

**Business, Higher Education
And Innovation
Institutions for Engagement in a
Mode 2 Society**

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Forethought

A little Learning is a dang'rous Thing;
Drink deep, or taste not the Pierian Spring:
There shallow Draughts intoxicate the Brain,
And drinking largely sobers us again.
Fir'd at first Sight with what the Muse imparts,
In fearless Youth we tempt the Heights of Arts,
While from the bounded Level of our Mind,
Short Views we take, nor see the lengths behind,
But more advanc'd, behold with strange Surprise
New, distant Scenes of endless Science rise!
So pleas'd at first, the towring Alps we try,
Mount o'er the Vales, and seem to tread the Sky;
Th' Eternal Snows appear already past,
And the first Clouds and Mountains seem the last:
But those attain'd, we tremble to survey
The growing Labours of the lengthen'd Way,
Th' increasing Prospect tires our wandering Eyes,
Hills peep o'er Hills, and Alps on Alps arise!

An Essay on Criticism
Alexander Pope, 1688-1744

Abstract

This thesis explores the nature and extent of interactions between higher education institutions and industry in the production and utilisation of industrially relevant knowledge. These relationships are explored in the context of the institutional development of the higher education sector as it goes through a process of industrialisation, and in the changing way in which businesses access, acquire, and utilise knowledge in the management of their innovation processes.

It is argued that the relationships between higher education institutions and business are best understood in terms of *engagement*, and the form of engagement can be based on community, organisational or market relationships. Under these forms of engagement, knowledge can be shared, managed or traded between institutions.

The concept of engagement is closely related to the concept of mode 2 knowledge production, where knowledge is created in the context of its application. Mode 2 knowledge, which is trans-disciplinary in orientation and directed towards the resolution of problems, differs from mode 1 knowledge which is dominated by academic and disciplinary agendas and is focussed on explanation of phenomena.

Over the last five years the concept of a mode 2 society has been used to support the notion of a convergence between the institutions of higher education, industry and state, with each taking on the characteristics of the other (the “triple helix” view). The argument of this thesis is that the idea of convergence not only suffers from a conceptual weakness, it is also inappropriate in that it compromises the ability of institutions to achieve high levels of performance in relation to their foundation purposes. In fact, the efforts of higher education institutions to operate as businesses in a commercial environment have been largely unsuccessful and major problems have emerged in relation to the integrity of their missions relating to teaching and research when this has been attempted. Similarly, businesses have not embraced the contribution of higher education institutions to industrial innovation.

There have, however, been substantial developments in the way in which higher education institutions *engage* with businesses. These changes reflect institutional developments *within* higher education and industry in terms of the way in which academic knowledge is created and business innovation is managed.

The thesis argues that relationships between higher education and industry are themselves institutionally driven, and the concept of a mode 2 society can be best understood in this institutional context. These institutions are evidenced in *organisations* that are formed at the interface between higher education institutions and businesses, and in *markets* for knowledge. The way in which knowledge is shared in a community setting is, it is argued, also institutionally driven and reflected in knowledge communities.

It is the development and operation of these institutions of engagement that give effect to the emergence and development of a mode 2 society. A focus on institutions of engagement also identifies the importance of capacity and capability building in the management of knowledge organisations (for example, cooperative research centres), intermediaries in the market for knowledge (for example, early stage venture capital investors) and leadership in knowledge communities. These issues also suggest new directions and approaches to public policy in promotion and support for the knowledge economy.

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Foreword

This work reflects the culmination of many years of thinking about the transfer of research results into practical application. In addition to the research undertaken specifically for the project, it draws on knowledge and experience gained in numerous research and consulting assignments undertaken for government agencies and non government organisations.

Initial interest in the project was stimulated with a consulting assignment completed for the Australian Research Council (ARC) undertaken in 1999 and published as *Mapping the Nature and Extent of Business-University Interaction in Australia* (Howard 2001a). In undertaking that work it was felt there was a need to look behind the observed relationships and identify how and on what basis interactions occurred.

The interest was further stimulated through a number of other assignments undertaken for the Australian Government relating to the commercialisation of publicly funded research (Howard, *et al.* 2001a), the activities and performance of Australian venture capital investors (Howard 1998a, 2002d), and the management of cooperative research arrangements (Howard 2003b). These projects were undertaken against a background of many years as a practising management consultant, advising public and private sector organisations on management strategies for innovation (Howard and Johnston 2001a, 2001b). Running through this work has been a constant theme that “management matters” and its importance had been given insufficient attention in the design of public programs. This view was sharpened in the Review of the Administration of the Natural Heritage Trust – a \$1.5 billion natural capital repair program (Howard 1999).

The background material for this work draws heavily on the vast literature on management strategy, business innovation and the disciplines of organisation theory and finance as well as reports and papers prepared for clients. Where possible and appropriate that material has been sourced and referenced. In reviewing the business literature and undertaking research for client projects it became apparent that there was very little mention of university-business interactions and relationships and the role of science and technology in the business innovation literature or in the design and implementation of public programs. By contrast, discussions of the knowledge economy, reflected in new growth theory, the science and technology management literature, and official reports and papers, point to a critical role of higher education institutions as creators of industrially relevant knowledge.

Something seemed to be amiss. There appeared to be a significant divergence in the thinking about innovation as seen by business and government program managers, and innovation seen by the science and technology community. Moreover, policy discussions about business-university relationships have tended to be conducted in terms of linear or looped processes where information and knowledge is communicated (transferred) between one institutional setting to another through various channels – or “pipes and wires”. A great deal of analysis and policy prescription has been focused on removing blockages in these electronic or hydraulic metaphors and advocating that something be done to ensure that knowledge is communicated. Many of these initiatives have been based on strategies of “telling” people about what should be done, and “selling” an idea, technology, or discovery. By contrast, the literature in business innovation focuses on market opportunities, product development, process (including supply chain) improvement, and customer response.

In undertaking the reviews and assignments referred to above, very little evidence could be found that strategies of telling and selling actually worked. An underlying premise in management theory is that communication has not occurred until it has been *received* (Drucker 1988). In this regard the most effective forms of communication are through consultation and engagement (Munter 2000). This issue was explored in detail in an assignment for a client on communication strategy, structure and resources (Howard 2002f). It followed, therefore, that the relationships between institutions in the area of science and innovation (that is, industry, higher education, and government) could be better understood on the basis of *engagement* and that engagement itself was institutionally driven. Those institutions could be based on the features of markets (where knowledge is traded) organisations (where knowledge is managed) and community (giving and sharing). Exploring these relationships forms the major focus of this thesis.

There has also been a view, coming mainly from institutional sociology that institutional issues may actually be of little long term relevance as institutions are converging – that is, beginning to look like each other by taking on each others characteristics. However, in looking at developments and patterns of change within the institutions of higher education, business, and government, there is very the idea of convergence must be viewed with a great deal of caution. This observation is based on the reality of fundamental differences in the underlying purposes of higher education, business, and government institutions.

There are many reasons for trying to ensure that institutions *do not* start to look like each other – having regard to both purpose and the way in which performance is assessed.

However, institutions need to be able to interact in order to capture the opportunities that stem from a knowledge based economy. These opportunities arise at the institutional interface. This thesis is an endeavour to untangle these issues and to develop a model of *institutional engagement* that provides a basis for understanding the way in which knowledge is transferred and how the processes can be improved.

The structure provided by higher degree enrolment has provided focus for the work and provided a rationale for placing thoughts and ideas in a framework and developing that framework as a model that represents the forms of engagement between higher education institutions, businesses and government. The opportunity to interact with colleagues in an academic environment and to discuss ideas that would not otherwise receive much interest or attention in a commercial setting as a practising management consultant has been particularly valuable.

This work has been prepared with the guidance of Professor Ron Johnston, Executive Director of the Australian Centre for Innovation and International Competitiveness at The University of Sydney. Ron is an internationally acknowledged expert in the field of knowledge management and science and innovation policy. Ron's contribution has not only been in the area of academic guidance, comment and advice but also in encouragement to see the venture through. In this he has exhibited a remarkably high level of tolerance, forbearance, patience, and above all, an enduring friendship.

The incentive to undertake the work would not have been provided without the assistance and support provided by the Faculty of Engineering in granting a HECS scholarship for the duration of the project.

There are a number of people in the Australian Government Departments of Industry, Tourism and Resources, Education, Science and Training, and Agriculture, Fisheries and Forestry, and the Australian Research Council, Knowledge Commercialisation Australasia and State Departments of Innovation and Economic Development who have provided assistance and support for this project in the course of tender processes and during consultations and interviews through responses to thoughts and ideas over the last five years. The thesis has benefited from this form of engagement, but the findings and recommendations of the assignments have also been informed by the overall context of the work for this thesis.

Undertaking a project such as this whilst having to generate a commercial income creates a great deal of pressure on family. Many aspects of what for many would be a normal family

life, disappear. Not only has Anne Howard accommodated this abnormality in personal relationships, she has also provided continual support and encouragement. She has acted as a sounding board for ideas and has commented on the logic of many of the arguments. She has also had to endure my habit of thinking as I talk at all sorts of odd times – day and night. To many this would have been immensely dull and tedious, but Anne's interest and commitment to ensuring that the ideas do not float away has been the motivation for completion. Anne's dedication and ongoing commitment to the enterprise – not only in relation to this project but also in relation to many others over the years – creates a level of appreciation that will be impossible to reciprocate.

Some elements of the thesis have been published in articles, monographs and reports either in my own name or as part of reports I have researched and written for clients under the name of my consulting business (Howard Partners) over the last three years. These are listed below:

2003: "Evaluation of the Cooperative Research Centres Programme". Department of Education, Science and Training: Canberra.

"Commercialisation Discussion Paper". Knowledge Commercialisation Australasia: Sydney.

2002: "Evaluation of the New Industries Development Program". Department of Agriculture, Fisheries and Forestry: Canberra.

2001: *Mapping the Nature and Extent of Business-University Interaction in Australia*. Canberra: Australian Research Council.

"Partnering For Policy." *Canberra Bulletin of Public Administration*, 99, pp. 50-56.

2000: "Case Studies of Innovation in the Agri-food Industry." Department of Agriculture, Fisheries and Forestry: Canberra. Published as *Recipes for Success*.

Papers published in collaboration with Professor Ron Johnston:

2003: "Engagement in an Era of Industrialisation," in *The Idea of Engagement: Universities in Society*. Svava Bjarnason and Patrick Coldstream eds. London: Association of Commonwealth Universities.

Best Practice Processes for University Research Commercialisation. Canberra: Department of Education, Science and Training.

2001: "Study to Support the Development of a National Food Industry Strategy - Management Capacities and Culture." Department of Agriculture, Fisheries and Forestry: Canberra

"Securing Our Manufacturing Future: Small Business Manufacturing to 2015 and Beyond." Small Business Development Corporation: Sydney.

Chapter 1. Introduction and Overview

The purpose of this thesis is to propose an institutional model of engagement between higher education institutions, business organisations and government agencies. The model draws on the framework developed by Michael Gibbons (Gibbons 2003; Gibbons, *et al.* 1994) and an extensive body of knowledge of management practice in the tradition of Peter Drucker (Drucker 1985, 1993a, 1993b), institutional sociology, particularly in the works of Richard Scott Paul, Paul DiMaggio and Walter Powell (DiMaggio 2001b; Powell and DiMaggio 1991; Scott 2001), and the strand of organisation theory that originates in the works of Herbert Simon (Simon 1965) and James March (March and Simon 1958).

The need for a model arises from shortcomings in existing representations of the relationships between higher education institutions, businesses and government in the formulation, implementation and review of public policy relating to the knowledge economy. Of particular concern is the relationship between scientific discovery and technological innovation carried out in a higher education environment and the discipline of innovation executed in a business environment. Existing representations provide valuable frameworks, but do not explain the way in which linkages, interactions and relationships form, operate and become sustained.

These relatively unsophisticated representations of relationships between higher education and industry have limited the scope and depth of policy debates and program initiatives. They have, for example, attempted to push higher education institutions down a track of research commercialisation which may put at risk their basic missions in teaching and research and potentially undermine and compromise their core values of scholarship and learning. Similarly, there is an expectation that businesses should commit to a greater use of the outcomes of higher education research. This is not to say that higher education institutions do not have an important role in this area; rather that role must be able to accommodate and protect the distinctive features and characteristics of the institution.

There are many frameworks that endeavour to represent the process of transformation of scientific discovery into commercial application. Some of these represent a “linear flow” between the community of science and the world of business where products and services are manufactured, marketed and sold to customers. The frameworks are useful in that they draw attention to *what* happens along the way in terms of linkages, but are of little assistance in explaining *how* transformations take place. Most frameworks identify “gaps” in the process and suggest interventions to overcome them. The most commonly advocated intervention is finance to start a new technology based business.

In a series of papers Etkowitz and colleagues have developed the concept of the *triple helix of university-government-industry relations* (Etkowitz and Leydesdorff 2001). They argue that it is no longer the case of considering university-industry linkages to achieve commercial outcomes, and university-government relations addressing investment in research and education. Rather, the three are not only converging but are now in continuing dynamic interaction, reshaping each other. The same argument has been developed in different directions to identify the emergence of a new model of the university – emerging from the research university to a more commercially oriented entrepreneurial university.

The entrepreneurial university is seen to be a result of the working out of an inner logic of academic development that previously expanded the academic enterprise from a focus on teaching and research to generating income from commercial activities. The internal organisation of the research university in this context consists of a series of research groups that have “firm-like qualities...sharing qualities with a start-up firm even before it directly engages in entrepreneurial activities” (Etkowitz 2002). This view, whilst having gained some currency in academic circles underplays fundamental cultural differences between the community of science and a commercially oriented business organisation. These differences relate quite fundamentally to how success is measured and performance assessed.

An alternative view characterises the evolution as one *from sponsorship to partnership in university-industry relations* (Jacob, *et al.* 2000). The evolution is characterised through four stages: the science-society contract as captured by Vannevar Bush, the era of strategic research, the Science Park, and the knowledge partnership. This last model, which corresponds substantially to the much-discussed mode 2 model of knowledge production, (Gibbons, *et al.* 1994) emphasises the joint creation of knowledge between researcher and user, as opposed to the transfer of knowledge from researcher to user. However, it is often overlooked that the arrangements for knowledge creation in this partnership context require management and accountability arrangements that are often difficult to negotiate and activate.

A feature of the triple helix and the partnership models is an assumed institutional convergence between universities, business and government agencies. Such models tend to overlook the important changes that are going on within those institutions that are not impacted by cross-institutional relationships. They also gloss over fundamental differences in, and influences of, the cultures, structures and routines that occur in each institutional category that impact on either the creation of knowledge and/or its application. To address these influences it is not only important to understand the features of the structures, cultures and

routines *within* each institutional setting but also the institutional characteristics of the modes of interaction that form the basis of engagement *between* institutions.

In these respects the purpose of this work is to develop a model of relationships between higher education, business and government that builds on institutional characteristics (and strengths) and specifically recognises the distinctive features of knowledge creating and knowledge adopting institutions. The model should also recognise and accommodate demonstrated trends in the production of knowledge – that is, as Gibbons *et al* have described and documented, a move to mode 2 knowledge production, or knowledge produced in the context of application.

It will be argued that the concept of institutional convergence is confused with a degree of integration relating *functions* and activities in areas where there is commonality of interests between the higher education, business and government institutions. It is also argued that effective functional integration requires institutional strength rather than weakening, and that effective outcomes will build on contributions derived from institutional strength rather than all institutions looking like each other. For example, higher education research relevance does not imply or downplay the need for research excellence in addressing industrial problems and issues.

In developing a model of institutional engagement it is necessary to explore the form and content of engagement – something more than describing interactions. An essential feature of the model of institutional engagement is the identification of *forms* of engagement. It is intended that the model will provide insights into the operation of universities in the knowledge economy based on their institutional features and characteristics related to the production, distribution, exchange and management of knowledge.

Three basic socio-cultural and economic frameworks with the following broad characteristics are identified in the model:

- Knowledge communities – primarily, although not exclusively, universities, often referred to as the academic community or community of scholars, built around open interactions and the sharing of knowledge
- Knowledge-based organisations and 'knowledge-creating' companies, built around roles and relationships and the management of knowledge
- Knowledge markets, involving the exchange of knowledge products.

Knowledge communities, like that of science, are structured around the rules of a gift economy. For example, scientists give, or present, papers to their peer community via conferences and journals. This gift economy has been explained in terms of a 'cycle of credibility' which allows conversion of one form of capital into another in order to make scientific progress. The forms of research capital include money, data, prestige, credentials, problem areas, conceptual developments and publications (Fuller 2002; Latour and Wolgar 1982).

The community dimension stresses the importance of social and relational capital; that is the stock of trust, mutual understanding, and shared values and behaviours that bind members of communities and make cooperative action possible. It is characterised by high levels of mutual respect, robust personal networks, vibrant communities, shared understandings and a sense of equitable participation in a joint enterprise – all of the things that draw people to a group (Cohen, Don and Prusak 2001; Lewis 1999). This type of connection supports collaboration, commitment, ready access to knowledge and talent and coherent organisational behaviours.

The concept of *communities of practice* has emerged from considerations of social capital (Wenger, *et al.* 2002). These communities grow out of practical need; that is, they are drawn together by common activities. They cannot be mandated or ordered into existence.

Knowledge organisations have emerged in the context of a more competitive global environment and a shift away from mass production as the major driver of industrial development. Analysts have come to regard an organisation as a collection of resources that is managed to achieve particular purposes, results or outcomes (Dosi, *et al.* 2000) These resources embody a range of distinctive capabilities that allow organisations to survive, develop and retain competitive advantage in a commercial context. These resources include: tangible assets such as buildings, facilities, equipment, property and patentable inventions; intangibles, such as brand, image, reputation, human skills and knowledge; financial capital that the organisation is able to access; and management capacity and capability.

Organisations are choosing to adapt to their changing environments by deliberately externalising some capabilities, and in the process, retaining a certain degree of influence outside their boundaries. As a result, externalisation of capability, involving inter-organisational collaboration through outsourcing, subcontracting, and franchising are tending to increase. These collaborations are managed through joint venture agreements, partnerships

and contracts. These forms of collaboration should not be confused with supplier or purchase contracts that specify in some detail services that are to be provided.

Conversely, firms may decide that they wish to protect their current physical and intellectual assets by building more internal capability. These considerations are important for addressing how and why corporations seek to acquire knowledge through market and managed arrangements with higher education and other knowledge creating institutions. In these environments the management of knowledge and innovation creates important challenges.

More recently, knowledge markets have emerged as an important form of engagement between institutions. Economists have promoted a view that the market is the ideal way to organise all economic activities and that organisations are simply a special case to address problems of market failure, due largely to limited information and a propensity for people to behave opportunistically. Over the last 20 years there has been a substantial growth in the scale, reach, complexity and popular legitimacy of market institutions and market players. The extension of markets is seen to flow from a complex of factors, summarised as scope, sophistication and legitimacy (Donahue and Nye 2001). Public policies of privatisation and deregulation have seen the expansion of markets in utility services, education, health care, telecommunications, aviation, banking and insurance.

Market forces power the movement of knowledge, working in a similar way to markets for tangible goods:

Like markets for goods and services, the knowledge market has buyers and sellers who negotiate and reach a mutually satisfactory price for the goods exchanged. It has brokers who bring buyers and sellers together and even entrepreneurs who use their market knowledge to create internal power bases. Knowledge market transactions occur because all of the participants believe they will benefit from them in some particular way (Davenport and Prusak 1997a).

Within firms, research and development is increasingly being organised on a market basis. Corporations are creating market-type mechanisms that impose market tests on research and development. Research and development units are being set up as profit centres within corporations, and they charge other business units within the corporation for the results they produce. This can be in the form of formal licensing of Intellectual Property or through inter-company transfer arrangements. Some corporations have actually divested their research and development laboratories and floated them as separate companies (for example, Lucent being divested from AT&T) or transferred to universities (for example BHP transferring its research laboratories to a Victorian university).

The emergence of science based innovation and the possibility that scientific discoveries in a research environment could be transformed almost directly into economic returns has been associated with the definition of knowledge products in the form of Intellectual Property and small, start-up firms as vehicles to commercialise discoveries and inventions. In this context, commercialisation refers to the objective of selling the work of a university for a profit. There is a growing practice among universities to package research discoveries, licences and associated knowledge capital (that is, the expertise of the researchers) in start-up companies. This largely accounts for the observed increase in the number of start-up companies in recent years (Johnston, *et al.* 2003; Yenken and Gillin 2002).

The increasing scale of the knowledge market has become apparent, offering both threats and opportunities to higher education institutions. There is an imperative to operate effectively in a competitive market, while not destroying the components of the organisation, and its community, which gives universities such a special place, and brand image.

But the most important relationships with the world of business may not be contractual. Academic and scientific communities have thrived for centuries and provide the basis for high levels of competition within strict rules, and at the same time a high level of collaboration, and community allegiance. Increasingly, the community is being extended, or new communities formed between universities and businesses, in the forms of alliances, networks and clusters. It is this form of interaction that has generally formed the major focus of attention in the presentation and discussion of the mode 2 model (Gibbons, *et al.* 1994).

The broader model of engagement presented in this thesis points to the need to build and sustain institutional strength in both universities and industry. There is little to be gained and much to be lost as universities seek to imitate businesses and businesses are expected to accommodate the cultures of a university. This is not to say that universities should not be more “business like” in the way they manage their resources and businesses should not give greater attention to community type cultures in managing knowledge workers and to their roles concerning environmental and social responsibility.

