment than has been the case in the past.

These business process inefficiencies can introduce an expectation amongst researchers that the commercialisation process will be time-consuming, stressful, and with uncertain, possibly meagre, returns. In this view, involvement with research commercialisation may only serve to impede core research output. This fear can constitute a major barrier to research commercialisation.

These business process inefficiencies can, to a large extent, be attributed to the relatively recent growth of research commercialisation activity in Australian universities—in other words to a lack of cumulative experience in handling these complex processes. As cumulative experience increases, particularly in launching start-up companies, the business process efficiency can be expected to increase, thus adding to the virtuous cycle sought in the Wills Review recommendations.

In order to assist in the achievement of greater business process efficiencies in research commercialisation, a 'business process framework' has been developed, which identifies eight steps, or 'stages'. The commercialisation process is treated as a flexible process of scanning for options, developing these options and selecting the most promising options for commercial exploitation.

This framework is offered as a potentially useful device for understanding the problems and constraints faced by universities and the strategies that they are developing to deal with these problems. It also provides a checklist against which universities can assess their own performance in research commercialisation, and develop the basis of benchmarking.

5.4 Performance of Australian universities in research commercialisation

It is very difficult to provide anything like an adequate scorecard of Australian university performance in research commercialisation. Universities have not collected, or made these data readily available. The competition between universities, and university commercial arms, has probably provided the biggest obstacle to establishing better measures of performance.

With regard to start-up companies, on the basis of some broad assumptions, it can be deduced that about one-third of technology start-ups in Australia in 1997 originated directly from universities. This might be viewed as quite a reasonable performance. The only strong conclusion that can be drawn is that the rate of formation of technology-based start-up companies arising from university research, and their visibility, is increasing.

An assessment was made of current university performance against the generic business process framework:

Commercialisation Readiness—most universities do not employ procedures and protocols that provide the necessary information base for substantiating IP claims, and facilitating due diligence searches.

Scanning—most universities place responsibility on the researcher for identifying and reporting potentially commercialisable research. Many commercial arms operate in essentially a passive mode. The pool of potentially exploitable research in Australian universities is probably substantially greater than that being disclosed.

Option Creation—some universities have codified their selection procedures, others rely on ad hoc procedures. Best practice would appear to lie in establishing clear, codified procedures.

Option Evaluation—there is evidence of a relatively clear 'pecking order' of performance by university commercial arms. This is correlated strongly with the capabilities of the chief executive, particularly their industrial and commercialisation experience.

For many universities, the pool of commercialisable research is not sufficiently large to be effectively managed. Under these circumstances the arrangement whereby each university has its own commercial arm is highly inefficient from a national perspective. There would seem to be a good case for encouraging the removal of effective monopoly rights of university commercial arms.

Negotiation of appropriate commercialisation and protection regimes—considerable experience appears to have been developed in this area, though as it is a competitive field, the leading edge is continually advancing. There is a corpus of experienced IP evaluators and negotiators, though not sufficient to allow every university to have one.

Management of the commercial portfolio—universities have developed, to varying extents, the capability to manage a portfolio of licences. However there is much less experience in managing the stages of development of start-up firms.

However, assessment of the performance of Australian universities in research commercialisation needs to recognise the very considerable extent of experimentation and change which has occurred over the past 1–2 years.

These can be seen as a response to the new conditions of the global knowledge economy, the emergence of global markets for research, the dramatically growing value of technology-based companies, and the greatly increased availability of venture and other forms of capital to invest in research-originated technologies and companies.

These include:

- a greater emphasis on commercialisation through start-up or spin-off companies;
- decentralised mechanisms for research commercialisation;
- transfer of ownership from the institution to the inventor;
- abolition of monopoly in commercial arm operations; and
- direct provision of capital

The outcomes of these various changes are yet to emerge. However, they clearly signal a recognition of the significance of new approaches to research commercialisation.

5.5 An approach to best practice in research commercialisation

Effectiveness in commercialising university research is determined by a number of factors that characteristically interact in complex ways. Many of these factors relate closely to national-cultural circumstances that influence the role of universities in the national economy. Other factors depend on general cultural attitudes.

'Best practice' in arrangements for research commercialisation cannot ignore these factors. Consequently it is appropriate to treat best practice as a *match* between national circumstances and university motives, policies and procedures in the sense that the two sets of factors *co-evolve* over time. Co-evolution is an interactive process in which developmental trajectories impact upon each other *via learning-by-doing*

In effect, to use the basic approach recommended in the Wills Review, creating a *virtuous cycle* of academic-industry-government interaction is a crucial policy objective. However, there is more than one type of virtuous cycle that can be created and the appropriate type of virtuous cycle is largely determined by national circumstances.