The essential argument of the thesis is that the engagement between universities and businesses are themselves institutionally based. They reflect the institutional characteristics of markets, organisations and communities. Effective engagement will in turn depend on how well these institutions perform. Specifically, this concerns performance in:

- The skills, knowledge and experience of technology transfer professionals and the integrity of brokers in knowledge markets (for example, technology transfer offices and companies and technology investors)
- The management capacities in knowledge organisations (for example, cooperative and collaborative research joint ventures, partnerships and alliances)
- The leadership capacities in knowledge communities (for example the vision and commitment of university, government and business leaders in knowledge based regional development).

It is argued that public policy needs to focus not only on ensuring that universities and businesses work to sustain their own institutional strengths but also that there is capacity and capability developed in the institutions of engagement. Public policies that confuse the institutions of engagement (knowledge markets, knowledge organisations and knowledge communities) with the institutions for the creation of knowledge (universities) and the application of knowledge (businesses) will inevitably result in institutional confusion and sub-optimisation in achieving objectives of wealth creation.

The essential message is that public policies should seek to build institutional capacity – not institutional convergence. In the movement to a mode 2 society there is much that can be done to build those institutions for effective engagement.

The work that follows is presented in the following order.

Chapter 2 addresses issues about the nature of interactions between higher education and industry, the concept of engagement and features of a mode 2 knowledge creation. The relationship between engagement and mode 2 is also explored. An example is taken from the field of management and policy to illustrate the features of mode 1 and mode 2 knowledge and the implications for management practice.

Chapter 3 presents a model of engagement based on the institutional features of managed, market, and community based relationships. It is suggested that institutions of engagement are vital for ensuring effective interactions between higher education and industry in the mode 2 context. It is also suggested that institutional development requires guidance and capacity building to ensure that they are both credible and effective. The model provides background for exploring relationships between higher education and industry in subsequent chapters. Engagement is also facilitated by a set of institutions manifested as the state, financial institutions and the institution of place and space.

Chapter 4 provides additional context for the model of engagement by examining changes and developments that have occurred in higher education through a process of industrialisation. This has been associated with the commodification of knowledge and the marketing of knowledge products. It provides a basis for looking at the extent to which higher education institutions can be seen as businesses engaged in the production, distribution and sale of knowledge products. It is suggested that the model of the entrepreneurial university has only limited application and efforts to push higher education institutions too far down this track place at risk their foundational legitimating purpose in teaching and research. It is suggested that the “business” of higher education is best approached as a form of engagement between the universities and corporations rather than something that universities undertake on their own behalf.

In this way, the core values of the institution can be maintained and tasks of marketing can be assigned to market-type or management-type institutions in the engagement space. This provides a strong case for separation and independence in the functions of technology transfer offices, university consultancy operations and marketing of courses and programs. From this perspective it is possible for higher education institutions to commit to their core institutional purposes and yet maintain the linkages with businesses and government in a mode 2 context. It follows that the form and structure of those arrangements become important for retaining and building institutional strength as well as creating value for both sets of institutions.

Chapter 5 is a complementary analysis of the trends and developments in industrial innovation that influence the form and structure of engagement. It points to some evolutionary changes in the corporate sector focussing particularly on changes in business and innovation strategy, outsourcing and capability acquisition. There is a trend towards businesses acting more like *traders* and/or *integrators* in corporate capability rather than *creators*.¹ In this context there is not an automatic, or even strong, pressure from businesses to engage with higher education. For engagement between the two sectors to work, attention is required to the way in which *the forms of engagement* operate. For example, joint venture arrangements in industrial research require a high level of management competency and capability. Similarly, knowledge markets require skilled and competent intermediaries including technology investors and brokers and knowledge communities require leadership.

¹ For example, corporations in the food industry buy and sell *brands* according to a strategic fit as an alternative to building brands organically.

Chapter 6 examines in more detail the nature of market based engagement between higher education institutions and business. Chapter 7 provides some statistical and other material about the actual extent of market type activities conducted in Australian universities. It points out that, despite the rhetoric and the envisaged opportunities from research commercialisation, the amount of income is quite small and is likely to remain that way. This provides a rationale for ensuring that institutions do not compromise their core institutional values for what are relatively small amounts of money.

Chapter 8 examines the characteristics, structures and routines relating to managed engagement, with a particular focus on industry and business supported research centres. The chapter draws on research undertaken for the recently completed review of the Australian Cooperative Research Centres Programme (Howard 2003b). It draws attention to the need for collaborative research to be supported, and led, by strong management and organisational capacities and capabilities. Chapter 9 examines issues relating to community based forms of engagement and draws attention to relationships between higher education institutions and business in science and technology cluster development.

Chapter 10 provides a brief overview of industry and science and innovation policy and suggests that future development and evolution should be directed towards strengthening the institutions of engagement. Up until now policy has focussed on encouraging the core institutions of industry and higher education to change and adapt. The message for policy in the context of this work is that efforts should be taken to ensure that there are strong institutions – world class higher education institutions famous for research and teaching and an industrial base that is competitive and globally focussed – with well developed and high performance institutions for engagement.

The thesis concludes with a view that public policy should be directed towards developing capacity and capability in the markets for knowledge, joint venture industrial research management and cultivating knowledge communities. Policy efforts in this area to date have been haphazard and poorly focussed. The Cooperative Research Centres Programme has contributed to developing industrial research managers and the Innovation Investment Funds Program has provided an opportunity to develop early stage investors in the market for knowledge. However, these initiatives have not focussed specifically on institutional capacity building creating a risk that measures will not be sustained when the funding runs out.

Recent efforts to build institutional capacity through new institutions have been well intentioned, but have fallen short of the mark as proponents have misunderstood the

capacities and capabilities required and where effort should be targeted. There is still a view held by some policy makers and venture investors that scientists and researchers should be converted to entrepreneurs. The institution building effort needs to be more focussed and targeted and policies and programs should focus much more on where capacity is needed and the sustainability of that capacity.

Chapter 2. Interactions, Engagement and Mode 2 Knowledge Production

The purpose of this Chapter is to discuss the nature of interactions between higher education and industry, their form and content and the basis on which they work. The issue of interactions is associated with substantial public policy interest in what have become known as *national innovation systems* that identify and portray linkages and inter-relationships between knowledge creating and knowledge using institutions and a range of intermediary institutions. These linkages presuppose some form of communicative interaction between the institutions involved. A question that has not been adequately explored in the literature on innovation systems is the extent to which the linkages actually represent *channels of communication* between institutions, the way in which communication occurs and the behaviours that follow.

This Chapter proposes a way of thinking about communicative interaction in terms of the content and style of communication that would be required for effective interaction. It is suggested that communicative interaction is likely to be most effective where there is a high level of *engagement* between institutions in the national innovation system. This concept of communicative engagement is linked to the underlying premise of mode 2 knowledge creation and it is suggested that mode 2 is best understood in terms of engagement between institutions in the system.

The concept of communicative engagement in knowledge creation leads directly into consideration of the supporting institutions for engagement between science, government, industry and society. This aspect of the argument is developed in Chapter 3.

2.1 Interactions in the “national innovation system”

In its report *National Innovation Systems*, the Organisation for Economic Co-operation and Development (OECD 1997) observed that technical progress is largely the result of a complex set of relationships among institutions and individuals, who produce, distribute and apply various kinds of knowledge, and thus translate the inputs into outputs with higher degrees of value-added. The links that tie them can take the form of joint research, personnel exchanges, cross patenting, co-publication, purchase of equipment and a variety of other channels. The performance of a country in innovation depends on the effectiveness of these ties in uniting the diffuse elements of a collective system of knowledge creation and use.

Studies undertaken for the OECD on national innovation systems suggest that high degrees of technical collaboration, technology diffusion and personnel mobility can improve the innovative capacity of businesses in terms of products, patents and productivity. Moreover, current approaches to understanding the process of economic development stress the importance of links between national productivity growth and investment in tangible and intangible (knowledge) assets, and the ability to absorb new ideas. This is the essence of new growth theory which highlights the importance of innovation in starting and sustaining economic development and growth.

It is now well recognised that a nation that can foster an infrastructure of linkages among and between firms, universities, and government gains competitive advantage through quicker information diffusion and product deployment (United States. Council on Competitiveness 1998). Companies and research organisations that can increase their ability to interact will be able to move more quickly and effectively to take advantage of new opportunities. The form of that interaction, and how it is managed or mediated, has turned out to be a major issue in the success of these interactions for innovation and wealth creation. It cannot be assumed that interactions built around social relationships in a community setting will necessarily achieve these outcomes. The idea of innovation occurring in knowledge communities is seen as a special case among more structured relational forms based on knowledge markets and knowledge organisations.

In its 1997 policy paper, *Investing for Growth*, (Australia. Prime Minister 1997) the Government identified the key elements of an effective innovation system as:

- An education system which encourages creativity and entrepreneurship
- A research base which provides excellent basic and applied research
- High levels of public and private R&D
- Strong linkages between business and research providers
- Effective and rapid commercialisation of successful R&D
- Businesses that are open to change and learning
- A high rate of technology diffusion—the take-up of improved products and processes across the economy
- Effective access to new technology through good links into leading-edge international basic and applied research
- A learning oriented workforce
- An internationally competitive financial and venture capital market attuned to the needs of developing high technology firms
- A legal and regulatory framework that encourages competition and innovation.

All of these elements are present to a greater or lesser extent in what is often described as the Australian innovation system. In reality, the elements identified above do not relate to each other in a systematic way. There can be no presumption that the potential for communicative interaction actually occurs in practice. The elements identified above can be seen more realistically as constituting what may be termed an *innovation domain* - where a domain is defined as a recognised field of institutional life bounded by the presence of either shared cultural-cognitive or normative frameworks, or a common regulatory system (Scott 2001). Institutional structures and characteristics will be considered in more detail in Chapter 3. The remainder of this Chapter explores the possibilities of, and styles for, communicative interaction.

2.2 Classification of interactions

A framework of university-business interactions was developed in a report for the Australian Research Council, *Mapping the Nature and Extent of Business-University Interaction in Australia* (Howard 2001a) that provides the basis for classifying interactions and relationships between higher education institutions and industry. Interactions were identified in several categories:

- Knowledge interactions, occurring across a spectrum that ranges from information transfer to knowledge enhancement via research, to access to facilities and capability through to commercial knowledge exploitation, involving the transfer, sharing, and purchase of knowledge between people
- Business relationships, covering the way in which businesses and higher education institutions interact in a business sense. They can also be considered in terms of a spectrum that ranges from unconditional financial flows to highly structured corporate arrangements in the form of joint business ventures
- Structural interactions, covering institutional and organisational arrangements ranging from research institutes and organisations with business people on governance boards through to networks, forums and roundtables
- Geographical interactions, where higher education institutions interact with communities and regions and reflected in forms such as technology precincts, business incubators and technology clusters
- Government support programs that facilitate interactions through membership of advisory councils and committees, government research organisations and research funding organisations and provide specific forms of assistance through government policies and programs.

These categories are not mutually exclusive. However, as a classification it is intended to provide a logical and consistent way of presenting and interpreting information. The

categories are important not only for the purposes of organising information but also for drawing inferences about content and meaning from the way in which the information is organised.

The classification that is presented below, set out in more detail in the Report for the ARC, is indicative, but it does serve to identify, separate and differentiate categories of interaction in discussion and analysis of engagement between higher education, industry and government. The basis of the classification is provided in Figure 1.

Table 1: Classification of university-business interactions

<i>Knowledge interaction</i>	<i>Business relationships</i>	<i>Institutional and structural arrangements</i>	<i>Spatial (geographic) interaction</i>	<i>Government support arrangements</i>
Strategy and planning	Corporate gifts and bequests	University research institutes and organisations Research centres	Technology precincts	Advisory councils and committees
Information transfers	Corporate sponsorship	Cooperative Research Centres Technology transfer (licensing) companies	Business incubators	Research performing institutes and organisations
Skill transfers	Cooperation	Joint venture companies	Science and technology parks	
Skill enhancement	Collaboration	Professional advisory and consultancy services	Industry clusters	Research funding councils and corporations
Knowledge enhancement	Contract and consultancy	University-business interface organisations Business associations		Commonwealth Government departments
Access to facilities and capability	Commercial partnership	Networks, forums and roundtables Alumni bodies		State Government departments
Commercial knowledge exploitation	Commercial competition	Personnel interchange Personal networks		

Source: Howard, John H. 2001. *Mapping the Nature and Extent of Business-University Interaction in Australia*. Canberra: Australian Research Council.

An important issue to consider is the extent to which the interactions identified can be supported and strengthened to improve the level of communication between higher education institutions and business towards the objective of increasing the commercial application of university research. In developing this theme a classification of interactions and relationships is developed based on the *form* of the interaction and classified broadly as knowledge sharing in a community setting, knowledge purchase or acquisition through a market for knowledge, and knowledge creation and management through an organisation relationship.

2.3 Interactions and communication

The interactions and relationships identified above reflect the very broad nature of the way in which higher education institutions, industry and society interact and work together. The classification is of interest in that it separates out and lists different classes of interactions, but it falls short of identifying them in specific institutional settings. Moreover, the classification

does not suggest the way in which the interactions actually operate and are sustained. It presupposes, however, that if the interactions are working, there is some sort of interactive communication taking place between institutions.

The classification of interactions can be seen as suggesting the existence of channels of communication. The way in which institutions communicate will, however, be determined by the effectiveness of the channels which will, in turn be determined by how participants perform their roles as senders and receivers. It follows that understanding the nature of communication is essential to understanding the workings of interactions and relationships.

From the perspective of communication theory, communication involves perception, expectation and demand. (Drucker 2001). In communicating, in whatever medium, the first question has to be: is this communication within the recipient's range of perception? Can it be received? There is no possibility of communication unless it is known what the recipient can see and why. Thus, despite the appearance of links and channels, there cannot be communication unless the senders and the recipients have the same perceptions about content and subject matter and that communication will attract the attention of intended recipients (Davenport and Beck 2001). It has been recognised for quite some time that separate and distinctive cultures of scientists, engineers, marketing professionals, and business executives make communication across these groups particularly problematic (Kleiner 2001).

Before communication can occur, what the recipient expects to see and hear must also be known. Only then is it possible to know whether communication can utilise expectations, or whether there is a need for an awakening that breaks through recipients' expectations and forces them to realise that the unexpected is happening. There are many organisations in business and government that cannot handle realities and seek to define issues in ways that give them greater comfort and make it possible to shut out unpleasant, unwanted or disturbing information. And finally, communication always makes demands: it demands that the recipient do something, believe something or act in some way.

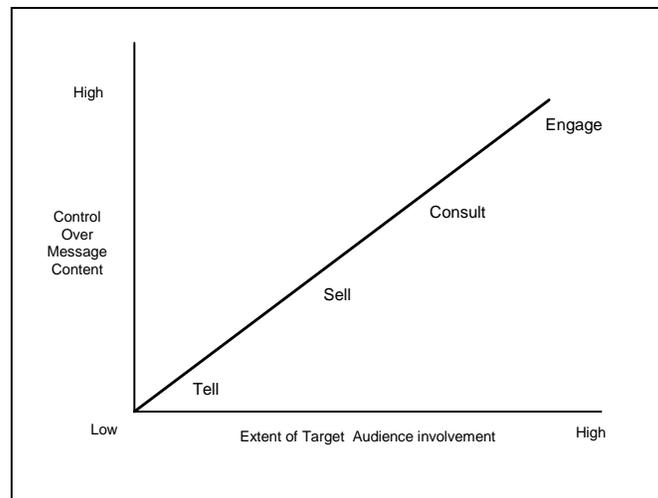
From these perspectives it is *the recipient* who communicates. Thus people in community, organisational and market settings where there are shared values and common belief systems are likely to be able to communicate more effectively than when these attributes are absent. If communication fits within the aspirations and values of communities, the purposes of organisations, and the rules of markets, it is powerful. If it goes against aspirations, values, and rules, it is likely not to be received – or at least to be resisted (Drucker 2001). In this

respect, views from scientists that industry lacks receptor capability (Australian Academy of Science 2002) provides an indication that the problem might be with scientists – not industry.

Scientists should be able to communicate in terms of industry perceptions and expectations about how business is conducted. In practice this may require the involvement of intermediaries. This does not necessarily involve simplification of messages. It means putting them in the language and style of the recipients' perceptions and expectations. Quite often science and technology communication is simplified to the point of being simplistic and conveyed in the form of “good news stories”. Such messages are also unlikely to be received by people in business. Communication in science and technology requires preservation of message content but expression in the language of the potential user.

Perceptions, expectations and demands are shaped to a large extent by the embedded *style* of communication. Communication theory identifies four styles of communication, depending on the control over message content and extent of target audience involvement (Munter 2000). These styles can be represented as a spectrum moving from a style of *telling* through *selling* and *consulting* to a style of *engagement*. This is illustrated in Figure 1.

Figure 1: Communication style



Munter, Mary. 2000. *Guide to Managerial Communication: Effective Business Writing and Speaking*. New Jersey: Prentice Hall.

The telling style involves informing or explaining: it is based on the communicator wanting the target audience to understand something that the communicator knows. Many technology transfer strategies are based on a style of telling. It assumes that the audience shares the same perceptions and expectations as the communicator. These assumptions are quite often invalid and a great deal of message content gets lost as it is simply not received by the target.

The selling style involves persuading or advocating: a communicator wants an audience (eg industry) to do something different. Quite often this involves convincing the target audience that receiving and understanding the message will lead to benefit and value being created. This involves firstly attracting the attention of a business and then advocating the merits of a new technology in a way that indicates how the technology can be adopted and applied and used to find new customers who are prepared to purchase and pay for the products associated with the technology. This is a tough ask for many scientists.

The consult style suggests a conferring approach, which involves a degree of give and take with the target audience in order to match perceptions and expectations. A scientist may want to learn from a business executive but still seeks to control the agenda associated with the adoption of a technology. Many universities approach technology transfer from this perspective, reflecting a science and technology push approach to industrial innovation. Business people are quite often unimpressed by the values and expectations of returns advocated by scientists in technology marketing and licensing negotiations. Similarly, businesses become concerned when research agendas in collaborative research are driven by scientists wanting to do more research rather than directing efforts to outcomes.

The engagement style is a collaborating approach, with the communicator and the audience each working together to come up with the content (Munter 2000). It is from this perspective that *engagement communication* provides a foundation for innovation where researchers in higher education institutions work collaboratively with researchers and managers in industry - and citizens in a broader social context. There is an emerging literature on citizen engagement in public policy that addresses similar issues to those raised in the analysis of science industry relations (Edwards 2003).

Engagement is reflected in a range of formal and informal alliances, partnerships and joint ventures. The way in which these arrangements are managed is receiving an increasing level of attention in the management literature. Inevitably, however, the criteria for success comes down to values such as leadership, mutual respect, commitment, communication and, above all, trust (Austin 2000; Child and Faulkner 1998; Doz and Hamel 1998; Dyer, *et al.* 2001; Ernst and Halevy 2000; Harbison and Pekar 1998; Kanter 2002; Spekman and Isabella 2000). The characteristics are fundamentals of engagement.

Given the divergence of value systems between scientists and business executives, communication is unlikely to be easy without some form of engagement institution – that is, a structure and set of activities that provide stability and meaning to interactions - that interprets

and resends the communication in a form that the sender and recipient can understand and possibly act upon. It will be argued later that these institutions can be built around and based upon either community, organisational or market interactions. In the following Section the nature of engagement is discussed

2.4 From communication to engagement

Notwithstanding the description and identification of linkages between higher education institutions and industry that are seen to lie at the basis of national innovation systems, there is a perception that higher education institutions are often out of touch and out of date with the industrial and social contexts in which they exist and perform. On the basis of the discussion in the previous section, this is seen as a problem of communication. Much of the communication between the higher education institutions and industry is based on a *tell* style: businesses tell universities how they should be run, and higher education institutions tell students and businesses what they think they need to know and what they should be doing in taking up new discoveries and inventions. Telling is the essence of teaching, extension, outreach, and technology diffusion.

In many ways this reflects a fundamental difference in the issues confronting higher education institutions and the way in which they are structured and operate. Industry and businesses have *problems* that they wish to resolve in finding and satisfying customer wants; higher education institutions are built around the concept of an academic community with faculties, schools and *disciplines*. Despite the expertise and resources that exist on campuses, higher education institutions are not well organised to bring them to bear on business problems in a coherent way. Business problems generally require prescriptive rather than descriptive analysis which is often found in trans- or cross-disciplinary approaches to problem resolution.

There are, however, several financial and resource pressures confronting higher education institutions. They include: long term financial constraints, demands for cost containment, a demand for greater accountability, and more recently, requests from policy makers for institutions to provide solutions to national and international problems. There has, at least in the United States, been a view that higher education institutions need to move beyond outreach to what the Kellogg Commission (Kellogg Commission on the Future of State and Land-Grant Colleges 2001) defines as engagement. The Commission sees engagement as a reference to institutions that have redesigned their teaching, research, extension and service

functions to become even more systematically and productively involved with the communities in which they are located and function. The Commission points out:

Engagement goes well beyond extension, conventional outreach, and even most conceptions of public service. Inherited concepts emphasize a one-way process in which the university transfers its expertise to key constituents. Embedded in the engagement ideal is a commitment to sharing and reciprocity. By engagement the Commission envisages partnerships, two way streets defined by mutual respect among the partners for what each brings to the table. An institution that responds to these imperatives can be called what the Kellogg Commission has come to think of as an “engaged institution” (Kellogg Commission on the Future of State and Land-Grant Colleges 2001).

The Commission identified seven guiding characteristics of engaged institutions:

- Responsiveness – listening to the communities, regions and states that are being served
- Respect for partners – to encourage joint academic community definition of problems rather than simply providing the university’s superior expertise to the community
- Academic neutrality – to maintain the university as a neutral facilitator and source of information when contentious public policy issues are at stake
- Accessibility – assisting potential partners to negotiate complex structures to ensure that expertise is available
- Integration – a commitment to interdisciplinary work is probably indispensable for an integrated approach
- Coordination – ensuring that the engagement agenda is understood across institutions
- Resource partnerships – costs need to be identified and resourced; the most successful engagements appear to be associated with strong and healthy relationships with partners in government, business and the non profit world.

The Commission saw that among the significant problems facing society are challenges of creating genuine learning communities, encouraging lifelong learning, finding effective ways to overcome barriers to change, and building greater social and human capital. The guiding characteristics stress interaction and relationships but they do not envisage or imply that higher education institutions should act, behave or seek to emulate business organisations.

Partnerships and sharing represent two forms of engagement. There is, in addition, another form of engagement based on the production and marketing of knowledge products. These three forms of engagement exist in parallel but operate according to their embedded characteristics and features. Some of these may be supportive of the other, some may be in conflict.

2.5 Engagement and the evolution of mode 2 knowledge production

The concept of engagement relates closely to what has been identified as the emergence of mode 2 knowledge production; that is, knowledge created in a broad trans-disciplinary, social and economic context. Mode 1 knowledge creation, by contrast is generated primarily in a disciplinary, primarily cognitive context (Gibbons, *et al.* 1994). Mode 1 knowledge creation is dominated by an academic agenda, is largely executed inside academia, is focused on analysis and on “fundamental knowledge” (as opposed to “applied knowledge”), has a preference for mono-disciplinarity and its products are primarily shared with fellow researchers. Further dissemination occurs downstream of knowledge production and there is little interest in the exploitation of such knowledge by practitioners.

Mode 1 is associated with the Newtonian model of what is considered to be sound scientific practice. It extends beyond physics and the natural sciences to a group of social sciences including psychology, sociology and economics. It reflects the classical trinity of scientific endeavour in description, explanation and prediction based on the discovery of universal truths, principles or laws. It has a focus on research excellence rather than relevance to resolving industry or societal problems. This approach differs from prescription driven approaches to knowledge creation in medicine and engineering where the core mission is to develop valid knowledge that can be used in designing solutions to problems (van Aken 2001). However, mode 1 knowledge can be an important source of value for practitioners, particularly in the social sciences, in that it provides a conceptual base and general enlightenment of problems and issues under consideration. But this generally falls short of prescription.

Gibbons *et al.* consider that the emergence of mode 2 is profound and calls into question the adequacy of familiar knowledge producing institutions whether they are universities, government research establishments or corporate laboratories. The attributes of mode 2 knowledge production centre on the idea that knowledge is created in the context of problem solving leading to an application, a form of adoption or an end use. Research carried out in the context of application is seen to characterise a number of disciplines in the applied sciences and engineering – such as chemical engineering, aeronautical engineering and more recently computer science – and in the life sciences where discoveries in molecular biology have application in improving health status.

Mode 2 knowledge creation is also characterised by trans-disciplinarity where inquiry is guided by a specific consensus among researchers from different disciplines as to an

appropriate way of working. This consensus is conditioned by the context of application and evolves with it (Gibbons, *et al.* 1994). There is a strong interplay between the tacit knowledge of the practitioners involved and the activities of researchers to produce codified knowledge. Moreover, in a mode 2 environment knowledge creation is *distributed* across a range of sites including higher education institutions as well as non university research institutes, research centres, government agencies, industrial laboratories, think tanks and consultancies. A number of these sites constitute specific *institutions of engagement* between higher education institutions and businesses.

In mode 2 there are seen to be elements of social responsibility and accountability in the process of knowledge creation. Industry, government, and society generally are often seen to be influencing the direction and outcome of the research process. This is reflected not only in the interpretation and dissemination of results but also in the definition of research agendas and setting research priorities. Industry and governments wish to see research accommodating their needs for knowledge and outcomes. There is therefore a growing interest and commitment to securing high standards of ethics and ethical behaviour, particularly in medical research.

Finally, there is the matter of quality control. Under mode 1 quality control through peer review plays a crucial role in knowledge production. It does so by selecting the research products that are allowed to reach the academic forum and by “exerting through its jurisprudence an all pervading influence on the research questions asked and especially on the research methods used. It is this quality control that creates Kuhn’s normal science” (van Aken 2001). In contrast, mode 2 knowledge production is solution-focused, oriented towards analysis of problems and designing solutions. It is “characterized by a constant flow back and forth between the fundamental and the applied, between the theoretical and the practical” (Gibbons, *et al.* 1994). Whereas quality control in mode 1 knowledge production can be seen as supporting a quest for truth, quality control in mode 2 may be seen as supporting a quest for performance, outcomes and results.

In a later work, Nowotny, Scott and Gibbons (Nowotny, *et al.* 2001) took the new production of knowledge argument further by suggesting that the pattern of industrial research responsibilities between industry and government had undergone fundamental change. They argue that industrial research after the Second World War represented collusion between industry and the state. This collusion was reflected in industry involvement in the development of national research programs where it lobbied the state to ensure a better fit

between its scientific programs and national (as well as corporate) economic objectives. Industrial leaders sat on committees that steered these programs and national laboratories as well as the universities (technology institutes) that contributed to them.

In addition, large industrial corporations developed research programs analogous to national programs in which priorities were established and outputs pre-planned. This sometimes led corporate programs and industrial laboratories to imitate the processes of academic science – they produced basic science almost indistinguishable from that produced in university laboratories. In Britain and Australia this state-like behaviour was particularly characteristic of nationalised industries and utility companies, because they were state owned or state regulated, sharing a state bureaucratic culture. But multi nationals also felt a need to produce “state-like” organisation in terms of planning research and development. The contribution of corporations to industrial research in the United States has been well researched and documented by Alfred Chandler Jnr (Chandler 1990; Chandler, *et al.* 1997; Chandler and Hikino 1997).

The environment is now seen as somewhat different following a greater separation between the concerns of industry and state. This separation is supported by the prescriptions of public choice economics and political conservatism. It is argued that in this framework industrial leaders, once seen as sounding boards for ideas through membership of research councils and advisory bodies, are now defined as users - and not just in the case of near market research. Long term research programs previously dominated by large industrial players are being replaced by medium term and medium scale research initiatives with a greater diversity of participants. Thus, industry is seen as less able to influence the state’s research and development policies – not that its involvement is no longer welcome, but the policies are more tentative and less ambitious (Nowotny, *et al.* 2001).

The argument suggests that, in Britain and Australia, as public enterprises have been privatised the new enterprises can no longer afford large-scale research infrastructures and cannot maintain their previous commitment to in-house research. In the United States and elsewhere industry de-regulation and striking down anti-monopoly practices has had similar effects. The overall result is that industrial research activities in industry have been seriously affected, with some simply abolished, others have been “re-engineered”, often losing their quasi-academic characteristics. Others are expected to pay their own way within internal markets, and others have been floated off. But, it is argued, this has not necessarily led to a decline in industrial research – in fact the opposite has occurred. That is:

- Businesses are now subject to powerful forms of social contextualisation – for example, health and safety research occurs alongside research into the core of science and technology; peripheral research, once undertaken in government laboratories is undertaken in laboratories established by industrial organisations for collective benefit.
- Industrial research is now much more distributed; specialised R&D companies have emerged – some based on outsourced industrial laboratories but others are new creations, especially in areas of fast moving science and technologies; research is also distributed back along supply chains, as component manufacturers and service providers are seen as more efficient than the big companies they supply; the effect may have been to expand industry's total knowledge capacity.
- Businesses have been forced by the dynamics of international competition to carry the innovation process into the heartland of knowledge production itself – firms are increasing the number of agreements and partnerships to which they are party. That is, knowledge production is becoming distributed (Dodgson 1993); successful innovation is seen now to require knowledge from the social sciences, even the humanities.
- To deal with social, regulatory, ethical and natural environmental issues, companies need specialised advice, which is being provided by an increasing number and wide range of specialised advisory and consulting businesses. Some are located in a university environment whilst others are spin-offs from large corporations; spin-offs are currently “pouring” into the distributed knowledge production system and are available in increasing numbers to catalyse the production of contextualised knowledge.

These developments can be seen as reflecting an increasing contextualisation of research and development, that is, a mode 2 form of knowledge creation (Nowotny, *et al.* 2001).

The mode 2 concept has attracted some criticism on the grounds that it represents an excessively dichotomous picture of the relationship between mode 1 and mode 2 knowledge production. It is based on empirically thin evidence, of extrapolating to the whole of science what may only characterise certain fields and of characterising shifts that are not new and more comprehensively explained by other frameworks. The relationship between mode 1 and mode 2 also has implications for the effectiveness of good quality teaching and learning: the effectiveness of good quality mode 2 research is dependent on good quality mode 1 research.

Data presented in an Appendix provide some indication of a trend towards mode 2 knowledge production in Australian higher education institutions in terms of an increasing emphasis on applied research and experimental development.

Nonetheless, the underlying premises of the differences between mode 1 and mode 2 are useful in that they underlie important differences in the way in which higher education institutions and industry communicate. Whereas communication in mode 1 is based on a style of telling, mode 2 is based on a style of engagement. Mode 1 communication involves higher education institutions *telling* governments, industry and society what they should be

doing on the basis of explanations and predictions derived from science. Mode 2 communication involves higher education institutions *engaging* with government, industry, and society to address and solve problems.

The historical failure of science in its mode 1 construct to resolve social problems is currently paralleled in doubts that academic science can seriously address and resolve problems and issues in industrial innovation without effective engagement. There is now a strong view from within industry that the policies of government to generously fund higher education on the premise that academic research will lead to commercial outcomes is fundamentally flawed. Commercial outcomes are more likely to be associated with a deep seated appreciation of market opportunities and customer behaviours. Technological inventions and scientific discoveries are at best enablers in this process. Whilst higher education can work with industry in these areas, available evidence suggests that engagement works best when research agendas are set by businesses, not academic researchers (Mowery 2003).

In other contexts, mode 1 knowledge has been referred to as *disciplinary knowledge* and mode 2 as *engagement knowledge*. Disciplinary knowledge has relevance to industrial application to the extent that it provides context and a basis for inter- and trans-disciplinary exploration and search for solutions to industrial problems. This provides the basis for industry driven research and development. (Ganguly 1999; Miller and Morris 1999). These solutions are developed and applied, it is argued, through institutions of engagement.

2.6 Mode 2 and the new social contract

Michael Gibbons has argued that the nature and extent of engagement between society and higher education institutions depends on the terms of the prevailing social contract between them. That is, to the extent that society has a requirement for scientific knowledge there will exist a social contract between that society and the institutions that produce it (Gibbons 2003). This thesis is directed towards exploring the form and nature of that contract from the dimensions of community, market and organisational relationships. Before addressing that task in detail, it is useful to explore more fully the concept of engagement and how it impacts on institutional practice.

Gibbons notes that engagement has been discussed primarily between relatively discrete institutions, principally government, industry and universities. He argues that these institutions have formed a “more permeable system and, accordingly, engagement is now more profitably discussed in terms of processes of communicative interaction, rather than

formal linkages between them”. This expansion in communicative interaction derives from the need in both government and industry to address complex problems, “the provenance of which is often far removed from the world occupied by academics” (Gibbons 2003).

Gibbons argues that the prevailing social contract between society and science has been structured primarily on the basis of knowledge creation, education and training. Universities have been established to undertake research and teaching. They are in the “business” of knowledge creation and the transfer of knowledge through education. From public funds made available, universities generate new knowledge in the form of scientific discoveries and educate people in the theories that form the basis of those discoveries who in turn interpret and apply that knowledge in practical situations such as in corporate or public research and development activities. This is essentially a mode 1 orientation.

Under the prevailing social contract, Gibbons sees engagement as occurring primarily through communicating the results of research in academic publications and providing educated graduates to work in industry or government. Building on the mode 2 analysis, Gibbons goes further and argues that the separation between the major institutions of society have begun to break down. He argues, for example:

The once clear lines of demarcation between government, industry and the universities and the technology of industry, between basic research, applied research and product development, between careers in academe and those in industry seem no longer to apply. Instead there is a movement across established categories, greater permeability of institutional boundaries, greater blurring of professional identities, and greater diversity of career patterns. In sum, the major institutions of society have been transgressed as institutions have crossed onto one another’s terrain. In this, science has been both invading (the outcome of one way communication with society), but also invaded by countless demands from society (Gibbons 2003).

This change, it is argued, has occurred because institutional leaders, industrial managers and people generally understand the importance of science and they respond to the growing complexity of the contemporary world by drawing on the research capabilities of universities into their interests and concerns. Scientists are now seen to be more actively engaged in more open and complex systems of knowledge production (Gibbons 2003). The way in which they engage and how research agendas are set are important issues that will be addressed in later Chapters.

The argument of this thesis is that the proposition that “the major institutions of society have been transgressed as institutions have crossed onto one another’s terrain” suffers not only from a conceptual weakness, it is also inappropriate in that it can lead to institutions to compromise their capacity to achieve high levels of performance in relation to their

foundation purposes. Where transgressions have been attempted, for example, through initiatives designed to make a university operate more as a business, major problems have emerged that have threatened the foundational purpose of the institution. There are profound reasons why such a transgression will not work, and these are explored in Chapter 3. It is argued that relationships are better understood and approached on the basis of *institutions of engagement*.

In a contemporary context industry organisations view the contribution of knowledge generated in higher education institutions as of little relevance to industrial innovation and are beginning to question the logic of public funding of higher education to generate research outcomes that are expected to have a commercial application. As former Chair of the Australian Research Council (Professor Don Aitken) has argued, the notion that the natural sciences will provide economic recovery through the commercial exploitation of great ideas is fundamentally wrong (Aitkin 1992).

Moreover, suggestions (and even advocacy) that research universities should (or could) be run as businesses – that is, actively engaged in selling their output for a profit through active marketing and customer service - runs counter to deeply engrained institutional values and responsibilities to key constituencies and stakeholders. Similarly, the idea that businesses should be open receptors for university research runs counter to the institutional purposes of a corporation to develop a business in the interests of customers, employees, suppliers, shareholders and the wider community.

Whilst it is acknowledged that there is an evolution and change in how and where *functions* are carried out between universities, industry and government, this does not of itself suggest that the lines of demarcation have begun to break down. It is, however, possible to accept that there has been an expansion in the form and level of engagement between institutions. There remain, however, fundamental differences between the legitimising purposes of institutions of higher education, industry and the state. In particular, the performance expectations and the criteria for success in each institutional category have changed little.

There is a substantial literature on institutional change and adaptation associated with economic and social change (Cohen, Linda R and Noll 1998; Nelson 1998; North 1990). The pressures for change do not imply a weakening of the boundaries. Change has more to do with factors that are peculiar to the institutions concerned. However, analysis must also allow for the emergence of *new* institutions that work at the interface of established institutions that

are founded on embedded structures, routines and cultures. These are what have been referred to as the institutions of engagement.

Pursuing the concept of institutional convergence runs the risk of undermining the stability of institutions as well as their distinctive capacities and capabilities. Institutional convergence should be seen as fundamentally different from the tasks of institutional development and capacity building in the knowledge society and the economy. A central argument of this thesis is that society requires strong and robust institutions that are capable of performing the tasks they are required to do to the highest standards. This observation does not alter the thrust and tenor of the arguments about the evolution of mode 2 knowledge creation, but it does affect the understanding about how institutions engage in this process.

In particular, the concept of engagement is quite different from the concept of convergence. Engagement requires looking at relationships between institutions from a number of perspectives and inquiring into the form, content and style of communicative interaction. Put simply, institutional convergence is neither a necessary nor sufficient condition for distributed knowledge production under a mode 2 regime. Quite the contrary: it will be argued that the benefits of distributed knowledge production are more likely to be realised with strong rather than weak institutions. These institutions include engagement institutions.

2.7 From mode 1 to mode 2 knowledge production in the fields of management and public policy

Most of the attention in discussions of mode 1 and mode 2 knowledge production has been focused on the natural and life sciences. The issues do extend however into the social sciences and humanities. It is therefore of interest to focus briefly on knowledge production in the fields of management and public policy.

Academic research in management and public policy can largely be characterized as mode 1. The academic evolution of these disciplines has been similar to the evolutionary paths of psychology, sociology, economics and politics (political science) which sought to follow the explanatory tradition of the natural sciences by trying to discover and articulate theories, principles and laws. They sought to attain the same academic respectability of physics. Academic research in these disciplines tends to be *description* driven and the mission of teaching is essentially to train researchers, not professionals (van Aken 2001). There is no formal system of accreditation that determines who can refer to themselves as an economist, sociologist, psychologist, political scientist, or manager – or even a management consultant.

There are of course numerous professional associations that claim to offer such credibility and respectability.

Medicine, engineering and to some extent law, by contrast, evolved as academic disciplines through *application* of research products and of the research testing methods of the natural sciences. They did not try to *emulate* physics, but translated its products and approaches to their own needs. Professional training remains the core of medical, engineering and law schools. The training of researchers is seen as secondary. Academic research in these areas is *prescription* driven. The focus of training and the methodology of research is focused on application in health services delivery and in industrial and commercial contexts. There are also formal systems for accreditation and licensing of professionals. It is also in these two areas where much of the focus and opportunity for university research commercialisation has taken place. That is, here is a pre-existing basis for engagement.

Academic management and public policy did not choose the path followed by medicine, engineering and law. It has tended to follow the path of economics, sociology and psychology. Whereas teaching in medicine, engineering and law relies heavily on practitioner input (for example, clinical schools located in public hospitals), teaching and research in management and public policy eschews this involvement. In doing so it has focussed on descriptive research, explanation, and training researchers. This research is very important in providing contextual knowledge but has offered little in the way of prescription for practising managers. The substantial intellectual contributions of researchers in the area of industrial innovation and the management of research and technology fall into this category. This includes the work of Alfred Chandler Jnr, Giovanni Dosi, David Mowery, Richard Nelson, Ikujiro Nonaka, Nathan Rosenberg and David Teece. (Chandler 1977, 1990, 2001; Chandler, *et al.* 1999; Chandler and Hikino 1997; Dodgson 2001; Dosi, *et al.* 2000; Dosi, *et al.* 1998; Mowery and Nelson 1999b; Mowery and Rosenberg 1999; Mowery and Teece 1996; Nelson 1998; Nonaka and Nishiguchi 2001; Nonaka and Takeuchi 1995; Nonaka and Teece 2001; Rosenberg 1994; Teece 1986).

The gap in the provision of relevant management research and prescription based knowledge has been largely filled by the global management consulting firms - such as Boston Consulting (Stern and Stalk 1998), McKinsey (Hagel 2002; Hagel and Armstrong 1997; Hagel and Singer 1999a, 1999b; Katzenbach 1998, 2000; Katzenbach and Smith 1993), Booz.Allen and Hamilton (Kurtzman 1998b, 2002), and Accenture (Davenport 2000; Davenport and Beck 2001; Linder, *et al.* 2003a, 2003b) and consulting academics attached to

business schools at the major private US universities - for example, Clayton Christensen (Christensen 1997; Christensen and Raynor 2003a, 2003b, 2003c) Jim Collins (Collins, Jim 2001; Collins, Jim and Porras 1994), Gary Hamel (Doz and Hamel 1998; Hamel 2000; Hamel and Prahalad 1994), Rosabeth Moss Kanter (Kanter 1995, 2001, 2002; Kanter, *et al.* 1997), Robert Kaplan (Kaplan and Cooper 1998; Kaplan and Norton 1996, 2001), John Kotter (Kotter 1995, 1996), and Michael Porter (Porter 1980, 1985, 1998b, 1999). The work of consulting academics does, however, provide an insight into the risks involved with an *over* commitment to mode 2 knowledge creation.

The involvement of consulting houses and academic consultants in research has meant that the creation of relevant and applicable (mode 2) management knowledge has become increasingly commercially driven. This has tended to make management knowledge non-cumulative and driven by fads and fashions that compete for attention - and the next consulting assignment. It tends to rely on case study and market research type survey methods and offer generalisation from the specific to the universal. In the process the profession of management consulting has gained a poor image with offerings of poorly crafted and inappropriate prescriptions for management improvement (Collins, David 2000; Micklethwait and Wooldridge 1996; O'Shea and Madigan 1997; Pinault 2000). This issue of commercial orientation in management knowledge is taken up again in Chapter 4. At this stage it is important to note that there is very little overlap and integration between the description driven work in industrial innovation and science and technology management with the prescription driven offerings of consultants and consulting academics.

Description driven academic management and policy research does produce valid research products in the form of observations, analyses, commentaries and explanations that may attract the interest of practitioners. Much of this research is based on analysis of time series and cross sectoral data from official sources and structured and statistically robust survey methods. However, unlike sociology, psychology, economics and political science, management does not provide an integrating theory or model. In economics for example, research is often orientated towards placing observations in explanatory frameworks offered by leading economic philosophers such as Smith, Ricardo, Marx, Keynes, and Milton Friedman. More recently attention has been given to the frameworks provided by Joseph Schumpeter and Austrian economists as a basis for new growth theories and addressing the impact of technological change.

Similarly, in sociology, research explanations are offered with frameworks provided by philosophies of Weber, Durkheim and more recent critical theory strands of thinking. In political science research explanations are offered within a range of philosophy from thinkers from the left to the far right. Analysis and descriptions that follow in the tradition of one or other of the great philosophers contribute to academic understanding and explanation of the world of economics, sociology and political science and to academic debate – as well as enhancing the position of researchers in the academic reputations system. There is, however, a problem of its relevance and applicability outside academia.

The differences in the research interests of management consultants and academic researchers should provide fertile ground for cooperation and collaboration. It was in this context that the 1996 Report of the Strategic Review of Management Research undertaken for the National Board of Employment, Education and Training, comment that:

Consultants are primarily dealing with applied, short term problems. Academic researchers, on the other hand, whilst also dealing with short term and applied problems are seeking to generate knowledge for improving teaching practice and informing research more generally. A key issue that emerges from this relationship is to ensure that this interrelationship can remain productive between the research sectors rather than competitive (Australia. National Board of Employment 1997).