Therefore, in order to provide an appropriately contextual basis for the assessment of best practice, four distinct 'configurations' or approaches to research commercialisation by universities have been identified:

- *Isolation configuration*—a mix of deliberate and unintentional impediments to that result in little or no linkages between university activities and the business sector.
- *Technology-transfer configuration*—dominated by public interest-driven motives, under-pinned and enabled by strong indirect private sector financial support.
- *Passive commercialisation configuration*—dominated by licensing activity and a passive attitude to exploiting commercial opportunities as they arise.
- *Pro-active commercialisation configuration*—the university actively seeks to encourage a higher level of research commercialisation via internal business processes and to modify its operating environment by creating a constituency of start-up companies able to interact more effectively with the university in the future.

The last of these is seen as particularly appropriate for the Australian situation, in which there is not a strong industry structure with which the universities can interact. Returns from a licensing strategy are ultimately limited by the dearth of potential licensors. Alternatively, a strategy to commercialise through new ventures, while carrying higher risk, offers the possibility of greater long-term returns **and** the gradual development of an industry base symbiotically related to the university.²⁴

²⁴ A similar finding is reached in ARC 2000, which was released after this report had been prepared in draft.

5.6 Policy implications

The main policy implications to emerge from this study are that sufficient funding should be provided for proof-of-principle activities in order to remove a major impediment to the operation of the effectiveness of the commercialisation learning-by-doing process within universities.

This learning process is already under-way and is leading to innovative approaches to handling research commercialisation, particularly in the integration of the scanning of research activities for possible commercial application into everyday university activities. The improvements in business process efficiency that this learning process will produce, in turn, should stimulate greater researcher interest in commercialising their research.

The strategy of generating an increased number of start-up firms in the bio-science field will significantly help to improve universities' business 'constituency' by producing cohorts of growing science-based firms better equipped to interact with universities across a broad spectrum of channels. This may include the capability for greater mobility of staff between industry and academia. This 'co-evolution' of university and industry capabilities promises to be a major pay-off to universities' current commercialisation efforts.

Government should therefore consider the adequacy of the level of funding available for proof-of-principle work against requirements, particularly in relation to the likely net public benefits to Australia of capacity-building in research commercialisation in the health and medical area.

Given the need to reduce uncertainty over the availability of funding for the commercialisation process there is a strong case for examining new approaches to providing such funding. New approaches could be based on overdraft facilities or rapidly obtained loans rather than grants designed to reduce the uncertainty and time lags in funding availability. The leverage provided by the organisational learning process we have highlighted is likely to generate a significant public benefit relative to the cost of such support.

In addition, the lack of time available to researchers to engage in research commercialisation is a major constraint. There is a challenge to Government to provide adequate resources to allow this crucial activity to proceed, and to universities to seek to arrange their constrained resources in ways that support those researchers capable and active in research commercialisation.

Appendix A

Terms of reference

Objectives

The purpose of this study is to:

- 1) Investigate the issues relevant to university researcher involvement in new business enterprises including barriers to researcher involvement in new business enterprises and, in particular, ability to hold equity, accept directorships and move between academia and industry; and
- 2) Examine existing and emerging practices, nationally and internationally, in order to identify best practice models which could then be promoted to the higher education sector as a whole. The use of case studies and examples is encouraged.

Issues

In conducting this study, the consultant is expected to:

- Provide an overview of international best practice in university researcher involvement in new business enterprises;
- Identify institutional structures and processes which may facilitate or act as impediments to researcher involvement in new business enterprises;
- Examine financial and other incentives, including opportunities for promotion, which may enhance involvement in new business enterprises;
- Describe any impact on staff mobility, either beneficial or detrimental, caused by increased opportunity to participate in new business activities;
- Consider the relevance of Intellectual Property policies of universities; and
- Describe the level of information available to university researchers about opportunities for involvement in business enterprises.

Appendix B

Survey methodology and results

Methodology and procedures used

The on-line survey form contained the following components:

- A section designed to capture basic information on the respondent such as name, institution etc.
- A section designed to capture information on the extent of experience in research commercialisation in terms of the: research areas, target industry sectors; number of relationships to date; personal financial outcomes, and financial outcomes for the research team/laboratory.
- A section designed to capture information on the appropriateness of a range of different research commercialisation avenues and to assess whether current impediments to research commercialisation affect the preferred commercialisation avenues.
- A section designed to capture information on the relative strength of key impediments to research commercialisation.

The on-line form used can be found at:

<http://aamcdb.anu.edu.au/policyintelligence/>

The following table lists the research commercialisation avenues used in the on-line submission form.

Table 6 Research commercialisation avenues used in the submission form

-
- Licensing of IP by direct deal with existing firm
 - Licensing of IP by deal mediated by university commercialisation arm
 - Contract or collaborative research for an existing firm
 - Consultancy advice for an existing firm
 - New joint venture involving an existing firm
 - New independent start-up with university equity investment
 - New independent start-up without university equity investment
-

Contract and collaborative research (the former involving risk born by the contractor and the latter involving shared risk), and consultancy work were

included because these can be important channels for research commercialisation/technology transfer.

The following table contains a list of the impediments to research commercialisation used in the on-line form.

Table 7 Impediments considered

Administrative

- 1 University regulations—constraints to taking up directorships
- 2 University regulations—constraints to holding equity
- 3 Limits to commercialisation activity caused by the University technology transfer office's monopoly over intellectual property deals
- 4 Uncertainty and confusion over University policies and whether or not they actually have to be followed.
- 5 University employment contracts
- 6 Superannuation practices
- 7 University promotion & staff retention criteria
- 8 Time available for research commercialisation given research, teaching and administrative burdens

Financial

- 9 General availability of funding for post-research activities such as 'proof of principle' and securing IP that are pre-requisites for significant commercial investment
- 10 Access to external investment funding for subsequent commercialisation activities (eg by Venture Capitalists)
- 11 Uncertainty about future government Research and Development funding availability
- 12 Insufficient share of financial rewards when the IP is owned by the University

Legal infrastructure

- 13 Lack of legal capability in the University to secure intellectual property within required lead times
- 14 Lack of legal capability in the University to secure intellectual property effectively
- 15 Insufficient general capability in Australia to rapidly secure defensible IP
- 16 Insufficient general capability to defend IP in order to obtain economic advantage

Cultural

- 17 Perceptions by research colleagues that commercial activities compromise academic reputation
- 18 General antipathy in Universities towards commercial activities stemming from research
- 19 Pressure from the University to secure intellectual property via patenting irrespective of the nature of the technology or the stage at which its development is at

Experiential

- 20 Insufficient previous personal experience of research commercialisation given the level of tacit knowledge required
 - 21 Insufficient collective experience of commercialisation within the University given the level of tacit knowledge required
 - 22 Insufficient access to external advisers with practical experience of commercialisation
 - 23 Insufficient information available on basic commercialisation practices and procedures to offset a lack of personal experience
-

These impediments can be distinguished in terms of their *causality*. The *administrative* and *financial* impediments are, in a sense, independent variables in the sense that they block the learning-by-doing processes that determine the levels of the *legal infrastructure, cultural* and *experiential* impediments—the dependent variables.

This framework consequently allows us to distinguish between impediments that can be expected to reduce via learning-by-doing and the impediments that restrict the extent of learning-by-doing. It is the latter type of impediment that policy can, and should, focus on reducing or removing.

Submission process

Once completed the data collected via the form was sent electronically to a database file for immediate analysis. Where necessary, the facility existed for respondents to be invited to re-examine their answers in order to deal with any problems and/or missing replies.²⁵ This was been done in cases where there were missing values in the data-set.

The form was been designed to allow both university staff to respond *and* people in other sectors who may wish to submit their views on the problems faced within universities. The rationale for this is that commercialising university research often involves research collaborators or commercial partners in organisations in other sectors, notable the CSIRO, CRCs, private-non profit research organisations and of course business enterprises.

Notification of the existence of the on-line submission form was been achieved by:

- Email messages to senior university staff. In most cases PVC/DVC (Research) and/or Directors of Research Offices. These messages requested that the recipient forward the message to relevant people in the University.
- An information sheet handed out those who attended the series of Biotechnology Australia IP management seminars.
- An emailed letter sent by the acting CEO of the NHMRC to all universities, and also to other research organisation alerting people to the existence of the study and the on-line submission process.
- Contacting the CSIRO.
- Emailing the CEOs, or equivalent of relevant CRCs.
- Arranging for the Australian Society of Medical Researchers (ASMR) to email all their (1100) members about the study and the on-line form.
- Arranging for the National Association of Research Fellows of the NHMRC to email all their (183) members.

²⁵ This involves entering a serial and PIN number in order to access and modify the data on the database server.

- Contacting the Directors of university research commercialisation firms/offices via an email message.
- Emailing the 1095 people who either made a submission to the Wills review, or commented on the draft report, for whom email addresses were available.