The Review reported a concern among consultants that collaboration with universities was “under threat” as universities had come to see themselves as a primary source of applicable management knowledge or were in direct competition with consultants. The Review commented that whilst competition may be productive, inadequate levels of basic research funding for management research may lead to universities leaning too far toward consulting activities, at the expense of scholarship and the development and dissemination of basic research knowledge {Australia. National Board of Employment, Education, and Training, 1997 #2446}. This issue is raised again in Chapter 7 in a discussion of academic publishing.

With the survey being the dominant research strategy of mode 1 knowledge production in academic management studies, the causal model is the typical research product. The causal model explains the behaviour of one or more dependent variables in terms of the behaviour of a number of independent ones. It is developed to support the understanding of the problem at hand. This still leaves to others the task to develop alternative solutions for those problems. This is a characteristic of much evaluation and public policy research. Academic researchers are quite often uncomfortable with offering policy prescriptions. There is a view that prescriptions may taint the independence and objectivity of the research process. From another perspective there is a significant difference between the methods that are required to

identify and articulate problems and the strategies and actions that are required to address and resolve them. This has become known as the *knowing-doing gap* (Pfeffer and Sutton 2000).

In mode 1 knowledge production, the managerial and policy implications of research results are more or less treated as an afterthought. Typically they take at best only one or two of the last pages of an academic article (van Aken 2001).

By comparison, serious studies in mode 2 knowledge production in management involves finding *generative mechanisms*: that is asking the question “what are the mechanisms that make an intervention work in order to design or redesign a function, activity or program to its maximum effect”? Inquiry is essentially context dependent (van Aken 2001). In medicine and engineering for example, technical rules prescribe a series of actions, interventions or cures. These are developed and tested under closed system conditions (models and laboratory testing) or in clinical research (open system conditions as a complement to laboratory conditions). In management and policy technological rules have to be developed under open system conditions – i.e. in the context of their intended application. Typically, this would require close engagement with businesses in executing a research agenda.

A typical strategy for developing these generative mechanisms, or heuristic rules, is the multiple case study or pilot. This involves a *reflective* approach: case studies are undertaken and solved, one reflects on the lessons learnt, uses lessons in the next case, reflects again, and so on: the rules, or the prescriptions, on how to tackle this type of problem, are developed through the technique of *analytic induction*. That is, the processes by which observers reflect upon their experience of social phenomena and then attempt to formulate explanations that may be used to form an abstract rule, or guiding principle, which can be extrapolated to explain and predict new or similar experiences (van Aken 2001).

On the basis of several cross case analyses, hypotheses are developed on the relevant generative mechanisms. These hypotheses are also tested through further cross case analysis. Successes and failures are both interesting as one wants to know what the driving and blocking functions are behind the rules. Both the induction of technological rules and of generative mechanisms can, of course, also use the research products of prior description driven mode 1 research. A theoretical framework can guide data collection and analysis – but it may blind the researcher for important cases outside that framework. The availability of these products is coming under pressure as academics turn into consultants in order to generate revenue to fund their faculty positions.

In management research multiple extractive case studies involve a researcher collaborating (engaging) with a client to diagnose and specify a problem in that system. In this respect it is similar to action research (Argyris 1993). To pursue research in this framework it is critical that academic researchers engage effectively with business and government in the design and carrying out of research programs.² In the current climate the key players in this field are consultants involved in program evaluation and policy review. Academic researchers have not made a significant impact in this area.³ Academic activity in program evaluation and policy studies has tended to focus on methodology – not execution.

Academic management suffers in this environment in that there is no integrating theory or pre-eminent philosopher - although Peter Drucker is regarded as having come the closest to being one (Beatty 1998; Crainer 2000) - to provide direction and guidance in the interpretation of results. Many other recognised leaders in management philosophy such as Frederick Taylor (Taylor 1911), Chester Barnard (Barnard 1968), Henri Fayol (Fayol 1967), Henry Ford, and Alfred Sloan (Sloan 1993) have been practitioners (Gabor 2000). Current and former CEOs also contribute in important ways to the philosophy of management. Recent contributions include Lou Gerstner from IBM (Gerstner 2002), Bill Gates from Microsoft (Gates 1999), Andrew Grove from Intel (Grove 1997), Howard Schultz from Starbucks (Schultz 1997), Tom Watson from an earlier generation of IBM (Watson 1990), and Jack Welch from General Electric (Welch 2001).

Academic training in management and public policy provides valuable *contextual* knowledge. Research projects carried out as part of graduate curricula develop a capacity for problem solving based on structured inquiry and hypothesis testing in real world situations. They assist in approaching problems – not providing the solution. Unlike medicine and engineering, academic management and public policy education does not provide practitioners with a set of tools and techniques that set down a way of resolving problems and issues in an operational and policy context. They provide a platform for understanding them.

Like the practice of medicine and engineering, which draws on disciplines such as biology, physics and mathematics, management *as practice* draws on other disciplines such as

² The same principles apply in industrially oriented collaborative search.

³ When academic researchers are included on project teams with consultants they tend to focus more on the descriptive aspects of the research project rather than the outcomes in terms of relevance of findings for application and adoption. Description is an important part of the process – but it often results in telling clients what they already know. This may of course be useful in providing a new perspective, but rarely does description and rationalisation provide a solution. This issue has implications for management and control of research agendas – both in the social and the natural sciences.

sociology and social psychology, reflected in the human relations movement (Katz and Kahn 1966; Maslow 1998; McGregor 1985), economics (Cyert and March 1992; March and Simon 1958; Simon 1965), politics (Clegg 1975; Clegg and Dunkerley 1980; Salaman 1981) and more recently what has become known as organisational economics and the economics of transactions costs which endeavours to integrate thinking drawn from economics, social psychology, finance and law (Milgrom and Roberts 1992; Williamson and Masten 1999; Williamson and Winter 1993). Organisational economics has also been developed by global management consulting firms (Anslinger, *et al.* 1999; Day and Wendler 1998; Foster and Kaplan 2001a; Hagel and Singer 1999b). However, this thinking is rarely presented in terms of an overarching view and direction for management practice.

Commercially oriented business schools are endeavouring to address the question of relevance through commitment to case-study based research and qualitative theory building. This is aimed at offering prescription and is becoming more and more accepted in academic studies in management and in teaching. Books and articles published by consulting academics attached to US business schools (Harvard Business School Press and the *Harvard Business Review* are the major publishers) are heavily oriented towards case studies. The content and messages of short articles published by *Harvard Business Review* in its numerous Newsletters are highly prescriptive in their orientation.

Outside the commercially oriented business schools, and in schools and faculties linked to economics, sociology and social psychology, the dominant research strategies are still descriptive and survey-based, especially for research aiming for the leading academic journals such as the *Academy of Management Review*. These approaches tend to have limited interaction with practitioners and they tend to be dominated by an academic agenda. They are undertaken predominantly within a more traditional academic institutional environment with funding provided by research councils. Research results are primarily shared with fellow researchers at academic workshops, seminars and conferences and through limited distribution (albeit peer reviewed) books and academic journals. Integrating this thinking into prescriptive messages for management practice remains elusive.

The shift of public administration from a practice based field of enquiry that offered a range of prescriptions for the conduct of public administration, to an academic orientation, has also been associated with its integration into economics and public policy studies with a political science orientation. The link between public administration and public finance has largely

been lost. Issues in public finance, such as taxation and the theory of public goods are now examined in neo-classical economics.

To enhance practitioner relevance, management and policy research would benefit from more prescription driven, design oriented and engaged mode 2 research that links to and complements the description driven, analysis oriented mode 1 research undertaken in an academic environment. The management consulting profession may have a key role as an institution of engagement in developing the knowledge flowing from mode 1 research into application that meets the needs and requirements of managers in industry. Management consultants may be able to engage with their clients in developing relevant and applicable knowledge based on case study methods and generative inquiry.

2.8 Summary

An essential argument of this thesis is that the evolution of a mode 2 society is not contingent upon, or related to, institutional convergence. The argument is essentially the reverse: an enriched society based on mode 2 knowledge production requires strong institutions that are capable of providing stability and meaning to economic and social behaviour. It is argued in subsequent chapters that converging institutions are likely to be weakened and confused as to purpose, direction and meaning.

The extent to which there has been an evolving form of engagement based on more open and complex systems of knowledge production will depend to a large extent on the way in which knowledge is created in the institutions of higher education and the way it is applied in industrial contexts. However, changes in this arena will not be sufficient to progress a new social contract. The necessary conditions revolve around characteristics and performance of *the institutions of engagement* and the capacities within those institutions.

Exploration of the structure, operation and performance of the institutions of engagement is the major focus of this thesis. In the following Chapter various models of engagement will be examined with a new model presented drawing on neo-institutional theory. These institutions operate in the context of evolution of change in the core institutions of higher education and industry. To provide context for examination of the institutions of engagement subsequent chapters will outline the processes of evolution and change in core institutions of higher education and industry and set the framework for analysis of engagement in later chapters.

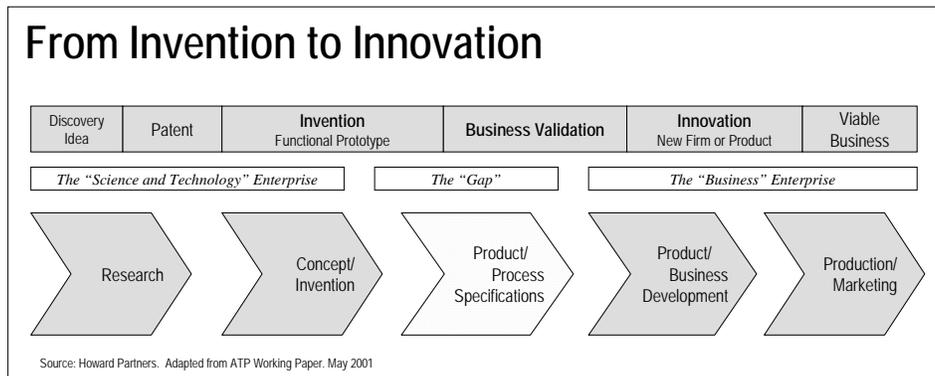
Chapter 3. Models of Engagement

The purpose of this Chapter is to present a model of engagement based on institutional theory. In the first Sections existing models are described and their shortcomings identified. These models include gap and relationship frameworks and convergence models.

The institutional model provides a basis for further analysis of engagement between universities and business in subsequent chapters.

3.1 Gap frameworks

It is common to visualise a pathway from scientific discovery and/or idea generation through to “commercialisation” – that is, the operation of a viable business built around the sale of that discovery or idea. Such a pathway is illustrated below:



The framework diagram identifies a “gap” between the science and technology enterprise (built around the “ladder of science”) and the business enterprise (that operates on a “product development” cycle). It is a gap between an idea and the experiment on the one hand and the business venture on the other. It is between the “stable shore” of the S&T enterprise and the commercial reality of the business enterprise (Branscomb and Auerswald 2001). *Crossing the gap is about building a business.* Gap models presuppose a linear flow or progression between scientific discovery and technological invention through to production and sale of marketable products.

This gap concept is useful in that it points to the specific region of the innovation space where there is considerable interest in innovation policy. It is bounded at the earliest stage with the verification of a potentially commercial concept through laboratory work, and a later stage

with identification of what looks like a product that could be sold in an appropriate market. Recent research has pointed to not one but several “gaps” or disjuncture between the science and technology enterprise and the business enterprise: a disjuncture in motivation for research; a disjuncture between technology and business managers; a disjuncture in sources of funding (Branscomb and Auerswald 2001).

Few scientists engaged in academic research are motivated to undertake the research necessary to ensure that envisioned products are transformed into commercial reality with sufficient function, low enough cost and high enough quality and sufficient market appeal to survive competition in the market place. This research, often referred to as *reduction to practice research*, represents a departure from discovery and curiosity driven inquiry that motivates most scientists and researchers in an academic environment.

Many scientists would like to continue with discovery and curiosity driven research. They would, of course, like to receive recognition and reward from their discoveries and inventions in publications, patents and license income. However, it makes little sense to exhort all scientists and researchers to take greater responsibility for reduction to practice research and encourage them to be entrepreneurs. The entrepreneurial function is different and distinct from the discovery and invention function; only a few scientists/researchers have become successful in business. From this perspective, there is a shortage of entrepreneurs, or more specifically, people with entrepreneurial management skills to work at the interface between science and commerce.

There are important differences in cultures between scientists, executive managers and operational (sales and marketing) professionals (Kleiner 2001). Each has different training expectations, information sources and modes of communication. For example, the technologist knows what is scientifically interesting, technically feasible and fundamentally novel; the risks are loss of reputation and foregone returns; there is no risk in funding as work is financed from grants. By contrast, the investor manager knows about bringing a product to market, but will have to trust the technologist on technical particulars; an investor is generally risking other peoples' money.

In this context there is a gap between understanding technology risk and addressing market risk. Evaluation of risk depends critically on personal relationships and trust. They also depend on the institutional setting of those who share the risks of new ventures, innovators and investors alike. Deadlines, milestones and working to budgets are key performance indicators in business. These indicators are less important to scientists and researchers.

Delays can be explained and justified in terms of methodology, data problems and/or unexpected results, and budgets can be supplemented by another research grant. Pressure to meet customer and market expectations can distort objectivity and compromise research results (Bok 2003).

Assessment of risk ultimately depends on the definition of success or failure. This, in turn, relates to objectives, which may be institutional, personal or project related. Thus, an investor might define success in terms of return on capital – even if technical specification and market objectives change. However, government might define success as broad benefits to the economy (spillovers) – these may occur through commercialisation but also through transfer of IP created as a result of the project, or by knowledge embodied in researchers. In a university, academic professionals define objectives in terms of their research program; in learning by doing approaches, there are very few failures.

In a business environment the gap becomes apparent when the amount of money sought for research starts to add up to the point where management asks “what are you people up to?” and “what are we going to get out of it?” It is often too early in the process to answer these questions. If a researcher is fortunate enough to have the answers at the time the questions are asked, then the gap has been traversed. Stage gate and go/no-go resourcing and commercialisation strategies are an attempt to address this problem (Baghai, *et al.* 1999; Cooper 2001; Jolly 1997).

There is also a gap between research funds available to support the creation of an idea and the initial demonstration that it works – and the investment funds that are required to turn the idea into a market ready prototype. Typically there are few sources of investment available to bridge the gap in the funding sources. Investors include angel (seed) investors, venture capital firms specialising in the early stage, military or other public procurement, state or federal programs specifically designed for the purpose, and university funding from public or private sources.

Recognition of the gap has prompted numerous public policy and program interventions. These interventions have tended to focus on the finance dimension. Very few public policy interventions address the more institutionally embedded disjuncture between research motivation and management and commercial behaviours. That is, few interventions are directed towards building management capacity and capability at the interface between scientific discovery/technological invention and commercial application.

At a series of joint Harvard and MIT workshops undertaken in 2000 a general consensus was reached that technical risks are, in general, more manageable than other sources of risk in that the research process for dealing with them is better understood and easier to evaluate. Investors would prefer to take a technical risk rather than a market risk. Technical risks are much more accessible to deterministic tools than are some of the market risks at an early stage in new product innovation (Branscomb and Auerswald 2001).

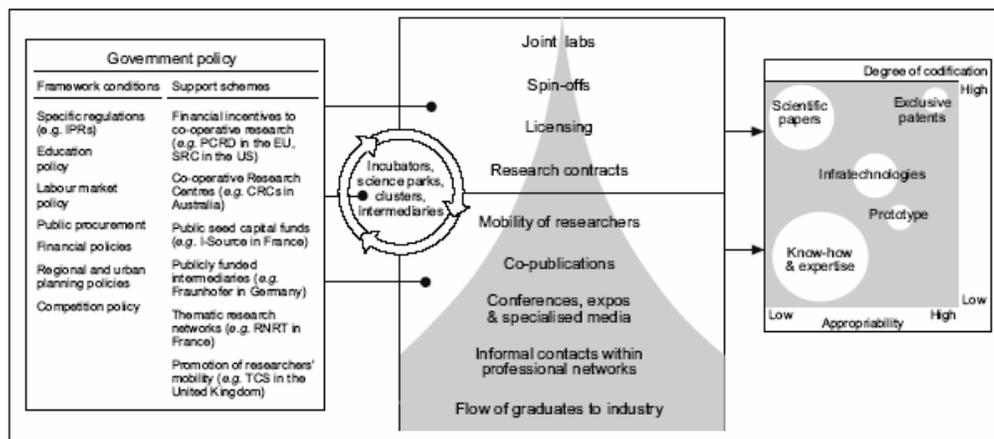
As the gap framework is a representation of a “linear flow” between discovery and commercial return, it does not focus attention on the various pathways that may have to be traversed and the relationships that need to be established to facilitate the movement. A relationship framework is outlined below.

3.2 Relationship frameworks

The interest of policy advisers, industry and universities in technology transfer and industry science relationships (ISRs) has generated numerous representations as to how this occurs. A great deal of management writing consists of organising frameworks that assist in thinking about the information that already exists. These frameworks include diagrams, pay-off matrices (eg the Boston Matrix) and check lists.

The OECD in its benchmarking study of industry-science relationships (OECD 2002) developed an intricate structural model of relationships and interactions. This is illustrated in Figure 2. The framework implies a very strong public sector role in stimulating industry-science relationships.

Figure 2: OECD Structural Framework



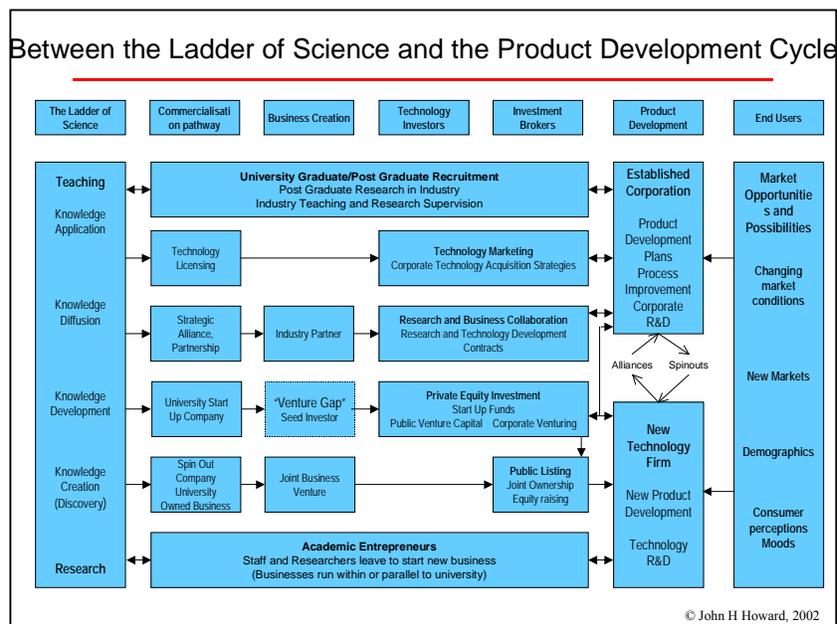
Source: OECD.

Models of Engagement

The OECD suggests that the bulk of industry science relations takes place through informal and indirect channels as well as through unrecorded direct channels. In the United Kingdom for example, innovation surveys have shown that, while almost half of manufacturing firms consider universities to be an important source of innovation, only 10 percent have developed formal relationships with them.

The flow of skilled personnel to industry is seen as the single most important channel of industry science relationships. Informal networks between faculty and former graduates and between former public researchers and their institute of origin account for a large, although difficult to measure, share of the total amount of knowledge exchanged between industry and public research. New information and communication technologies are seen to reinforce the role of these social networks. The existence of these technologies is a sufficient condition for communication to take place; the necessary condition is that industry has a *capacity to receive* communication through appropriate institutions for engagement.

By focusing on what is measurable through conventional techniques, economists and governments have generally underestimated these human resource-related relationships. They tend to overlook the fact that access to scarce human resources is always a key objective of industry in considering the merits of any type of linkage, formal or not, with public science. Nonetheless, a great deal of commercialisable knowledge, or what has been referred to as *knowledge product*, is transferred through a range of market based or management based institutional settings. A framework for thinking about transfer of knowledge products, drawing attention to some key institutions involved, is represented in the diagram below.



This framework is drawn from work undertaken for the Australian Research Council and published as *ARC Research Investment, Innovation Pathways and Support for Commercialisation: A Discussion* (Howard 2002a)

The framework draws attention to the relationships through which knowledge transfers take place between the higher education and business sectors. They include –

- The movement of personnel between the two sectors – most knowledge flows out of a university in the heads of the graduates and post graduates; there are also arrangements for bringing industry people into academia on specific projects
- Licensing of technologies to businesses – the most common form of formal technology transfer
- Strategic alliances and partnerships – for activities such as contract research
- Establishment of start-up companies – to commercialise a “breakthrough” discovery or technology
- Spin out of activities into new entities – where a research organisation has nurtured a business enterprise and no longer sees it as “core” business – such as consultancy, laboratories doing commercial work
- Academic entrepreneurs who undertake commercial activities and may leave to start a new business.

Both relationships and gap frameworks have been important in creating better understanding of the way in which knowledge is transferred into application and use, and the institutional settings in which they occur. They tend to focus, however, on a so-called *innovation progression gap* which has come to occupy the minds of science policy advisers and others concerned with the commercialisation of university research in the new science and innovation policy domain.⁴

Discussion of the innovation progression gap presumes some sort of logical flow between discovery, invention, and application, with an emphasis on creating and sending knowledge – but not receiving: inability to receive is considered to be a shortcoming on the part of technology investors, sometimes referred to as *industry receptors*, who are criticised for not taking up the high quality research that comes out of research institutions (Australian Academy of Science 2002).

⁴ The “Innovation Progression Gap” is a term that has entered into the lexicon of Australian science and innovation policy. (Australia. Coordinating Committee on Science and Technology University-Industry Interaction Working Group 1999). This gap has also been referred to as the “valley of death” (Branscomb and Auerswald 2001).