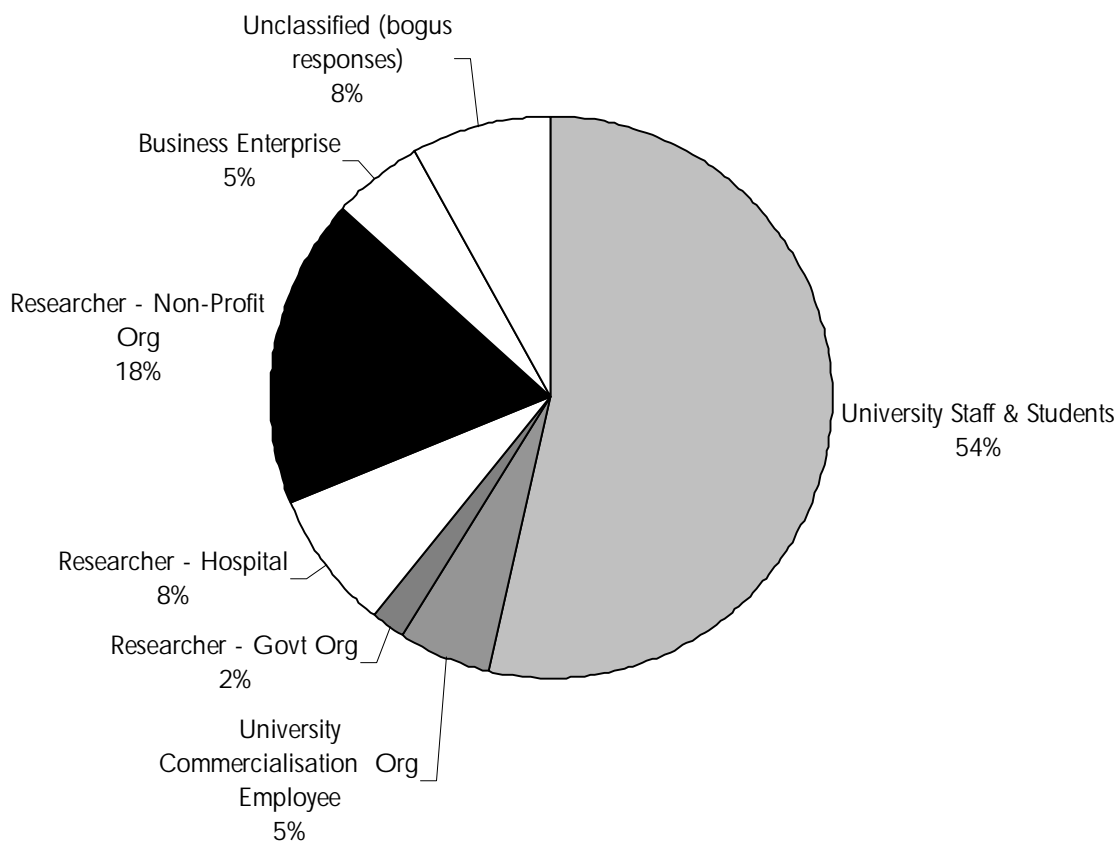
Attempts were also made to arrange for the Licensing Executives Society Australia and New Zealand (LESANZ) to email their members about the on-line submission process, and for a reference to the submission process to be made in a communication to those in the National Innovation Summit email list. However, in these cases it did not prove to be possible to do this within the required time frame.

Response obtained

As of 12 July 103 useable responses (out of 113 in total) have been received via the on-line form and 14 longer textual submissions from researchers who have completed the form. The results discussed below are based upon the 103 useable responses available for analysis.

The following pie chart shows the breakdown of these responses by the sector of the respondent.

Figure 6 Sectoral breakdown of responses



Just over half the responses are from university staff & students (primarily staff with a few graduate students). There have been six from staff in university research commercialisation arms. Responses from people outside of the higher education sector are dominated by researchers in the private non-profit sector and from researchers in hospitals.

The data-set has been analysed with respect to sectoral location as two groups of respondents:

- university staff & students, and;
- staff from university research commercialisation arms and all other respondents.

This division of the sample allows the characteristics of the responses from each sector to be compared in order to identify differences between the two sub-samples.

Three factors seem to be responsible for the current response rate:

- *general awareness*: the senior university staff contacted initially have not forwarded the message in many universities;
- *time constraints*: the period available for raising awareness, and for making a submission given other commitments may be too short (particularly as awareness takes time to increase within universities);
- *low levels of researcher interest*: the number of researchers with an active interest in research commercialisation may be low relative to the total number of researchers in relevant research fields.

Findings from consultations and submissions

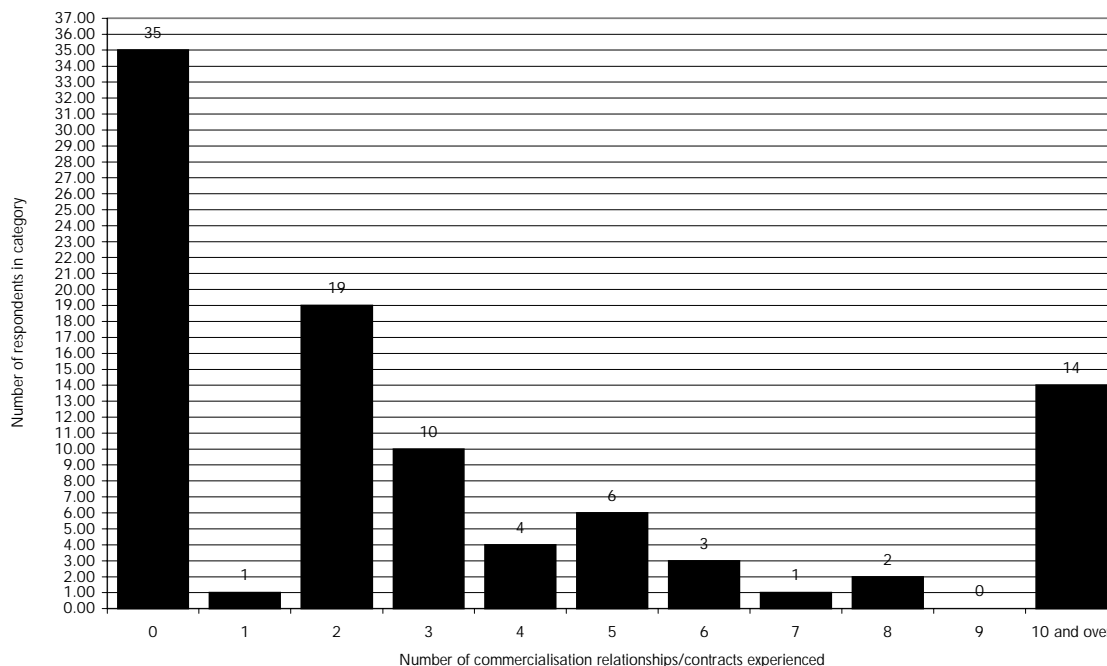
The following pages contain data not presented in the main body of the report.

Levels of experience and commercial outcomes achieved

Levels of experience in research commercialisation are an indication of the level of tacit knowledge of these issues held by the respondents.

The following graph shows the variations in the extent of experience of research commercialisation across the sample, as measured by the number of commercialisation relationships or contracts engaged in to date.

Figure 7 Experience in terms of numbers of commercialisation relationships



Note: based on 103 submissions from a total sample of 113.

There were a large number of respondents (35) with no experience of actual research commercialisation relationships or contracts, and the extent of experience (measured in these terms) drops off fairly rapidly—though with 14 respondents being involved in ten or more relationships.

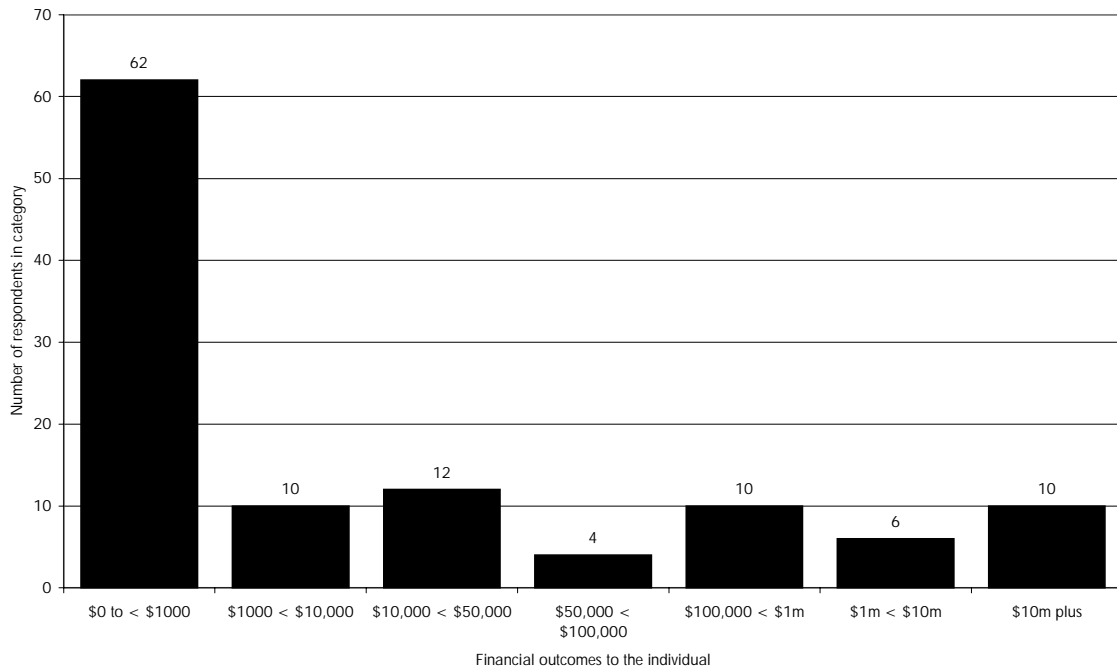
This implies that the views expressed on preferred research commercialisation avenues and the various impediments to research commercialisation are not, in general, based upon extensive experience *throughout the sample*, but nevertheless 68 out of 103 respondents who gave answers here (66 per cent) do have some experience of research commercialisation.

Financial outcomes from research commercialisation activities

The submission form requested information on two aspects of the financial outcomes from research commercialisation activities: the value to the individual and the value to the team or laboratory under that individual's direction.

The results obtained are shown in the following two graphs.