Relationship and gap frameworks and rationalisations gloss over more fundamental issues relating to the *demand* for new knowledge in a contemporary business climate, the way in which applicable knowledge is created in an engagement (mode 2) environment, and the characteristics of the industrial landscape. Forging strategic alliances, including industrial research partnerships and technology alliances, and creating markets for knowledge, underpin the observed progression from knowledge production to application. These managed and market relationships, it is argued in this thesis, are institutionally embedded and their performance requires strong institutional capacity and capability.

That is, the underlying argument of this work is that the concept of an innovation progression gap reflects a deficiency in capacity to organise and manage public-private industrial research collaborations and an institutional weakness in the market for knowledge. There are several dimensions to this issue: Firstly, there is a limited ability in university-business collaborations to create genuine strategic alliances and joint venture partnerships due to a lack of management skills in this area. Secondly, the supply side of the market is poorly organised and lacks leadership; markets work best when the supply side can assure quality, consistency and competency in relation to the products and services provided. And finally, technology investors, confronted with investment opportunities have limited capacity to build and create businesses due to their primary role as fund managers.

In relation to the first point, the problem has arisen in large part because of the tendency to focus attention and analysis on cooperation and collaboration – rather than coordination. This possibly reflects the influence of market type analysis of organisations that draw on transaction cost economics, and the tendency for analysis of organisational structures to be dominated by matters relating to control, compliance and incentives. However, the problem of “coordination in collaboration” is far from trivial. There is a tendency to treat coordination as a problem of cooperation (Grant 2001).

The second issue concerns the way in which the suppliers of knowledge products and services can assure potential purchasers that their approach to doing business is based on the highest levels of integrity, credibility and professional standards. Markets work best when there is leadership and commitment to fundamental principles concerning the way business is done. Industry and professional associations perform a critical role in this regard. Where leadership is lacking, markets become unstable and unreliable. This is not an argument against competition: it is a matter of having appropriate and well understood “rules of the game”. If

industries do not, or will not, commit to rules then governments tend to move in and take the initiative. This requires coordination at the level of the industry.

In relation to the third issue, it is often overlooked that linking buyers and sellers in a market environment requires skilled intermediaries who can manage the information asymmetries as between what is on offer and what might be required. The greater the level of uncertainty, the greater the level of risk, and the greater the need for effective intermediation. Venture capital investors, for example, stand between the creators of knowledge (scientists and researchers) and users, who may be businesses along the value chain, or final consumers. This relationship requires effective coordination between the seller and a potential buyer – that is, making the deal.

In other words, gap frameworks do not address *how* knowledge moves along the lines and through the boxes. They do, however, focus attention on the different pathways that knowledge can follow from creation to application. But frameworks tend to be one dimensional and do not necessarily allow for exchanges and building of two way relationships along those pathways.

The organising frameworks outlined above, and many others like them, provide a focus on what people already know (at least intuitively) and formalise and extend that knowledge. The development of frameworks is a lead into the assembly of empirical knowledge. There is simply too much information about business for it to be interpreted without some extensive conceptual structure.

A model, by contrast, contains premises and deductions and provides insights that can help explain and predict. A useful model is a way of learning about processes and interrelationships and goes beyond the structuring of existing knowledge. The usefulness of a model is determined by the extent of its application. In the following section a model of higher education-business-government interactions, based on a theory of convergence between institutions and which has received a great deal of attention in academic sociology and in public policy circles is outlined and appraised.

3.3 Convergence models

Drawing on the concept of mode 2 knowledge production, referred to in Chapter 2, there has been a great deal of effort directed towards developing models of engagement based on convergence of higher education institutions, industry and government. The best known

model is the so called “triple helix” model articulated by Henry Etzkowitz and Loet Leydesdorff in a number of publications over the last five years (Etzkowitz 1999, 2002; Etzkowitz and Leydesdorff 2001; Etzkowitz, *et al.* 1998; Leydesdorff and Etzkowitz 1998a, 1998b, 2001).

The triple helix model is based on a perception that in the context of the knowledge economy there has been a transformation in the functions of university, industry and government with each increasingly assuming the role of the other. Etzkowitz and Leydesdorff argue that:

Under certain circumstances, the university can take the role of industry, helping to form new firms in incubator facilities. Government can take the role of industry, helping to support these new developments through funding programs and changes in the regulatory environment. Industry can take the role of the university in developing training and research, often at the same high level as universities (Leydesdorff and Etzkowitz 2001).

The triple helix view is also associated with what is seen to be an institutional transformation of the research university into an *entrepreneurial university*. That is:

The entrepreneurial university is a result of the working out of an 'inner logic' of academic development that previously expanded the academic enterprise from a focus on teaching to research. The internal organisation of the Research University consists of a series of research groups that have firm-like qualities...sharing qualities with a start-up firm even before it directly engages in entrepreneurial activities (Etzkowitz 2002).

According to the triple helix view, the entrepreneurial university, with faculty and administration directly involved in translating knowledge into intellectual property and economic development, an “industrial penumbra” is created around the university. It is argued that changes within higher education are accompanied by an evolution of corporatist arrangements between academia, industry and government – with universities having a greater role in these relationships (Etzkowitz 2002).

The inner logic of the convergence argument is that the network relationships within the triple helix are changing the participating institutions into relatively autonomous yet interdependent spheres. The different helices are seen to be moving in a common direction to stimulate both competition and collaboration. The causal factor is identified as the knowledge intensity of economic development where institutional relations are restructured by reference to their innovative capacities. Organised knowledge production and control systems are seen to “provide a medium of social coordination that adds to economic exchange and political

decision-making with potentially synergetic interaction effects” (Leydesdorff and Etzkowitz 2001).

The convergence model recognises that in the knowledge economy innovation flows from the production of knowledge. However, the transformation of discovery and invention to innovation usually requires that the ideas be put to use through the involvement of a business partner (or a program manager in the case of public benefit innovation). Knowledge production is thus a sufficient but not necessary condition for innovation. Drawing on mode 2 thinking, the triple helix model suggests that convergence creates a potential that “can be actualised by bringing together users, producers, entrepreneurs, and policy makers in a ‘transaction space’ where problems and possibilities can be argued and traded” (Etzkowitz and Leydesdorff 2001). They state:

The construction of a transaction space does not have to lead to consensus. On the contrary: one expects differences of perspective, leading to creative interactions in which the participants can transcend the *idées reçues* of their respective organizations. When individuals take the network perspective, which can be broader than the sum of the participating groups, a new interaction dynamic may also be generated. When new ideas for projects and programs are exchanged among people of different backgrounds and interests, they may be challenged to act freely and creatively. Such mutual adjustments of expectations then begin to change the “selection environments” (Nelson & Winter, 1982) of the entrepreneurs and institutional agencies involved by making the options more knowledge-intensive.

The convergence model is based on a premise of communicative interaction in a network frame of reference that “opens a window on a universe of discourse that generates a set of coordinates transcending the points of reference of discourses that previously took place within separate institutional spheres” (Leydesdorff and Etzkowitz 2001). Examples are provided to validate the argument drawing on perceived interactions and inter-relationships in the information and communications technology industries and in biotechnology related pharmaceuticals.

The authors identify the emergence of a new profession of network coordinators and organisers who endeavour to make the complex system work progressively. Their task is to *translate* between different domains and languages and to get people who have been used to working in only one domain to perform tasks in several. These “innovation organisers” with inter-organisational and interpersonal skills have been seen to rise to senior levels in higher education institutions and companies, and increasingly form their own interface organisations and become known as “knowledge brokers”. (Leydesdorff and Etzkowitz 2001). These observations are relevant and applicable to the idea of the *engaged university* discussed in Chapter 2. However, the processes by which universities become engaged institutions are

complex and require careful consideration of the impact on mission and purpose and ongoing commitment to teaching and research in a mode 2 context.

The triple helix arguments are attractive, and have been quite influential, but are much overstated – and at times evangelical about the possibilities presented by the integrated institutional setting. The arguments are not, however, backed up by much in the way of systematic or empirical evidence. They extend observations in a narrow range of disciplines and industry sectors (notably life sciences and information technology) into a generalisation. The generalisations are supported by much anecdote, based on the University of California system and large US private universities that have a history of commercially oriented research. Moreover, the views have a heavy “statist” orientation, implying an important role for government, but overlook fundamental market issues relating to the sale and purchase of commercially applicable knowledge.

The actual scope and coverage of the triple helix type relationships may be much more limited than is assumed. It follows that promotion of such relationships, to the extent that this is seen as desirable by all parties, requires looking more closely at the formation, structure and maintenance of the relationships themselves. However, questioning the triple helix rationalisation is not to say that universities have a limited role in industrial development: rather, that role must be seen to accommodate continuation and maintenance of institutional values and reflect the resources that have to be committed to managing relationships and negotiating agreements with entrepreneurs for commercial activity. Too little attention to these matters in the past has resulted in misunderstanding, compromise and financial loss.

The most significant weaknesses in the triple helix argument are the underestimation of the complexity in establishing strategic alliances and joint ventures and then managing them in the transaction space, and assumptions of commonality in values and attitudes relating to the purpose and conduct of research. The experience of alliances in researcher driven collaborations has been that the initiative generally comes from individual researchers from various institutions coming together in an effort to find industry sponsors. These arrangements work when businesses have available significant amounts of organisational slack. Even where in principle agreement is reached for collaborations, there are often insurmountable hurdles to be crossed in resource allocation and reconciling institutional differences and priorities and the risks of compromise to institutional purpose.

Research alliances are often motivated by researchers to follow basic and/or personal research interests rather than participate in working towards a commercial outcome in a genuine

partnership. Universities still tend to see government funding for collaborative research as just another source of research funding.⁵ Businesses have been much more circumspect in initiating alliances with higher education institutions. These considerations, discussed further in Chapters 5 and 8, suggest that the concept of institutional convergence is inappropriate.

The overall impact of higher education research on business strategy is much less than is claimed (see Chapter 5). The relationships have potential and are emergent, but there are many underlying and fundamental institutional differences. Moreover, relationships are also much more complex than a simple observation of interactions would suggest. As argued above, there are complex market and organisational issues involved. Rather than convergence, the emergence of the corporate university, together with a capacity to create credible knowledge products in a research environment, is actually creating a separate and identifiable institutional space between higher education institutions and businesses. This is occurring in the context of the institutional development of the higher education industry.

It is the “transaction space” identified in the triple helix model that requires much more attention and analysis. A central argument of this thesis is that while there is a conceptual weakness in the concept of a triple helix effect, there are strong grounds to suggest that there has been an emergence of a mode 2 distributed system of knowledge production in which there is a wide variety of knowledge producers and knowledge users in an increasingly sophisticated, and global, knowledge market. The challenge for individual higher education institutions is to identify their strategic competitive advantages in this market and to decide when to enter the market, through mediated relationships, or enter into agreements with business partners in the form of managed relationships.

There is, at the same time, a great deal of interest in the development of *knowledge clusters* built around networks of interaction and communication among universities, businesses, government agencies, and the community in a specific geographical location. This has been the focus of attention in discussions of what has become known as *relational capital* (Florida 2002) that draws attention to the scope for knowledge sharing among people with interests in exploring creativity and arranging for its adoption, application and utilisation on a collective basis.

⁵ This is apparent in University Research and Research Training Reports submitted to the Department of Education, Science and training.

The point is that all three forms of relationship – market based, managed and shared - are developing in the light of both supply and demand conditions. To suggest an institutional “convergence” based on network effects is to gloss over the important characteristics of market transactions, managed relationships and community based interactions and the institutional characteristics of each. It is argued in the next section that these relationships are in fact institutionally driven and require, for their effective performance, a commitment to institutional capacity building.

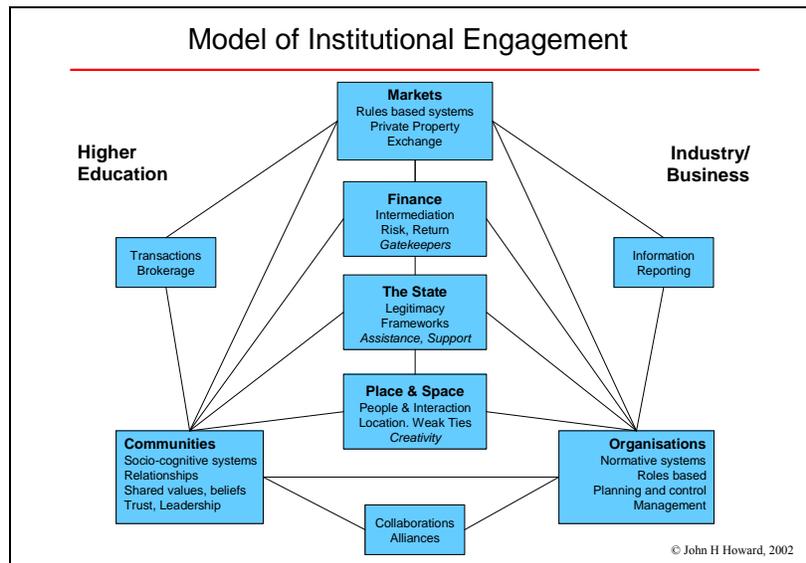
3.4 A new institutional model

A new model is proposed that provides insights into the operation of higher education institutions in the knowledge economy based on identification of the institutional factors and characteristics that impact on the production, distribution, exchange and management of knowledge. The focus is on the embedded institutional characteristics of the forms of engagement that occur between universities and industry. The model could be extended to cover the form of engagement between universities, industry and government where there has been a great deal of recent attention given to citizen engagement (Edwards 2003).

It is proposed that the forms of engagement between the core institutions of higher education and industry are themselves institutionally based. Engagement is also enabled by a set of institutions represented by the financial sector (often referred to as financial institutions), the state (institutions of government) and the institutional setting of place and space. Unlike the triple helix model, the state is not seen as a core institution. This is on the basis that innovation is something that businesses do to create wealth. The state can only be a supporter in this process through the provision of assistance and subsidies.

A diagrammatic representation of the model is set out in Figure 3. The model is described and articulated in the remainder of the Chapter.

Figure 3: Models of Institutional Engagement



3.4.1 Overall framework

The definition of institutions has created a lot of heat. A great deal of confusion has emerged as a result of the work and focus of economic historians, economists, organisational economists, political scientists, functional sociologists and organisation theorists. There is also a significant amount of academic imperialism between disciplines, although there is an underlying agreement that institutions are important. Richard Scott, an organisational sociologist, defines institutions in the following terms:

Institutions consist of cognitive, normative and regulative structures and activities that provide stability and meaning to social behaviour. Institutions are transported by various carriers – cultures, structures, and routines – and they operate at multiple levels of jurisdiction (Scott 2001).

Scott identifies six levels for the conceptualisation of institutions: world system; societal; organisational field; organisational population; organisation; and organisational subsystem. All levels are widely employed and recognisable in social and economic analysis. The least familiar, but which Scott argues is the most significant to institutional theory, is that of the organisational *field, or domain*. Drawing on DiMaggio and Powell (DiMaggio and Powell 1991), Scott defines an organisational field as:

... those organisations that, in the aggregate, constitute a recognised area of institutional life: key suppliers, resources and product consumers, regulatory agencies, and other organisations that produce similar services or products (Scott 2001).

Fields are bounded by the presence of shared cultural-cognitive or normative frameworks or a common regulatory system so as to constitute a recognised area of institutional life. This definition of an organisational field describes a level at which market, organisational or community forces are likely to be particularly salient (Scott 2001). These forces provide the basis for engagement.

Thus, from the perspective of institutional theory, the production, acquisition and utilisation of knowledge can be identified as an organisational field in that it involves the transactions, relationships, and interactions between higher education institutions, businesses, communities, the state and the financial sector. In this respect it connotes the existence of a grouping of organisations that “partakes of a common meaning system and whose participants interact more frequently and fatefully with one another than with actors outside the field” (Scott 2001). The concept of an *innovation system* or a *transaction space* reflects this concept of an organisational field or domain.

It is proposed that the engagement between organisations in the innovation domain are built around three institutional pillars: regulative systems (rules based); normative systems (roles based); and cultural-cognitive systems (values and learning based). These pillars are not mutually exclusive and they are in fact heavily intertwined, but they provide meaning, explanation and prediction in a variety of situations and circumstances (Scott 2001). The characteristics of each form a continuum moving from the legally enforceable to the taken for granted.⁶ The features of the three institutional pillars are summarised in Figure 4.

Figure 4: Institutional pillars and the institutions of engagement

	Institutional Pillars		
	Regulative	Normative	Socio-cognitive
Basis of order	Regulative rules	Binding expectations	Constitutive schema
Basis of compliance	Contracts	Social obligation	Cultural cognitive
Mechanisms	Coercive	Normative	Mimetic
Indicators	Rules, laws, sanctions	Certification, accreditation	Common beliefs, shared logics
Symbolic systems	Rules, laws	Roles, expectations	Categories typifications
Relational systems	Governance systems	Regimes, authority systems	Structural isomorphism, appearance
Routines	Protocols, standard operating procedures	Jobs, roles obedience to duty	Scripts
Artefacts	Objects complying with mandated specifications	Objects meeting conventions, standards	Objects posing symbolic value
Basis of communication	Transactions	Formal relationships	Social interaction
Basis of legitimacy	Legally sanctioned	Morally governed	Comprehensible, culturally supported

⁶ Scott suggests it would be possible to develop an all-inclusive model as an overarching social and economic framework, such integration would be over-deterministic and would mask important differences between institutional categories (Scott 2001).

Models of Engagement

	Institutional Pillars		
	Regulative	Normative	Socio-cognitive
Disciplinary orientation	Economics, Finance, Law Organisation economics	Sociology Organisational psychology	Anthropology Economic geography
Engagement institutions	Knowledge markets	Knowledge organisations	Knowledge communities

Source: Based on Richard Scott, *Institutions and Organisations*, Second Edition, 2001

The regulative or rules based institutional pillar acts to constrain and regularise behaviour through the creation of rules, laws and governance systems. In a Westminster system of government for example, the Legislature acts to create rules, the Executive is responsible and accountable for their implementation and the Judiciary is responsible for interpretation and enforcement and dealing out of sanctions. Governments operate under rules based systems to implement policies and programs to achieve objectives on the basis of legislation and other rules based specifications.

At a corporate level a company's Memoranda and Articles of Association, together with the Corporations Law, set out the rules under which a business operates and the system of governance covering the role of Boards and the duties of Directors. Corporations law and governance systems also provide a basis for investor confidence in corporations. Non Government organisations and even competitive sport operates under a rules based system ("the rules of the game").

Compliance with rules is secured on the basis of power and authority. Weber identified the capacity to execute authority in terms of traditional (tribal), charismatic and rational-legal characteristics (Weber 1964). Predominance of objective and unbiased rational-legal systems of governance has provided stability for the development of enterprise and risk taking in capitalist economies. The capacity to recognise, own, and trade property lies at the basis of the capitalist economic system. The development of capitalist society is largely dependent on the capacity to recognise, secure, protect and trade in those property rights (De Soto 2000; Weber 1964). In previous generations, the focus of attention has been land and physical capital. In the knowledge economy the focus of attention is intellectual capital registered by the state as Intellectual Property (IP) rights.

Markets operate on the basis of rules and, in particular, the capacity to negotiate and enforce contracts. Some of the oldest legislation relates to securing property rights in land and the sale of goods, now supplemented by a range of regulations and sanctions administered by state agencies concerned with fair trading. By comparison there is little legislation and regulation relating to the market for knowledge. Patent, trade mark, designs and copyright legislation provides for the vesting of property rights in inventions and other aspects of

intellectual property and facilitates the sale and licensing of those rights in the market for knowledge. However, unlike law relating to real property there are limited provisions relating to remedies for theft and expropriation and for the imposition of covenants to give effect to national interest considerations regarding exploitation and access (eg compulsory acquisition or surrender if not used or developed).

John Kay has observed that the rules of the market economy are extensive and largely implicit. They are determined and enforced more by social convention rather than legal processes. Government is seen as only one agent in the simultaneous evolution of technology, market institutions and the social and political context (Kay 2003). He notes, however, that many innovations in the rules of the market economy, such as the development of limited liability, require deliberate legal and regulatory structures. He points out:

New policies are required to establish a legal framework for new activities – such as the Internet and the genome – and to modify old rules to meet modern technologies. Good rules cannot be made by general principle: solutions are usually specific to technology and a market. The legal framework of both genome and Internet has been mistakenly allowed to depend on judicial interpretation of legislation directed towards quite different purposes. Government must often be the pro-active rule maker, not the referee (Kay 2003).

Compliance in rules based systems may be secured through force although approaches based on inducements and incentives are generally considered to be more effective in terms of motivating and changing behaviour (Scott 2001). Organisation and finance economists have taken an interest in the cost of compliance and enforcement of rules through analysis of transactions costs. Agency theory points to the cost of monitoring performance under contracts on assumptions that agents have incentives to abscond and principals have insufficient information to assess performance (Barney and Hesterly 1996).

These assumed behaviours provide a rationale for the involvement of third parties, or intermediaries, in securing and monitoring exchanges and contracts in a market environment. Venture capital investors are expected to perform this role in the commercialisation of research in start-up companies. Due to variations in perceptions of risk, this role of financial intermediation is often at odds with their role as a business advisor in the commercialisation process, particularly where they do not have sufficient business development skills and capabilities. There are no rules that constrain the capital gains, or what some see as the excessive economic rents, captured by venture capitalists in investment exits. Other intermediaries in the market for knowledge include technology transfer offices, patent attorneys, technology brokers, and corporate technology licensing executives. Collectively, these intermediaries operate as *engagement institutions* in the market for knowledge.

The normative pillar captures the prescriptive, evaluative and obligatory dimension in social life. Normative systems cover both values and norms. Values are conceptions of the preferred or desirable within a framework of standards of behaviour, while norms specify how things should be done. Normative systems define goals and objectives and ways in which they should be pursued. They reflect, for example, the way in which government relates to its constituents and stakeholders in the case of public programs, how businesses relate to their customers and suppliers, and how management relates to their employees and contractors (and vice versa).

Normative perceptions of institutions focus on how things are done as distinct from the formality of direction and control exercised through authority relationships. The normative dimension forms the foundation of the business enterprise. Business organisations are social institutions where activity is coordinated to achieve a common purpose or goal. The normative focus on organisation departs from the formal bureaucratic approach embedded in the concept of bureaucracy with its emphasis on the rational legal approach to authority relationships (Albrow 1970). Normative conceptions of institutions stress the stabilising influence of social beliefs and norms which are both internalised and imposed by others. To normative theorists shared norms are regarded as *the* basis of a stable social order. Social institutions are also seen to have moral roots (Scott 2001).

Whereas rules govern market behaviour, values and norms are seen to be more important in organisational behaviour. While rules based institutions are of interest to economists and lawyers, normative conceptions of institutions tend to be of interest to sociologists and social psychologists who focus on organisations as social institutions. Their focus is on *roles* – conceptions of appropriate goals and activities of individuals or specified social positions, that is, prescriptions about how specified actors are expected to behave. Roles can be devised formally as in an organisational context that defines a management hierarchy that sets out rights, responsibilities, accountabilities, and access to resources. This hierarchy forms the basis for a division of labour and specialisation of function. Roles can also emerge informally on the basis of interactions and experience.

Knowledge based organisations form the basis of engagement between universities and business when constituted as education services integrators, joint venture cooperative research centres, strategic alliances and public-private industrial research partnerships. Government is often included in the scope of knowledge organisations on the basis of its substantial financial involvement in many of these entities. Approximately half of Australian cooperative research

centres have government agency involvement and their activities are directed towards public sector problems and issues. In these respects knowledge organisations function as institutions of engagement.

Knowledge management in an organisational setting encompasses the following roles (Davenport and Prusak 1997b):

- Design, implement and oversee an organisation's knowledge infrastructure, including its libraries, knowledge bases, human and computer knowledge networks, research programs, and knowledge oriented organisational structures
- Manage relationships with external providers of information (eg academic partners or database companies) and negotiate contracts – already a major expense item for many companies
- Provide critical input into the process of knowledge creation and use – eg new product development, market research, strategy development – and facilitate efforts to improve such processes as necessary
- Design and implement knowledge codification approaches – specifying key categories of information or knowledge that the organisation would address and entail mapping both of the current knowledge inventory and future knowledge models
- Measure and manage the value of knowledge – either by conventional financial analysis or by “anecdote management”. If an organisation has no sense of the value of its knowledge it won't last long
- Manage the organisation's professional knowledge workers, giving them a sense of community, establishing professional standards and managing their careers.

The cultural-cognitive dimension emphasises shared conceptions of what constitutes social reality and the frames of reference through which meaning is derived. It is an area of institutional theory that is of interest to anthropologists who give attention to the cognitive dimensions of human existence. What someone does is considered to be in a large part a function of that person's environment. Symbols in the form of words, signs, gestures, have an effect by shaping meanings attributed to objects and activities. Culture is seen as more than a set of subject beliefs: it is seen as a symbolic system that is objective and external to its human participants. That is, interpretive processes are shaped by the external cultural framework (Scott 2001).

The cultural-cognitive concept of institutions forms the foundation of community, represented in various forms such as “the community of science”, “academic community” and more recently “communities of practice”. Institutions conceived in this way emphasise the central role played by the socially mediated construction of a common and shared framework of meaning and purpose – such as research excellence, scholarship and the creation of new knowledge. It also forms the foundation of thinking in relation to science and technology

“clusters” that are being identified and analysed by economic geographers and public policy academics and where knowledge based industrial development is advocated and promoted. The circumstances under which wider belief systems and cultural frames can be imposed on geographical areas to create knowledge clusters are an important issue in discussion and analysis of engagement.

As noted earlier in this work, discussion and analysis of engagement has tended to focus on the concept of communicative interaction – a socio-cognitive form of interaction. It has been argued here that engagement also takes place in market based relationships in markets for knowledge, and through managed relationships in the form of knowledge organisations such as joint venture arrangements (for example, cooperative research centres, strategic alliances and industrial research partnerships).

The way in which the institutional pillars identified in the preceding discussion relate to market, organisational and community settings are summarised in Figure 5.

Figure 5: Institutions of engagement - key dimensions

	Knowledge Markets	Knowledge Organisations	Knowledge Communities
Institutional foundation	Regulative – rules based	Normative – roles based	Socio-cognitive – relationship based
Approach to knowledge transfer	Trade, exchange Knowledge commercialisation	Manage, control. Knowledge application, adoption and use.	Knowledge sharing
Currency	Transactions in Intellectual Property	Roles - motivation – status, position	Relationships - shared values, beliefs
Key values	Distrust - The agency problem	Command, Control (direct or indirect – supervision or performance reporting)	Trust – loyalty and commitment Mutual obligation
Compliance mode	Contracts, “deals”	Coordination	Communication
Integrating mechanism	Rules, threat of legal sanction	Management, control, direction	Cooperation
Primary Behaviours	Hoarding	Need to know	Sharing
Property related issues	Secure ownership and control of property and assets	Assignment of property to “offices” or “positions”	Widespread sharing of information and knowledge
Methods to achieve results	Focus on rules, sanctions	Focus on strategies and structures	Focus on purposes, processes
Institutional representations	Technology Transfer Offices Venture capital investors Knowledge brokers IP lawyers, accountants	Research partnerships, alliances, joint ventures established as research centres and research organisations	Knowledge communities, knowledge clusters Civic entrepreneurs

The dimensions of the institutions of engagement are not mutually exclusive and some features on one may be reflected in another. It is the dominant form that is of interest. Moreover, the identification of engagement institutions eliminates the need to think of institutional convergence in industry-science relationships with core institutions taking on the

characteristics of the other. It will be argued in subsequent chapters that high levels of university and business institutional performance are more probable if these institutions work towards attaining high levels of achievement in the areas of institutional purpose, competence and specialisation. Broader objectives such as commercialisation, industrial research collaboration and regional development are best delivered through strong and effective engagement institutions.

It will be argued in Chapter 4 that higher education institutions that attempt to emulate the behaviours of a commercial business put at risk their institutional credibility and integrity. Companies that emulate the working environment of higher education institutions do so at the risk of compromising their purpose of satisfying customers and creating wealth for shareholders and other stakeholders through loss of control and accountability. At the same time, it has been argued that much of the contemporary change management and organisation development management theory and advice reflects a strong management ideology of securing compliance and commitment to corporate purposes (Clegg and Dunkerley 1980; Hoopes 2003).⁷

The actions and directions of engagement institutions are by no means mutually exclusive. To a significant extent performance in one form of engagement will be enhanced by the contribution of institutional behaviours from another. In knowledge organisations, relationships are often underwritten by market based exchange transactions relating to incoming Intellectual Property. It is well known that knowledge organisations work well when there are networks of informal, community forms of engagement. And finally, communities inevitably rely not only on leadership but also on effective management for their functioning as well as simple exchange transactions.⁸

Markets also work well when there is a high level of trust between participants. They also require some degree of organisation, particularly on the supply side. This is reflected in joint arrangements for quality control and assurance and commitment to professional standards and codes of ethics. However, trade practices legislation prevents collusion in approach in market transactions. Organisations are also adopting market based relationships for the internal

⁷ This issue was analysed extensively by the author in a paper submitted for a Master of Arts Degree in Administration.

⁸ The sporting arena also provides examples of where regulative, normative and cognitive elements are in place: cricket for example is governed by rules (the "laws" of the game), by norms (the roles of various players in nominated positions) and cognition (how the game is played – and won).

allocation and control of resources. However, internal market based arrangements if carried too far run the risk of driving out innovative capacity and capability (Ghoshal, *et al.* 1999).

The point is, however, that knowledge markets, knowledge organisations and knowledge communities exhibit a dominant form of institutional behaviour. What is of interest from the perspective of higher education and the production of knowledge is the movement from an essentially community based form of engagement to both a market and an organisational basis. What is also of interest is the formation and development of institutional underpinnings of the dominant form. This includes, for example, the academic values that underpin transactions in knowledge markets and in the managed relationships of research centres.

Finally, and contrary to much contemporary discourse, there is also a need to acknowledge the continuation and *reinforcement* of the institution of the community of science made possible through improved management practices and market considerations.⁹ In this regard, a former academic dean and chief academic officer in the US has commented:

If it is true that the American university system is the envy of the world, part of the credit rightly goes to the unrelenting influence of the for-profit sector, which has stood for the application of education in direct response to social and economic needs and the right to turn a profit on a product or service well delivered and which has continued to force change in a system that has stubbornly resisted it (Ruch 2001).

A central proposition of this thesis is that regulative, normative and cognitive institutional categories relating to markets, organisations and communities (as identified in Figure 4) are embedded in *the institutionally characterised forms of engagement between the institutions of higher education, industry and government*.

Further discussion of the characteristics of the three forms of engagement is provided below.

⁹ That is, and as discussed in Chapter 2, the “propertisation of knowledge” can actually strengthen the academic institution, providing its ownership is managed effectively and appropriately.

3.4.2 Knowledge markets

The evolution of the knowledge economy has seen the emergence of knowledge products reflected in forms such as patents, copyrighted materials, courses, and a range of advisory and consultancy services. These products are sold, and purchased, in a market – an institution where buyers and sellers meet. Knowledge markets, as with any other markets, have distinctive characteristics: they are focussed on a transaction, or exchange, that delivers value to both the creator and the user. Value relates to expectations, benefits and costs incurred by each party to the exchange.

The interests of the sellers and the buyers rarely converge in market transaction. Accordingly, either or both parties are represented by intermediaries. The development of the market for knowledge has seen a proliferation of intermediaries to stand between buyers and sellers as brokers, advisers and arbitrageurs. The greater the information asymmetry between buyers and sellers the greater the role of an intermediary to interpret and represent the interests of buyers and sellers. This need emerges particularly where the underlying institutional purpose of buyers and sellers are divergent. For example, higher education reflects a community institutional base whereas businesses reflect an organisational base. As the need for intermediaries evolves, knowledge markets develop further as institutions of engagement.

Technology Transfer Offices perform an engagement role in acting for the knowledge creator by securing Intellectual Property rights and representing the attributes of the product to potential purchasers in industry.

Venture capital investors are a special form of intermediary who seek to transfer knowledge to an end user by supporting the formation and development of knowledge companies. These companies continue as stand alone ventures or will become integrated into the value chains of large industrial corporations (for example biotechnology start-up companies as knowledge providers to pharmaceutical companies).

Corporations also purchase knowledge products and services through contracts with research providers. They also rely on intermediaries such as technology licensing executives and independent brokers to assess the efficacy of a knowledge product. However, the interest and expertise within corporations to source innovation externally is still in the early processes of development (see Innovation sourcing, page 117).

Other intermediaries in the market for knowledge include corporate lawyers, taxation accountants, management consultants and a range of other business advisers who seek to earn fees and rents on the basis of the value they might bring to a transaction.

Intermediaries have also been established to develop and market education courses for overseas students, vocational and professional certification and consultancy services. Some of these are conducted totally on-line.

As indicated previously, markets work on the basis of rules and regulations that provide the legal and operational framework for transactions to be negotiated, registered and enforced. Compared to other markets, the market for knowledge is relatively under-developed and immature. As indicated, the engagement institutions are still in the process of evolution. As with most markets in their early stages of development, it suffers from an absence of what has been referred to as honest brokers or trusted agents (Maister, *et al.* 2000) – people who have the reputation, credibility and integrity to act on behalf of both buyers and sellers of knowledge products.

The knowledge market tends to be dominated by considerations relating to Intellectual Property law and endeavours to place a value on inventions and discoveries. But Intellectual Property does not have any value unless there is a business model associated with it and a customer prepared to sign a cheque. The value of IP, like the value of land, is in its application and use from the point of view of the buyer. Moreover, accepted patent attorney practice is to assert a far broader range of intellectual property rights than a researcher could ever have realistically claimed. This practice, which is equivalent to a hoarding behaviour, can work to prevent much needed products from reaching the market promptly (Gwyne 2003).

With the number and scope of market intermediaries, the knowledge market also suffers from an *agency problem*. The agency problem arises where the interests of the agents and principals diverge. Agency costs arise where the principal wishes to ensure that the agent behaves as if it were maximising the principal's welfare. The problem is very apparent in the venture capital sector where the interest of the Technology Transfer Office and a venture capital investor quite often diverge widely.

The issues raised above will be canvassed more fully in Chapter 7.

3.4.3 *Knowledge organisations*

Knowledge is also transferred between institutions through managed relationships. These relationships include the wide variety of partnerships, alliances and joint ventures that stand between higher education institutions and businesses tasked with the production of knowledge for an industrial application. They operate as cooperative research centres, industrial research institutes or looser forms of association brought together on a project by project basis.

Notwithstanding a perception of virtuality, that is cooperative arrangements occur among multiple partners in different locations, they are based on fundamental principles of management: some form of organisation and executive responsibility is required to achieve the objectives of the partnership, alliance or venture; and people have to understand the organisation structure they work in (Drucker 1999). Beyond that, a person who may be a boss in a formal organisation becomes a partner in an alliance, joint venture or partnership. In other words, organisation becomes an instrument, not a structure. This requires people to have a high tolerance for ambiguity.

A great deal has been written about innovation management *within* organisations, including the creation of the right environment for the development and nurturing of ideas from conception through to market. One of the earliest, and most significant contributions in this area is by Burns and Stalker in *The Management of Innovation*, first published in 1961 (Burns and Stalker 1994). Importance is attached to “organic”, or community forms, of organisation that stress teamwork, collaboration and acceptance of a certain degree of uncertainty and ambiguity. These considerations are equally important to relationships *between* organisations in a distributed environment.

The tasks of managing in this inter-organisational environment are complex and are reflective of the well known challenges of matrix management (Mintzberg 1993). However, the basic functions of responsibility, authority and accountability relating to purpose and achievement of purpose must be accommodated in these organisations. There is also an expectation, however, that management will be undertaken in a *team* environment that is consistent with the values of research projects. But there are many types of team. As Drucker observes:

It is generally assumed that there is only one kind of team – the Jazz Combo – and that it fits every task. Actually there are at least half a dozen – perhaps a full dozen – very different teams, each with its own area of application, each with its own limitations and difficulties, and each requiring different management. The team that is popular now, the Jazz Combo, is arguably the most difficult to make work and the one with the most severe limitations. Unless we work out, and fast, what a given team is suited for, and what a given team is not suited for, teams will become

discredited as “just another fad” within a few short years. Where they do belong, and where they do work, they are the most effective organisation (Drucker 1999).

In the area of knowledge based organisations that are built around joint ventures, partnerships and alliances, teamwork is important, but it is also important to find the organisational framework that will deliver the results expected of the alliance, venture or partnership. The issue is not so much finding the right organisation *per se*; it is a matter of finding the one that fits the task. The joint collaborative climate has provided an opportunity to experiment with organisational forms and structures (Howard 2003b).

Difficult and complex issues arise in joint venture organisations concerning relationships, responsibilities and accountabilities to joint venture partners, particularly where a superior in one of the joint venture organisation is tasked to do performance appraisals of staff members who spend most of their time working in the collaboration team. Issues also arise concerning confidentiality in relation to projects underway in the joint venture organisation and the coordination of work between the joint venturers and the joint venture entity. Experience in the Cooperative Research Centres Programme suggests that the majority of the staff should be assigned to and effectively be employed by the partnership entity (Howard 2003b)

These issues are explored in Chapter 8 in the broader context of a collaboration continuum.

3.4.4 Knowledge communities

Science is organised as a community that follows the rules of the gift economy. Scientists “give” papers at conferences and seminars. The observation is made that:

If science followed the rules of an exchange economy, scientists would not give papers; they would seek to get a good deal by selling them or trading them in such a way that they got more knowledge than they gave. They would gain status not by giving away knowledge, but by hoarding it. If scientists had followed the rules of the exchange economy we might not have escaped the Dark Ages (Pinchot 1998).

In practice, the scientist with the greatest status is not the one with the greatest knowledge. Status comes from contribution to the field. A scientist with great knowledge, but only minor contributions would not get tenure (Pinchot 1998).

Peter Senge, author of the widely acclaimed book, *The Fifth Discipline*, has commented recently that:

The discipline of innovation is practised successfully in many domains of human affairs, notably the arts and science. Interestingly, when it is practiced effectively it is invariably done within communities, among diverse individuals who share a common purpose. Energised communities, for example, characterise most periods of

innovation in the arts, such as the birth of impressionism, or modern dance, or jazz. Likewise, science at its best is an intensively collaborative undertaking; even when the collaborators are strong individuals competing with one another, their competition occurs with a larger mediating community. Likewise in business, real innovation is much more collaborative than at first appears (Senge 1999).

The community dimension stresses the importance of “social capital”, that is, the stock of active connections among people: the trust, mutual understanding, and shared values and behaviours that bind the members of human networks and communities and make cooperative action possible. It is characterised by high levels of trust, robust personal networks and vibrant communities, shared understandings and a sense of equitable participation in a joint enterprise – all of the things that draw people to a group. This type of connection supports collaboration, commitment, ready access to knowledge and talent and coherent organisational behaviours. From the point of view of innovation, however, *too much* social capital can work against innovation and change (Cohen, Don and Prusak 2001).

Research has found inter-firm networks at the heart of the most vigorously entrepreneurial sectors of the US economy. The basis of inter-company collaboration is global as well as regional. Moreover, the “virtual” or “hollow” corporation, whilst large in terms of sales, may still be a small business in terms of numbers of employees. Observations of Japanese and Asian business behaviours have led westerners to perceive that they too had networks in their own economies. Corporate legal structures are “draped lightly” over underlying networks based on ties of consanguinity or shared ethnicity. This has raised fundamental questions about the nature of the firm itself, casting into doubt assumptions about identity, agency and legal personality that had long been taken for granted (DiMaggio 2001a).

It is important to note a difference between “communities” and “clusters”. Clusters of similar activities can be identified, described and documented, but they do not necessarily amount to communities in an institutional sense. Moreover, the co-location of universities, research institutes and businesses does not mean collaboration and the existence of a knowledge community. Whereas the primary instruments of engagement in markets are rules, and in organisations management, the primary instrument of engagement in knowledge communities is communication. Knowledge communities are characterised by a high level of interactive communication. It cannot be assumed that people and organisations that come from different institutional structures, routines and cultures will find the sharing of knowledge through communication easy – or even desirable.

The concept of *communities of practice* has emerged from the social capital discussion and analysis (Wenger, *et al.* 2002). Social capital consists of the stock of active connections

among people: the trust, mutual understanding, and shared values and behaviours that bind the members of human networks and communities and make cooperative action possible. This type of connection supports collaboration, commitment, ready access to knowledge and talent and coherent organisational behaviours. Social capital is mainly created and strengthened in the context of real work. Special events and team building exercises are seen to be largely ineffective (Cohen, Don and Prusak 2001). Communities are drawn together by common activities and working towards shared and mutually agreed purposes. They cannot be managed into existence and light touch leadership is advocated.

3.5 Institutional enablers and facilitators of engagement

Institutional engagement involves another set of institutions that enable, facilitate and support engagement. The most significant institutional enablers/drivers are financial institutions, the institution of place and space, and the state (government agencies and organisations). The institutional features of each are discussed briefly below.

3.5.1 Financial Institutions

Accounts of the innovation and technological advance often overlook the role of financial institutions and financial intermediaries. However, innovations in technology are closely associated with innovations in financial services. An intermediary is a financial agent that reduces net incentives and control problems in investment decisions. Virtually every model of a bank has as its fundamental feature some advantage from delegating decision making to a specialist and ensuring that the “delegated monitor” faces incentives to behave appropriately. Venture capital funds managers are a specialist intermediary.

Financial intermediaries perform a specialist role to transfer funds, screen applicants, monitor managerial performance and firm profits, and design and enforce specific contractual covenants. The growth of institutional investors and venture capitalists are the two important developments that have helped reduce financing costs associated with asymmetrical information problems and potential conflicts between managers and shareholders in financing high-risk new technology based companies.

Pension funds and similar institutional investors have also become an important element in financial capitalism. They have become major investors in public equity markets and more recently have become involved in growth stocks – taking positions in unseasoned companies. Growth in their holdings of equity has been dramatic (Calomiris and Ramirez 1996). This has

been facilitated by an ability to obtain information, control corporate performance, as well as non-wage compensation, and tax exemptions. According to a recent study, there has been

... a surprising lack of connection between economists studying finance and those studying technical change on the other. The neo Schumpeterian have neglected the financial aspects of the economic process – although they acknowledge that diffusion of technological innovations is a matter of investment and the role of new technologies as engines of innovation in the economy cannot be played without the financial fuel. Yet the relationship is consistently ignored. Schumpeter was clear about the two roles – that of the entrepreneur and that of the financier as the interdependent wheels turning innovation forward (Perez 2002).

Over the last several years people having been putting more money into mutual funds than they have into bank accounts. The trend to move money into the marketplace is a global phenomenon, although the trend has been led in the USA. The world's financial markets are flush with cash and are expected to grow ten fold over the next 10 years - from \$US20 trillion in 2001 (Kurtzman 2002).

Financial institutions have large amounts of capital to be allocated which allows substantial support for innovation as either start-ups or release of innovative capacity from existing corporations. It has been argued that with so much money invested in capital markets there is plenty of money for companies – new companies, established companies, or parts of established companies. There is also money for not yet profitable companies financed through the intermediation of the venture capital fund manager (Kurtzman 2002). In Australia there is, however, a shortage of skilled venture capital investors and business advisers capable of pulling through early stage companies to commercial (Howard 2002c, 2002d, 2002e). Whilst early stage investors are experienced in the finance sector and in funds management, very few have had direct experience in running a business. This is in contrast to the United States.