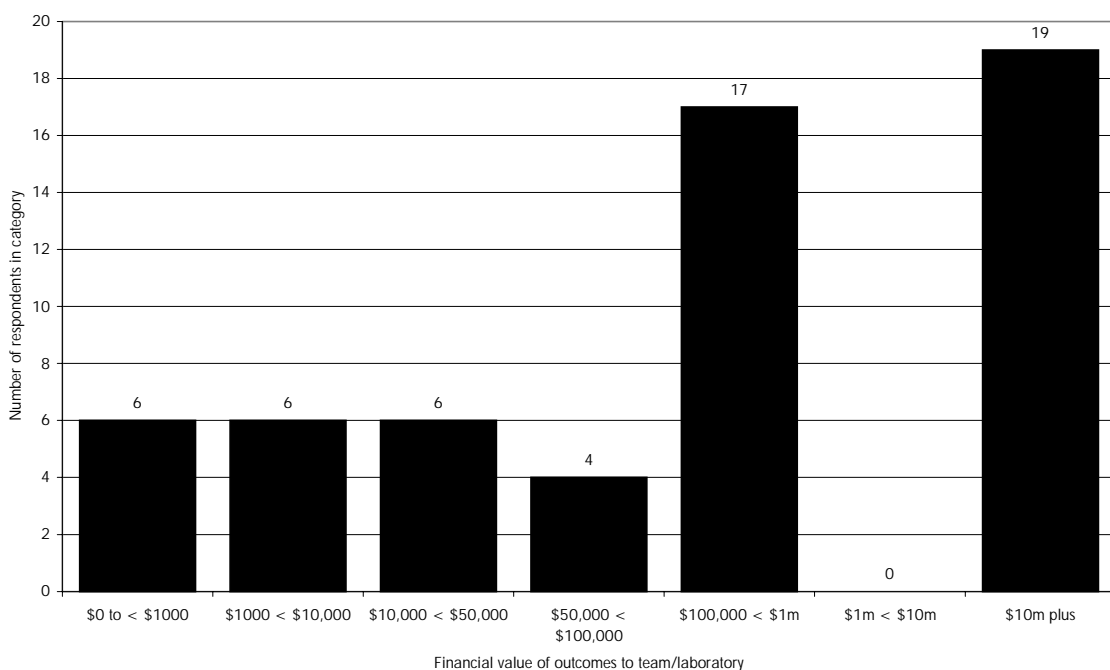
Figure 8 Commercial outcomes for the individual respondent



Note: based on 103 submissions from a total sample of 113.

With respect to the value of financial gains to the individual researcher, and setting aside the relatively large number of zero gains associated with no actual commercialisation experience, there is a reasonably even spread of gains across the specified financial ranges.

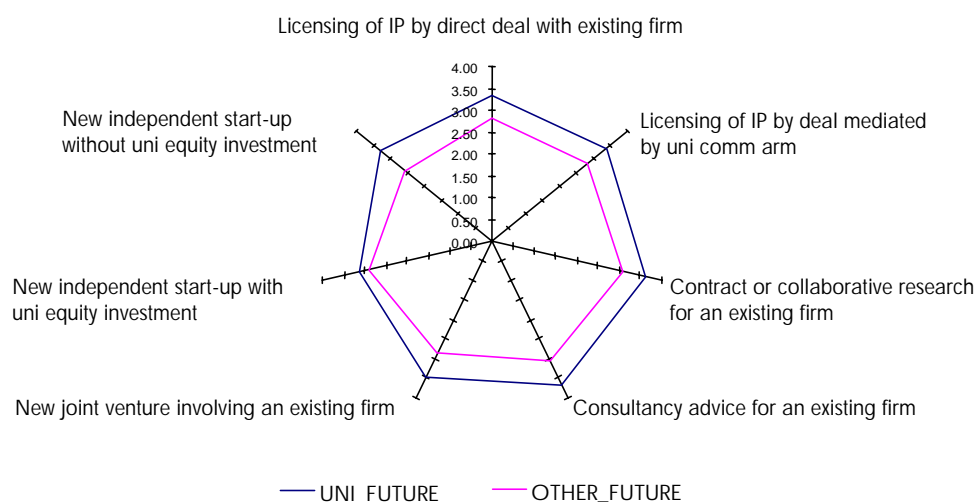
Figure 9 Commercial outcomes for the team/laboratory under the respondent's direction



Note: based on 103 submissions from a total sample of 113.

Turning to the financial gains to the team/laboratory under the direction of the respondent we see that 36 respondents had been associated with securing financial gains of over \$100,000 for their research groups.

Figure 10 University and non-university perceptions of the impact of impediments compared



The two sub-samples broadly agreed on the effect of removing current impediments to research commercialisation and were in most agreement over new independent start-ups *with* a university equity investment.

Note on the impact of university regulations

It is noteworthy that university regulations concerning the holding of directorships and equity, a problem highlighted in the Wills Review, do feature as significant impediments. This finding appears to contradict the view expressed by senior university staff (who set such policies) that these are not major impediments.

We obtained more information on this issue by contacting the 32 respondents who had given a significant score (of 3 or above) to these two impediments.²⁶ 15 respondents (just under half) replied within 24 hours and their responses allowed us to clarify this issue.

It turns out that these impediments were given significant scores as much because there is general dissatisfaction with the 'business process' efficiency with which universities handle a wide range of commercialisation matters as specific constraints caused by rules and regulations.