The growth resources made available by institutional investors, generated largely through provisions for pensions and superannuation, has brought a new scope to financial relationships in both the market for knowledge and the structure of knowledge organisations. Financial institutions have supported technology start-up companies as well as R&D spinout companies from large corporations (eg Lucent) in multi-tiered arrangements involving institutional investors, trust bankers, venture capitalists, large commercial banks and investment bank underwriters. These arrangements have parallels with the development of universal banking in earlier periods – large scale funding sources, and continuity in relationships between firms and intermediaries.

The interest of major institutions in the performance of corporations has given weight to the objectives of shareholder value and has increased the accountability of managers to boards and to shareholders for performance. Financial institutions have a major impact in corporate decision making, corporate structure and in a very real sense, the resources allocated to research and development.

The pattern of influence of financial institutions over corporate activity parallels the influence over state activity in connection with the financing of government debt. Financial institutions, through financial “markets” were major advocates of cutting public expenditure to eliminate budget deficits and thus ease the financing burden. They have are now having a significant influence in the break up and divestment of a number of global corporations as well as Australia’s major corporations. These factors influence the way in which corporations are able to source and acquire innovative capability.

3.5.2 *The institution of location (place and space)*

Institutions have a spatial or locational orientation. One of the earliest manifestations was the city state and later the nation state. Location provides the environment for markets to exchange, for organisations to manage and communities to share. While much has been said and written recently about “virtual” communities, markets and organisations it is still the case that these institutions are location specific, although increasingly footloose. It is also acknowledged that creativity occurs in locations where there are loose ties between people (Florida 2002).

Locations build *depth* of skill, capability and competency and an ability to respond to demands for quality, consistency and continuity. This may be referred to as critical mass. Depth might be built by organisations acting alone in a competitive situation, but it is more likely that it will be developed by organisations acting collaboratively in non-market arrangements. These arrangements involve *sharing of resources* as a basis of mutuality and common interest.

Spatial asymmetries in resources, including natural resources, skills, knowledge, and industry specific expertise have been an important dimension of location theory for some time. What is attracting current attention, in the context of thinking about the knowledge economy, is the idea that *industry specific knowledge* becomes cumulative and embedded in a particular *region or area* rather than a specific firm (Enright, *et al.* 1999). However, this attribute can

only be significant if knowledge can be created, shared and communicated uniquely within the community arrangement.

The geographic positioning of a large organisation (private or public), that has many suppliers and a broad base of clients and customers, as well as access to common infrastructure often impacts on decisions of smaller organisations to locate within close proximity. Close physical proximity reduces transaction costs and increases returns. It may increase local employment – but not necessarily impact on innovation. Large manufacturing assembly plants are a good example. They create many jobs and opportunities for component suppliers, but the impact in innovation depends on the sourcing strategies of the larger corporations. This is discussed further in Chapter 8. Town planning schemes and zoning regulations substantially influence co-location decisions.

Major manufacturing establishments, public hospitals and universities have always had significant “pull power” throughout Australia, particularly in terms of employment. State governments have been active in this arena. The development of non-market forms of collaboration may develop within these co-location arrangements – but equally, firms may choose to collaborate with organisations that are geographically distant. Research undertaken in relation to strategic alliances and business networks suggests that organisations collaborate across substantial distances.

Co-location is often driven more by competition than collaboration. Firms may be attracted to one location because it is important for competition - in that they want access to a specific client base and skilled staff and resources. The notion of collaboration or cooperation in critical business areas is not on the agenda. Similarly, the location of research institutes in close proximity does not of itself imply close collaboration in research effort. Research institutes may be fiercely competitive in their quest for funding from limited resources. In the Melbourne suburb of Parkville, for example, there is substantial competition between the many research institutions located there – which could gain a great deal of benefit by collaborating on a regional/metropolitan wide basis.

Issues concerned with the influence of place and space as an enabler for institutions of engagement are canvassed in Chapter 9.

3.5.3 *The State*

All working advanced industrial systems rest on an institutional base that accomplishes two things:

- Legal and government institutions (contract and securities law, consumer regulations) enable partners in market transactions to be confident that they will get what they are paid for, or can appeal effectively if they don't
- A range of enabling provisions and protections - limited liability, corporate law, monopoly protection, subsidies, infrastructure – that provide frameworks for commercial activity and limit uncertainty by pooling risk at more inclusive levels (DiMaggio 2001a).

The state emerged to provide the constitutional, legal and functional framework for governing relationships within and between the institutions. It became stronger on the basis of a need to uphold the rule of law, to establish the rules for ownership and protection of private property and to provide a framework for trade and exchange. The state now seeks to intervene in a wide range of corporate activity and behaviours through industrial relations, moderating employment conditions, ensuring environmental responsibility and, more recently, taking an interest in executive remuneration.

Notwithstanding the efforts to reduce the size of the public sector, public policy at all levels of government has been active in promoting and supporting economic and industrial development with an overarching purpose of creating employment for its citizens and wealth for the economy. Increasingly this is implemented not so much as industry policy but as an element of science and innovation policy. At the regional level policy involves active state involvement, often referred to as state entrepreneurship (Kayne 1999).

The enabling role of the state in science and innovation policy is exercised through five sets of instruments available to government, at all levels, to achieve its purposes (Howard 1986):

- Legislation and regulation, involving the state's unique power to coerce and direct – such as development controls, covenants and licenses; state and local government have used their powers of the use of land to promote (or restrain) development
- Creating organisations to provide advice, information, referral services, and develop technologies – such as Departments of industry, science and technology, innovation, economic, state and/or regional development in various combinations, and government research laboratories such as the CSIRO
- Establishing expenditure programs to provide specific forms of assistance – such as investment readiness programs, technology diffusion programs
- To provide subsidies and incentives - such as grants for research and development activities, subsidised venture capital
- To provide relief from taxation – such as research and development concessions, concessions available to Pooled Development Funds, (previously) R&D syndicates, and payroll tax relief.

The effectiveness of these interventions in creating employment and wealth is the subject of constant review and evaluation.

Further issues concerned with the role of government are canvassed in Chapter 10.

3.6 Summary

The institutional framework of engagement developed in this Chapter provides a basis for a more sophisticated discussion and analysis of relationships and interactions between higher education institutions, business and government. The framework draws attention to the characteristics of the core institutions of higher education, business in an industrial context, and the state.

The main point of the framework is to make it clear that *institutions matter*, and that *institutions of engagement* have developed their own structures, routines, and cultures to make possible the interactions and relationships anticipated in a mode 2 society.

The evolution of a mode 2 society is largely contingent on the performance of the institutions of engagement that operate at the interface between core institutions. The desirable features and current performance of these institutions is discussed in the next three chapters in terms of market based engagement (drawing material from the area of research commercialisation), management engagement (particularly in relation to cooperative research) and community based engagement (specifically in relation to knowledge communities).

The framework of institutional engagement allows for analysis of relationships between the state and a wide range of non government organisations under what is being referred to as the *new policy agenda* that involves greater participation by NGOs in public sector service delivery, and in relationships between government and industry in relation to public-private partnerships. The success of these initiatives is, it can be argued, contingent on the strength of the engagement institutions.

Chapter 4. The Industrialisation of Higher Education: Knowledge Commodification, Knowledge Products and Knowledge Businesses

According to the Ministerial Discussion Paper, *Higher Education at the Crossroads*, released as background for the Higher Education Review undertaken in 2002, “higher education has become a competitive industry and universities are directly competing with each other for students and sources of funding” (Australia. Minister for Education Science and Training 2002). The Paper continues:

In many cases, the strategy for responding to the new competitive environment has been to collaborate or form strategic alliances that make the institution’s products and services more attractive. Motives for forming strategic alliances include improving access to markets, building technological links, developing complementary assets, reducing costs and risks, and co-opting or blocking competition. Many universities have expanded overseas and formed teaching partnerships with international businesses, education providers and governments to increase their profile and diversify their revenue sources. Collaborative research centres have been established between institutions and with considerable success in gaining competitive funding from government and industry (Australia. Minister for Education Science and Training 2002).

This perspective reflects a widespread view that future wealth and power will be derived mainly from intangible, intellectual resources or *knowledge capital* (Burton Jones 1999). Knowledge has come to be seen as a key factor of production and society is in the midst of a knowledge revolution that exhibits similar processes to the industrial revolution in manufacturing two centuries ago. The main focus of attention in this knowledge revolution is higher education which is seen to be undergoing a comparable process of industrialisation.

The purpose of this Chapter is to trace the process of industrialisation in higher education in the context of what has been referred to as the *academic revolution*. This revolution is closely associated with what has been termed the *commodification* of knowledge and a growing emphasis on the ownership, marketing and sale of knowledge *products*. In this process higher education institutions are seen to have really emerged as *businesses*. However, the extent to which higher education institutions have emerged as businesses in a commercial sense remains problematic. In other words, industrialisation does not necessarily mean commercialisation – selling the work of a university for a profit (Bok 2003).

The creation of knowledge products and knowledge services raises the issue about the extent to which higher education institutions, or parts of them, should be seen as business organisations and the implications that this has for their institutional purpose. To address this

issue the range of knowledge products and services are defined. From this analysis it is possible to discern the actual significance of knowledge business activities to overall university functions and where these represent, or are likely to represent, core operations. It is suggested that over-emphasis on knowledge business activities may well compromise institutional purpose and performance.

This is different from arguing that higher education should not seek higher levels of funding from students in an environment of constrained resources and demonstrated private benefit from courses and programs, or from business where research has a direct commercial application. The issue is how and through what processes higher education institutions *engage* with students, industry and society.

The discussion forms the basis for later analysis of the proposition that knowledge business activities might be more appropriately conducted through intermediaries, or institutions of engagement formed around knowledge markets, knowledge organisations or knowledge communities.

4.1 Knowledge commodification and knowledge products

Governments and policy advisers, influenced by new growth theories are convinced that knowledge is now an important factor of production, and a major driver of economic growth (Freeman and Soefe 1997; Nelson 1996; Nelson and Winter 1982). In this context, knowledge is increasingly being seen as a commodity that has an exchange value. Moreover, higher education institutions are seen as a primary producer of *commodity* knowledge that is available to industry for use in the production of goods and services. In this process, knowledge is expected to contribute to the creation of employment and wealth.

The processes for determining exchange values are complex; economists like to simplify the process and link exchange value to the interaction of supply and demand in a competitive market environment. Within an emerging market environment competition occurs between suppliers who compete not only on price, but also on quality, reputation, brand and a range of intrinsic characteristics. As competition expands so do the rules for market engagement, as reflected in trade practices legislation and quality certification and accreditation of market intermediaries and agents.

Courses and programs when provided to students in return for fees clearly have an exchange value. Similarly, the income from advisory and research services provided by academics under contracts with businesses reflects an exchange value.

The recognition of an exchange value for certain assets is generally referred to as *capitalisation* of those assets. When ownership of land, buildings and some other physical assets is identified and defined, and can be clearly assigned to some one or some body, they become capital (De Soto 2000). The capacity to secure ownership rights in knowledge assets in the form of intellectual property rights is referred to as the *capitalisation of knowledge* (Burton Jones 1999; Etzkowitz, *et al.* 1998).

In 1996 the OECD recognised that knowledge was acquiring more of the properties of a commodity through codification and suggested that this allowed for the acceleration of its diffusion. The OECD suggested that:

. . . codification is reducing the importance of additional investments to acquire further knowledge. It is creating bridges between fields and areas of competence and reducing the “*dispersion*” of knowledge. These developments promise an acceleration of the rapid growth of stocks of accessible knowledge, with possible implications for economic growth. They also imply increased changes in the knowledge stock due to high rates of scrapping and obsolescence, which will put greater burdens on the economy’s adjustment abilities (OECD 1996b).

This observation points to one of the difficulties and paradoxes associated with discussion of knowledge as a commodity. At the level of the economy and the industry, free and unrestricted access to knowledge will provide a collective benefit and will, it is thought, enhance *industry* competitiveness. But in a commercial environment, *businesses* compete, not industries, and industry leadership can usually be traced to a relatively small number of highly competitive firms. Businesses focus on the creation of distinctive products and services and endeavour to *avoid* a commodity orientation.

The OECD has argued that incorporating knowledge into standard economic production is not easy as it “defies economic principles, such as that of scarcity”. That is

Knowledge and information tend to be abundant; what is scarce is the capacity to use them in meaningful ways. Nor is knowledge easily transformed into the object of standard economic transactions. To buy knowledge and information is difficult because by definition information about the characteristics of what is sold is asymmetrically distributed between the seller and the buyer. Some kinds of knowledge can be easily reproduced at low cost to a broad set of users, which tends to undermine private ownership. Other kinds of knowledge cannot be transferred from one organisation to another or between individuals without establishing intricate linkages in terms of network and apprenticeship relationships or investing substantial resources in the codification and transformation into information (OECD 1996b).

This assessment has been quite pervasive in discussions of the knowledge economy. It relates to situations where knowledge is, or can be, shared as a dominant form of communication.

Unfortunately it is misleading:

- The terms knowledge and information are often used interchangeably.
- Whilst knowledge and information can be abundant, it can be very quickly made obsolete, redundant and irrelevant, in a similar way to producers of consumer products; successful knowledge producers (such as Microsoft) invest in ensuring rapid obsolescence through processes of continuous innovation.
- Knowledge can be packaged as a product; the most obvious is a journal, book, or electronic publication; these products generate the publishers (and not necessarily the creators) substantial returns; a similar issue applies to patents where owners and licensees generate returns – not necessarily the creators.
- Companies invest heavily in turning commodity (general) knowledge into knowledge products and marketing them as such; management consultants have created products such as “business process engineering”, “total quality management”, “change management” that exhibit typical characteristics of product life-cycles.
- Relevant and applicable knowledge, important to sustain competitive advantage is scarce and sometimes difficult and costly to obtain; economic history indicates the lengths, and expense, that nations and businesses incur in obtaining trade secrets and recruiting knowledgeable process workers; even when recruited, they quite often only bring a segment of relevant knowledge on account of the division of labour in a firm (Landes 1998).
- Knowledge can be transferred from one organisation to another through the services of professional knowledge workers who market their knowledge in terms of “skill, capability and experience” and sell it on a time basis; however, to remain ahead this knowledge requires constant updating and where possible, the introduction of new knowledge products.¹⁰
- Asymmetries relate to a wide variety of goods and services in exchange relationships (otherwise there would be no need for trade practices legislation); an essential task of an intermediary is to act in behalf of buyers and sellers; licensing executives, for example, do not “buy knowledge” without seeing how it works.

These observations point to the need to recognise knowledge products and knowledge services that can be created, owned, licensed, sold and purchased in an exchange transaction, or controlled in a management relationship (even including caveats such as “need to know”). It is important that the debate moves away from a presumption that knowledge, once created and which is relevant to the production of goods and services that meet an economic or social want, is abundant is freely available.

¹⁰ Consultants and accountants have become adept at packing knowledge into methodologies, diagnostics and generic solutions which are marketed as “products” with appealing and differentiating names, or “brands”

The fact that knowledge can be communicated quickly, cheaply and widely through information and communication technologies does not mean that it will be “transmitted” or indeed effectively received.¹¹ There is also a need to distinguish between what knowledge is on the one hand and how it is used on the other. Recent studies have emphasised that access to information is not as much of a problem as attracting the attention of target audiences and users (Davenport and Beck 2001).

The unique feature of knowledge production in an industrial context relates to the capacity to create products and services with commercial potential based on the application of knowledge on knowledge - as opposed to the action of knowledge on materials. This has occurred predominantly in science based disciplines and trans-disciplinary areas such as molecular biology and biomaterials. Discovery is linked directly to a product for an uncertain, untested but potentially highly profitable market. It is in these trans disciplinary areas that higher education institutions and research centres are likely to be involved.

The ability to vest Intellectual Property rights in these products allows them to be recognised as capital and collateral for the formation of new businesses either in existing firms or as the basis for new firms. The innovation process *pushes* product and market opportunities.¹² This process differs from innovation based on shifts in *technical* knowledge, as in applications or engineering based innovation in the plastics, chemicals, and automobile industries. In these industries innovation is based on the action of knowledge on materials or machines and the innovation process *pulls through* basic research and new knowledge into technologies to create new and/or enhanced products (Mowery and Nelson 1999a).

These new generation pure knowledge companies have become important elements in industrial supply chains, particularly as corporations look to acquire capacities and capabilities from external sources. In this regard higher education institutions and research centres have become important elements in industrial supply chains through the creation, packaging, and sale of knowledge products in an emerging knowledge market.

Commodity knowledge becomes a knowledge product through the process of *propertisation*, that is, the vesting of ownership rights under the Intellectual Property system to scientific discoveries and technological inventions. Propertisation allows for subsequent sale

¹¹ That is, knowledge is not communicated until it is received; organisation theorists have written extensively about barriers to communication – including comprehension, language and context.

¹² “Discovery research”, using techniques of molecular biology, for example, is important in this process.

(commercialisation) through various forms of exchange transaction or managed relationship. To some this amounts to an enclosure of the knowledge commons where “huge swathes of knowledge are fenced off into privately owned plots” (Bollier 2002); to others it represents an opportunity for knowledge to be adopted and applied in the creation of wealth and for higher education institutions to retain and build their place in the increasingly distributed system of knowledge production.

This feature of knowledge as a commodity and as a product gives rise to a series of contradictions similar to those found in other industries, such as agriculture, where government targets support at the commodity level (primary production) on the basis of a collective industry benefit, but has difficulty in making the case to provide support for individual businesses that are seeking to differentiate themselves and compete on the basis of products that are marketed and positioned as proprietary brands with specific customer segments in mind.

Industry and taxpayer funded Rural Research and Development Corporations, for example, have traditionally had a focus on the generation of commodity knowledge that could be widely disseminated and taken up within industry. The recently established National Food Industry Strategy, by contrast, has a specific focus on innovation in food processing and manufacturing businesses. The strategy has a focus on lifting Australia’s export performance by supporting innovation through competitive grants for a limited number of food processing businesses (Australia. National Food Industry Strategy 2002).

Availability of commodity knowledge on an industry wide basis as a collective good may be useful for some aspects of corporate research and development but in areas of product development, production and marketing, knowledge is valuable only to the extent that it cannot be acquired easily *and applied* by competitors. This has been a major issue for Australian Cooperative Research Centres in terms of directing attention to production of knowledge that will be of value to industry generally and knowledge that is important to a business to enhance a competitive position. Businesses are likely to collaborate where there is collective benefit but compete fiercely where there is a prospect of private appropriation in a market context.¹³

¹³ Recently announced changes to the Cooperative Research Centres Programme that give a greater focus to commercialisation are likely to see a smaller number of businesses involved in a larger number of Cooperative Research Centres

A knowledge product can be defined as an idea, a concept, a method, an insight, or a fact that is manifested explicitly in a patent, copyrighted material, or some other form of Intellectual Property right where ownership can be defined, registered and assigned to an individual or corporate entity. The marketing and sale of knowledge products for a profit is the essence of commercialisation that has attracted so much attention in public policy and in the strategies of higher education institutions. There are several readily identifiable knowledge product categories:

- Academic publications – production, marketing, distribution and sale of books, papers, electronic material through academic presses established for this purpose
- Accredited courses, qualifications and certifications – the preparation, marketing and sale of courses and programs that meet a specific user need for professional recognition and career advancement
- Discoveries and inventions – reflected in the disclosure, the registration, marketing, licensing and/or sale of Intellectual Property rights
- Advisory and consultancy services – the sale of explicit and tacit professional knowledge
- Knowledge start-up (or spinout) companies – entities created to own and market a discovery or technology and (possibly) a product or service based on them.

Features of these knowledge products and aspects of their commercialisation are discussed in Chapter 7.

Businesses (and individuals) tend to be interested in knowledge products that are capable of delivering competitive advantage while governments and industry leaders are interested in knowledge as a commodity that will raise the productivity and performance of an industry in an internationally competitive environment. This creates a dilemma for higher education institutions in terms of deciding whether to focus on creating and disseminating knowledge for broad industry application and made available through general courses and programs and non-exclusive licensing (with a potentially small return), or alternatively, producing knowledge for a specific business application that will be delivered or licensed exclusively to an existing corporation or a start-up company (with a potentially larger return).

The difference between commodity and product knowledge lies at the heart of relationships between higher education institutions and industry and the forms of engagement that are created. A focus on commodity knowledge production presupposes an unrestricted and unrequited flow of knowledge between institutions. The issue in knowledge based economic development is broad dissemination and application from an industry and economy wide perspective. From this perspective, businesses, collectively, would be keen to acquire the

services of knowledgeable graduates who can work on commercially oriented problems and opportunities. Research outcomes could be expected to benefit an industry as a whole.

But as individual businesses see commercial advantage in having access to knowledge ahead of their competitors, knowledge takes on more of the characteristics of a product that meets specific customer or client needs. Higher education institutions have been targeting customers and clients through crafting knowledge products. In this respect, higher education institutions take on the characteristics of professional services businesses. To the extent that higher education institutions are businesses in this sense, or should be seen as such, it would involve a change in institutional purpose from a *non government* to a *commercial* orientation and a change in the way in which performance is assessed. Quite clearly, however, only a small proportion of the work of a higher education institution could be redefined in these terms.

These issues point to the need to look at knowledge creation from the perspective of both its commodity as well as its product characteristics. This, in turn, has implications for the structure, routines and cultures of higher education institutions, their internal relationships and relationships with industry. This will involve deciding in a strategic sense which parts of the knowledge market and knowledge relationships they wish to be engaged in, and making the necessary investments to build capability, and deciding which they will leave to others. The role of engagement institutions is vital in resolving this challenge. To provide further context for this issue, it is useful to look at the changing role and purpose of higher education institutions.