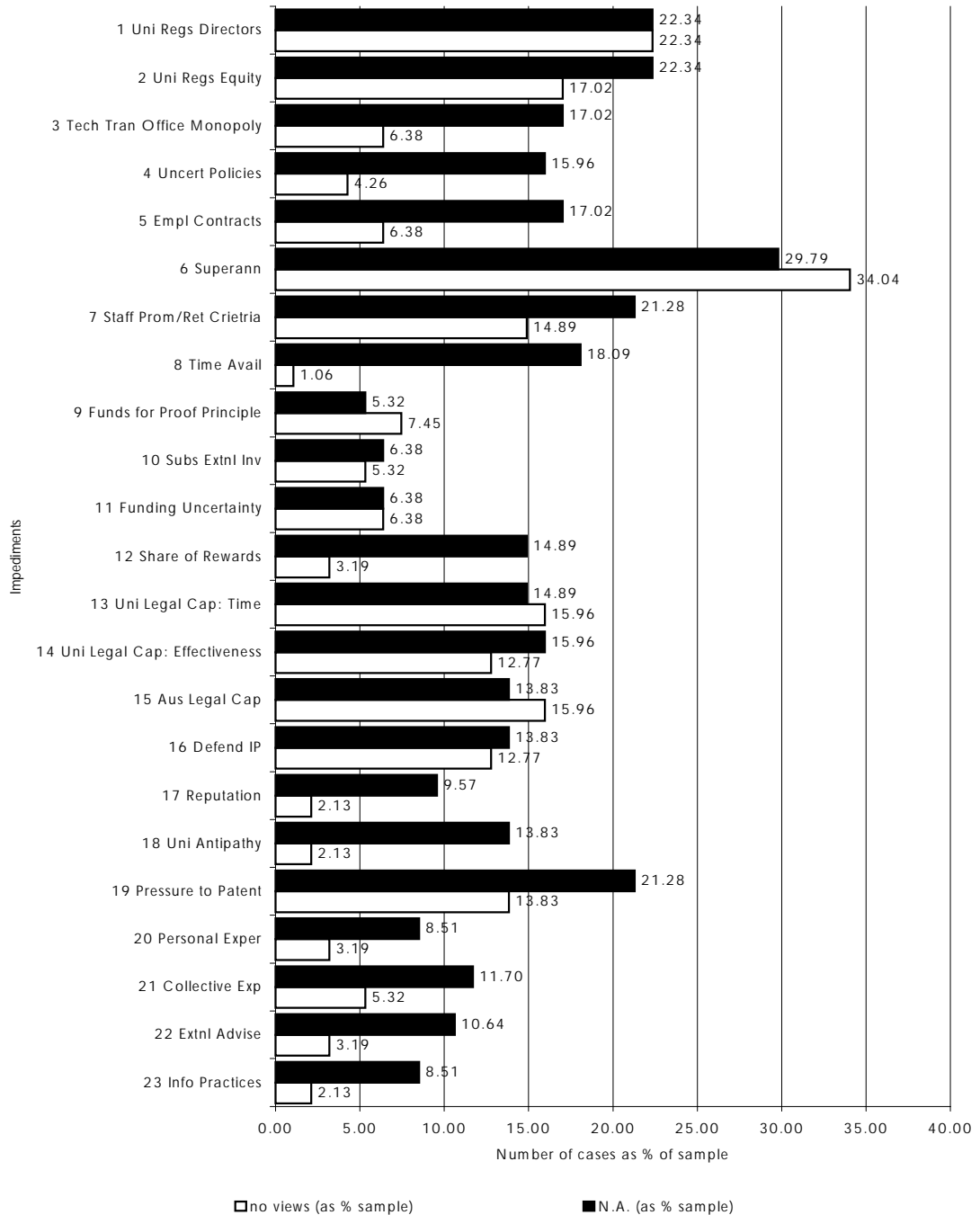
Levels of knowledge and the applicability of different impediments

It is worth considering the incidence of 'no view' and 'not applicable' responses for each impediment because this tells us something about the level of knowledgeability of these issues and the prevalence of the various impediments.

²⁶ This was done via an email message.

The incidence of 'no view' and 'not applicable' responses is clearly grasped in the following bar chart.

Figure 11 Percentage incidence of 'no view' and 'not applicable' responses for each impediment



These figures show that *superannuation policies* stands out both in terms of non-applicability and no view being expressed. University regulations over holding directorships and equity exhibit relatively high incidences of low knowledgeability and non-applicability.

Appendix C

List of interviewees

Interviews with the following informants capable of providing an informed view of the state of, and structural constraints on, the commercialisation of university research in Australia:

Professor Paul Alewood, IMB, The University of Queensland

Professor Warwick Anderson, former Chair, Research Committee, NHMRC

Dr Peter Andrews, Director, Centre for Drug Design and Development and Institute for Molecular Bioscience, The University of Queensland

Professor Jim Angus, Department of Pharmacology, School of Medicine, The University of Melbourne

Dr Claire Baxter, Manager, Business Liaison Office, The University of Sydney

Dr John Bell, former CEO, Anutech

Ms Anne-Marie Birkhill, General Manager—Operations, UniQuest Pty Ltd

Professor John P Coghlan, College of Health Sciences, The University of Sydney

Mr Andrew Davies, UniQuest Pty Ltd

Dr Roger Drinkwater, General Manager, Zenome Ltd

Ms Ros Engeldow, Director Research Policy, AVCC

Dr David Evans, CEO, UniQuest

Professor John Furness, Department of Anatomy & Cell Biology, The University of Melbourne

Professor Ashley Goldsworthy, CEO, BHERT

Professor Paul Greenfield, DVC, The University of Queensland

Dr Kate Grenot, MD BCP Investment Pty Ltd

Professor Stephen Harrap, Department of Physiology, The University of Melbourne

Mr David Henderson, General Manager—Technology Commercialisation, UniQuest Pty Ltd

Dr Carrie Hillyard, MD, Bionetworks Pty Ltd and Director, Cooks, Myer & Co

Mr Alan Jones, ISR

Ms Ene Juurma, Executive Manager, Australian Business Health Services

Mr Robert Klupacs, CEO Monash Institute for Reproduction and Development (ex AMRAD)

Professor Richard Larkers, Dean, Faculty of Medicine, The University of Melbourne

Professor Frank Larkins, DVC (Research), The University of Melbourne

Professor Stephen Leeder, Dean, Faculty of Medicine, The University of Sydney

Dr Ian Mair, CEO, CRC for Advanced Composite Structures

Professor Jane Marceau, PVC (Research), UWS

Professor Colin Masters, Department of Pathology, The University of Melbourne

Professor Jim McCluskey, Department of Microbiology & Immunology, The University of Melbourne

Philip Mendes, Adviser on Technology Law to UniQuest Pty Ltd

Dr Graham Mitchell, Foursight Associates (formerly Eliza Hall and CSL)

Professor Paul Rossiter, PVC (Research) Curtin University of Technology

Professor Vicki Sara, Chair, ARC

Mr Don Scott Kemmis, Biotechnology Australia, ISR

Professor Marilyn Sleigh, Dean, Faculty of Life Sciences, The University of NSW

Ms Gillian Turner, CEO, UniSearch, UNSW

Dr John Turner, CEO, Flinders Technologies, Flinders University

Professor Dick Wettenhall, The University of Melbourne

Ms Claire White, Counsellor, ARC

Mr Peter Wills, CRI and Chair, Wills Committee

Appendix D

Interview pro-forma

Removing barriers to research commercialisation in the health and medical areas

University-based case studies

5/6/00

Professor Ron Johnston
Executive Director
Australian Centre for Innovation
Faculty of Engineering, University of Sydney,
NSW 2006

Tel: (02) 9351 3934
Fax: (02) 9351 3974

rj@aciic.eng.usyd.edu.au

Dr Mark Matthews
Director
Policy Intelligence Pty Ltd
PO Box 3725, Manuka, ACT 2603

Tel: (02) 6269 8913
Fax: (02) 6249 0267

mark.matthews@policyintelligence.com
www.policyintelligence.com

Overall aims of the study

- To assist the Wills Review Implementation Committee to develop policy recommendations regarding research commercialisation in Universities by identifying any remaining barriers to research commercialisation
- To provide Universities with better information on domestic and overseas best practice in handling arrangements for research commercialisation

Scope of the study

The study covers all research fields that have the potential to be commercialised in the health and medical areas.

Nature of the overall study

The overall study involves:

- consultations with senior University staff over strategies and problems;

- the collation and analysis of information on different Universities policies and procedures for handling research commercialisation (both in Australia and overseas);
- documenting cases of good (and bad) practice within Australia;
- soliciting submissions from researchers on preferred commercialisation avenues and on the relative strength of different impediments to research commercialisation—an on-line process has been set-up to do this, see www.policyintelligence.com/willsimplem.html

The Australian case studies

The purpose of the Australian case studies to provide information on the strengths and weaknesses of current arrangements for handling research commercialisation within Australia.

Interview notes

General

Institutional issues

- *policies and perspectives* towards the role of research commercialisation in the University's mission;
- *rules and regulations* relevant to research commercialisation;
- the *specific strategies* developed to implement these policies;
- the *organisational structures and resources* utilised;
- the *outcomes* achieved to date
- remaining *challenges* and *solutions* being developed.

Good examples

Not so good examples

Analytical issues

- the range and significance of the different *commercialisation avenues* used (including the impact of any impediments on the preferred commercialisation avenues);
- the *range of technologies* being commercialised and the relationship with preferred commercialisation avenues;

- *cumulative institutional experience*—the extent of 'learning-by-doing' in research commercialisation and its impact upon the current probabilities of success in commercialisation;
- the impact of *country-specific factors* (eg. risk aversion in the finance sector, low levels of business R&D expenditure/technology capability)

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