4.2 The role of higher education institutions in the production of knowledge

The university started out as a community, a community of masters and students. It is now seen as a series of communities and activities held together by a common name, governing board and related purposes (Kerr 2001). It is not the purpose here to trace the development of the modern university from its beginning as a mediaeval institution and development under the competing visions of Newman (where knowledge is its own end and has an emphasis on moral philosophy and teaching) and Humboldt (an emphasis on science and research) and the values of democracy and access (Martin and Etzkowitz 2000). However, these historical strands have come together in the concept of the modern research university as a theoretico-political hierarchy with philosophy and reason at the top, “because it was the lowest and most useless order and free to evaluate everything” (McSherry 2001). The term “useless” is intended to convey a meaning of knowledge created with no particular application in mind.

Higher education institutions founded on this hierarchy were subsequently presented as *useful* to the nation state because they could produce the objective and *disinterested* information upon which rational social and economic policies and industrial programs could be built and citizens skilled in rational inquiry could develop, support and re-enforce those policies and programs. This provided a basis for extensive government funding of universities. But the groundwork for this perception of the university has never been particularly solid (Florida 1999). It has been rapidly eroded, as academic work is revealed as actively constructed as *interested*. This occurs as resources are provided by governments and corporations to support defined areas of research and scholarly inquiry, and students pay for courses and programs in which content is developed and targeted for particular market segments.

More recently aspects of higher education purpose have been defined in terms of - a *centre of excellence* for teaching and/or research. Public and private funding is increasingly being targeted in this direction. To some the embrace of excellence as a common standard ironically reveals a “ruined institution” whose fundamental category (reason) appears as a broken and lifeless tradition (Readings 1996). Others have argued that academics must dwell in the ruins and take responsibility for enacting a community of thought that, because it does not pretend to be disinterested or secluded from society, will no longer work to legitimate particular inquiries, policies and property claims. That is, higher education institutions will become more responsive to demands for their knowledge outputs (Slaughter and Leslie 1999). There are two broad interpretations of this trend:

- The *corporate manipulation thesis* (Noble 2001, 2002) under which corporations interfere with the normal pursuit of academic science and seek to control relevant university research for their own ends.
- The *academic entrepreneur thesis* (Etzkowitz, *et al.* 1998) where academic entrepreneurs in faculty and administration seek to cultivate opportunities with government and industry for funding to advance their own agendas.

The corporate manipulation view is reflected in a considerable body of critique relating to the evolution of closer relationships between higher education institutions and industry. This literature points to the need to preserve the institutional values and integrity of higher education teaching and research. The academic entrepreneur view has been reflected in aspects of public policy that seek to encourage higher education institutions to be more financially independent and achieve a return on their investments in the creation of knowledge assets. Selling work of an institution for a profit (commercialisation) is a strategy that is often advocated.

Both views are important in the context of discussion and analysis of the evolution of mode 2 society. However, neither perspective grasps the objective function of higher education institutions, the intricate ways in which they are embedded in the economy and society, and the tensions that have been created (Florida and Cohen 1999). To these authors, a better theory would identify what a university does, and wants to do. That is:

- Universities have a foundation purpose which is to generate and disseminate knowledge through research and teaching
- They compete with other institutions, and the competition is around *eminence*, which the university seeks to optimise along with reputation and prestige
- Competition is for highly regarded faculty, who attract outstanding graduate students, which in turn attracts leading undergraduates
- Eminence is reflected in publications, patents, and more recently, formation of start-up companies.

In this context higher education institutions are adopting a strategy that involves an alternative rational tradition embodied in legal discourse, specifically Intellectual Property law, to guard and *rebuild the university as a knowledge producing institution*. This involves seeking to protect and assure academic freedom through ownership and control of intellectual property assets, particularly patents and copyright, and the prospect of generating financial returns from licensing the use and exploitation of those assets. This, and the entanglement of academic freedom with property rights suggests that the community of scholarship may already be reconstructing itself as “disinterested” (McSherry 2001).

This view receives support from Martin and Etzkowitz who argue that the autonomy of the university may actually be strengthened as it becomes less dependent on unconditional government funding support. They argue that:

The ability to establish more explicit policies than previously may increase with the result that there may be less accidental evolution than in the past. Indeed, the university may be undergoing an historic shift from an eleemosynary institution, virtually wholly dependent upon other spheres for support, to at least a partially self sustaining institution, based on earnings from patent royalties and equity holdings in companies formed from academic research. Even after 20 years at technology transfer, there are few institutions such as MIT that receive as much as one quarter of their research funding from industry, or like Columbia that earn \$199m per annum or one tenth of their budget from patent income. Nevertheless, the trend towards the capitalisation of academic knowledge is growing, especially as the recognition of a clear relationship between a university’s research incomes and its production of commercially useful knowledge becomes more widely recognised (Martin and Etzkowitz 2000).

As a result of these differences in income generating capacity universities are no longer homogeneous entities; they are becoming differentiated according to their distinctive capabilities, core competencies and competitive advantages. Some of these attributes relate to traditional values and ideals such as research and scholarship and curiosity driven scientific inquiry whilst others relate to working with industry and society in relation to application of research and targeted education programs. A number of higher education institutions have taken a strong interest and active role in the economic and industrial development of the regions in which they are located (Walshok, *et al.* 2002).

There are, however, several outstanding issues. Firstly, industry funding may compromise eminence – although this need not occur with appropriately negotiated joint venture arrangements, strategic alliances and partnerships. Secondly, strategies for attaining eminence have changed – it used to be teaching, discovery research and publication but it is now also reflected in patents taken out by researchers and consulting. And finally, tensions arise with the “skewing” from basic to applied/project research and growing concerns about secrecy.

There is also another, but closely related, debate concerning the commercialisation of teaching and learning. That is, the design of courses and teaching programs to suit a market need as expressed in consumer wants. This differs from a more traditional approach to teaching and learning that concentrates on the supply side – what academics consider necessary and appropriate for a university education having regard to considerations of scholarship and reference to an accumulated body of (disciplinary) knowledge. Some see this trend as a fundamental threat to the integrity of the university institution.

The requirement for higher education institutions to seek funding from the sale of intellectual property rights, through strategic alliances, joint ventures and industrial research partnerships, and from students to cover the full cost of their education, gives rise to a tension between the pursuit of eminence and financial viability. The debate about the appropriateness of university relationships with industry and society is a manifestation of this tension.

4.3 Issues in ownership and access to knowledge products

It has been argued that as the action of knowledge upon knowledge (as opposed to action of knowledge on materials) becomes the main source of productivity growth, the ownership of knowledge provides control of a central means of production (McSherry 2001). That control depends, in large part, on both the circulation of property rights and the ongoing definition of the scope of those rights. A major issue that is emerging concerns the extent to which a

university, or other publicly funded research institution, *should* be a substantial owner of the means of production, how well equipped they are to perform that role in a business context, and what the implications are for the traditional role of a research university. The implications of this are:

. . . the special characteristics of the university (based in principles of disinterested rationality, communal obligations, and trust) secure and are secured by individual property rights. The university's own foundational terms – autonomy, freedom, integrity, collaboration, trust – implicate a discourse in which the claim to describe man becomes the practice of the owner (McSherry 2001).

A number of commentators have observed a *second enclosure* movement where newly extended state created property rights are intellectual rather than real and cover things that were formerly thought of as either common property, uncommodifiable, or outside the market (Boyle 2001).

Intellectual Property rights have traditionally been sought by corporations to prevent discoveries, inventions, and designs being used by those who have not contributed to their creation. IP protection is also thought to facilitate the commercialisation process by creating an asset against which funding can be provided for further research and development, manufacture and marketing as well as providing an incentive for innovation.

It now seems that Intellectual Property rights are sought as a means to force others to pay for the use of a discovery irrespective of whether a commercial outcome is sought or planned. That is, ownership is sought in any discovery, invention or design. It is being argued that the “commons of facts and ideas is being enclosed”, and that patents are being stretched to cover ideas that 20 years ago would be unpatentable. These include not only inventions in the life sciences but also business process methods and compilations of facts (Boyle 2001). Analogies are drawn to the first enclosure movement where common land became commodified as property through title defined and assigned by the state and alienated from the users.

The reality of the first enclosure is that it actually allowed an expansion of production possibilities, encouraging large scale investment and the resources to be used more efficiently. The enclosures were associated with substantial increases in agricultural output and economic growth. By analogy, creation of property rights in knowledge products should allow more knowledge to be put into productive use. There is however a robust debate over the extent to which the “enclosure of the knowledge commons” harms innovation as well as supporting it. A recent paper concluded that patents on research discoveries impose costs on

R&D and these costs may well exceed any social benefits that they offer in the form of motivating further private investment in product development (Rai and Eisenberg 2001).

There are emerging views that ownership and control of the means of knowledge production is too important to be left to the disparate efforts of individual universities. Strategies that assign exclusive licenses in knowledge products can have distorting effects on the innovation system. The issue is of particular importance in the biopharmaceutical area where knowledge products are inputs into drug production processes further along the value chain. The issue is not so much whether or not there should be property rights in products created by the action of knowledge upon knowledge, but how those products are accessed and at what price.

Restriction of access to knowledge products through *exclusive licensing* may be seen to amount to a restrictive trade practice – just as denying access to national infrastructure in transport and communications and electricity and water distribution networks. In terms of their institutional charters, higher education institutions should be finding ways to have commodity knowledge universally applied and adopted, as well as ensuring its protection from proprietisation (enclosure) by private interests, and assuring its availability and access through non-exclusive licensing. Few higher education institutions have the resources to underwrite such a strategy and keep important discoveries and inventions in the public domain. At the same time, however, the practice under which universities create knowledge products with the objective of establishing businesses and generating commercial income risks compromising their role and institutional purpose.

Discussions and consultations with Deputy Vice Chancellors (Research) undertaken during the recent evaluation of the Cooperative Research Centres Programme indicated that Australian higher education institutions did not see their institutional purpose as extending to research commercialisation (Howard 2003b). This points to a need for effective institutions of engagement, specifically, appropriately resourced technology transfer offices, to look after this aspect of research outcomes in the broader interests of society.

Australian academics Simon Marginison and Mark Considine have suggested that in pursuit of funding universities have developed as “islands of expansionary capitalism” where full commodity production is underway – overseas students, post graduate business education and commercial research and consultancy. They suggest that production is “impelled by a demand for capital accumulation with a focus on expanding production and reducing unit costs”. That is:

Whilst use value remains important for the consumer, the educational content is merely the vehicle for realising exchange value. Similar considerations apply in the life and applied technological sciences – research commercialisation is the vehicle for realising increased exchange value (Marginson and Considine 2000).

Marginson and Considine argue that seemingly marginal areas of market commodity production, particularly in areas where market subjectivities are strongly entrenched (that is, business and applied science areas), significantly influence the activities of universities. They suggest that the character and form under which knowledge is produced in these areas comes to resemble market commodities. These pressures and forces, it is asserted, are likely to have a significant influence in constituting the form and nature of academic management knowledge and applied science knowledge.

As market production is driven by the need for exchange value and the search for sites of expanded return on investment capital, the producer has a strong incentive in individualised consumption and in extending the number and range of exchange possibilities (Marginson and Considine 2000).

There is some validity in these arguments, although the extent to which the orientation of management research and teaching can be assumed to have a broader application in discovery and invention in the life sciences, natural sciences and engineering is a little more problematic. The commercial drivers of management research and education are discussed in Chapter 7 in the context of the commercial orientation of academic publishing. In the life sciences both universities and governments have taken steps to ensure independence and integrity through formation of ethics committees and similar checks and balances. An ethics committee for management research and teaching would be an interesting innovation.

Some critiques are even more polemical. A recently published paper on the globalisation and incorporation of education asserts:

We have witnessed a fundamental attack on the notion of public goods, and upon more liberal ideas of education. Learning has increasingly been seen as a commodity or as an investment rather than as exploring what might make for the good life of human flourishing. Teachers' and educators' ability to ask critical questions about the world in which we live has been deeply compromised. In a very real sense they are engaged in furthering what Erich Fromm described as alienation (Smith 2002).

These views reflect confusion between the concepts of knowledge capital, knowledge as a commodity and knowledge products and services. Contrary to much of the thinking that comes from the neo-Marxist literature critique, it cannot be assumed that higher education institutions are driven by a logic of accumulation or that they are behaving as industrial corporations.

There is a real difference between higher education institutions seeking funding to cover the costs of building and sustaining institutional purpose relating to research and teaching, and going into the market to generate profits and returns to owners. This is not to say that some higher education institutions depart from their foundation purpose in seeking to generate external income. To date, however, the record of success in commercial knowledge based ventures is very poor, and substantial losses have been recorded in many instances (Bok 2003; Howard 2003a; Lerner 1999).

4.4 Balancing excellence and relevance

Higher education institutions are predominantly government owned or privately owned non government organisations. Their purpose is defined in relation to their missions, which relate to research and educational outcomes. Success is judged in terms of achievement in these areas and will be reflected in indicators such as educated individuals and contributions to knowledge.¹⁴ Excellence has become a primary indicator. Nonetheless, in the current economic and industrial environment industry and society are expecting that research and teaching is also *relevant*. This interplay between excellence and relevance creates unique challenges for higher education institutions in terms of the way their work is conducted and the expectations of stakeholders (government, business and the community).

The challenges relate specifically to the nature of the commitment to, and management of, the commercial exploitation of knowledge resources on the one hand, and ensuring the sustainability of those resources, through ongoing investment to maintain and renew foundational (basic) research and teaching capability, on the other. Resource sustainability in higher education implies maintenance and building the base of disciplinary knowledge and attracting and retaining talented educators. Recent studies have pointed to the importance of higher education institutions retaining a portfolio of basic research as a foundation for industrially oriented multidisciplinary research and problem solving (National Academy of Engineering 2003).

Current interest in commercialisation of research and teaching creates a risk of over-exploitation of a valuable resource. The prospect of generating returns to higher education institutions by selling research and teaching outputs for a profit can run counter to objectives

¹⁴ By contrast, in the commercial, for-profit, sector success is achieved when a customer buys a product, pays for it, is satisfied with it, and a profit is generated (Drucker 1990).

of building a knowledge base to which those working in industry and at the interface between higher education and business can call upon and refer. As discussed in Chapter 7, over exploitation has already occurred in the area of management knowledge, for example, where commercial publication and consultancy has left a vacuum in the disciplinary knowledge base.¹⁵

A prominent industrial research manager has observed that there has been occurring, over a number of years, a break-up and re-ordering of traditional scientific disciplines such as mathematics, physics, chemistry and biology. In universities, much of this remained close to traditional activities in applied science and engineering - but at some distance from management strategy, economics, accounting and law. Physicists and mathematicians pioneered developments in biochemistry through curiosity about the logic and complexity of nature. Advances in medicine and surgery have required the contribution of electronics and design (Ganguly 1999).

Many of the real changes in inter-disciplinary and trans-disciplinary re-ordering of science have been initiated by industry which saw the emergence of new business opportunities emerging following the insights into DNA and the silicon chip driven growth fuelled by the computer industry. The consequence of these developments has been a new way of generating, managing and exploiting knowledge. Moreover:

Because the emergence of this new way of working had not been clearly foreseen or visualized and did not quite fit the linear management models of the day, the creation of trans- and interdisciplinary science clusters, which were task or sector specific, evolved more or less by trial and error (Ganguly 1999).

The capacity to combine diverse approaches to research makes the research university a particularly good place to pursue knowledge production, that is, applicable in business and commercial contexts. The research university also has the advantage of being able to cultivate and incubate a wide range of research approaches and strategies that are potentially relevant to industrial research and development and commercial technology. In this regard higher education institutions are becoming much more important as an economic and social institution than they have ever been. They are a critical provider of talent and knowledge products and services. This does not amount to taking over the role of businesses in finding and retaining satisfied customers. It is a complementary activity – not an alternative.

¹⁵ This trend was observed in the area of local government practice in the mid 1980s where it was noted that the pressure for academic employees to generate consulting income had left a void in fundamental research into local government structure, operations and finance. (Howard 1988)

The emergence and effective performance of cross disciplinary and interdisciplinary science clusters has required the development of *research centres* as institutions of engagement and a new type of industrial research manager capable at working at the interface between disciplines and institutions. This interface is reflected in an integrated organisation established as a partnership, joint venture and alliance. Success or otherwise in interdisciplinary entities depends heavily on the way in which they are managed and led. The importance of the managed relationship in an integrated form of collaboration is generally overlooked in discussions of industry-science relationships. Attempts to establish research centres as virtual organisations are bound to fail if not for the only reason that virtuality defies the basic and fundamental principles of management.¹⁶ This management dimension is the subject of discussion and analysis in Chapter 8.

Turning to education perspectives, a *Learning Partnership Roundtable* hosted by global professional services firm PricewaterhouseCoopers on the transformation of higher education in the digital age identified three broad trends that were challenging higher education institutions to evaluate their existing strategies (PriceWaterhouseCoopers). These were:

- Changes in market demand – the 40-59 year demographic, which is the fastest growing demographic, are expected to seek additional education; lifelong learning has become a necessity, which is, in turn increasing the size of the potential learning market; potential students are also more demanding as to availability (time and place), one-stop, cost effective, technical (but personal), integrated, consistent and dependable.
- The competitive structure of the industry – there are more suppliers, including corporate and on-line universities (the University of Phoenix enrolls 40,000 students across geographical boundaries) and corporate training programs that offer university degrees.
- The impact of technology – the development of instructional software (research reported that the creation of 25 courses would serve an estimated 80 percent of total undergraduate enrolment in core undergraduate courses); the costs of software development are high and maintenance is required. Technology also removes significant barriers to entry, by removing the need for campuses and full-time faculty.

The Roundtable report observed that

The very structure of higher education is poised for change. As has occurred in other industries, it is likely that there will be mergers, consolidations and shakeouts (PriceWaterhouseCoopers).

¹⁶ These are: every organisation needs a structure of some form or another so that work is coordinated in order to achieve results; and someone has to be in charge, particularly in times of pressure and crisis (Drucker 1999).

The changes are unlikely to occur immediately, and there will be substantial resistance, particularly from education unions. The point being made here is not whether the changes are desirable or not, but to suggest that there is a process of industry restructuring and, as with other industries, the major players need to respond and adapt. Preventing change is not really an option, but seeking to influence and direct it, is. That is the task of strategy.

The impact of these changes in the way research is undertaken and the expectations relating to education services has implications for the way in which higher education is structured and organised as an *industry*. This is discussed below.

4.5 Knowledge production and the industrialisation of higher education

Industrialisation involves a substantial change in the methods and focus of production, distribution and exchange. Those changes generally involve moving from an extensive mode of production to an intensive one aided and assisted by technological invention and an environment that encourages and supports entrepreneurship (Jones 1988). For example, the agrarian revolution involved changes in methods of production that made more effective use of land; industrialisation in textile manufacturing involved moving from the putting out system to the factory system where it was possible to achieve greater coordination in the quantity and quality of output; industrialisation in steel involved capturing economies of scale associated with large capital investments.

Large-scale production also requires the input of people (managers) who can coordinate a division of labour based on specialisation of task. The division of labour relates not only to production, but also to distribution (marketing) and managing exchange relationships. These are essentially supply side issues; demand considerations have been equally, and perhaps more, important in driving industrial change. That is, increasing population, rising real incomes and changing tastes and preferences pull through the processes of industrialisation. Industrialisation is also associated with substantial change in social relations. The demands by, and for, knowledge workers in the service industries have been an important driver in expanding business education, particularly at the graduate level.

In manufacturing, the industrial revolution involved a change from a society based on agriculture to one based on automation, scientific development, division of labour, and the replacement of barter with a money exchange. There was also a change in the social relations within industry – between the owner, the employer and the employed. This was reflected in the factory and later in the multi divisional enterprise which required professional managers

to establish mechanisms and procedures for planning and control. This change was also reflected in markets where trade was established and negotiated through agents and brokers. Financial institutions also emerged to facilitate trade. However, change was not evenly distributed or impacted throughout industry: craft production still prevails in highly specialised and high value added segments of the textiles and footwear industry for example. Industrialisation established segments and diversity.

The point being made is that industrialisation not only involves change within an industry, it also involves an evolution of institutions that work at the interface between an industry and other industries. The industrial revolution in manufacturing was associated not only with institutional change *within* manufacturing industries, but there was also an institutional evolution *between* manufacturing industries and their financiers, suppliers, distributors, retailers and customers. This is reflected in the current interest in supply chain management, particularly in the global food industry (Howard 2000a).

In higher education some see an academic revolution involving a change from the creation of knowledge in a community environment that values scholarship and sharing of knowledge among a community of science, to the production of knowledge in market and/or organisational environment, where knowledge is created, propertised, valued and exchanged through market transactions and managed relationships. But as with the industrial revolution these changes are unlikely to occur through all segments of the higher education sector. Nor will market or organisation based systems of production necessarily replace the community based framework. New institutional arrangements will inevitably emerge within and alongside existing arrangements. Industrialisation is associated less with conformity and more with diversity and segmentation in an industry.

There are many, however, who resist change and seek maintenance of a status quo and a return to traditional values and ideals of the Humboldt and Newman Models. There are others, who excited by the prospects of a greater role for universities in commercial application of discoveries and inventions, see endless possibilities for industrial development from university-sponsored start-ups. Former Vice Chancellor of Melbourne University, Alan Gilbert, has observed:

Terminal threats to traditional attitudes, practices and processes create revolutionary opportunities for bold entrepreneurs aware of the potential of new technologies and new forms of industrial organisation.

Higher education is experiencing just such a revolution at the beginning of the third millennium. It is a revolution driven by mass demand, the imperative of continuing professional education in a global knowledge economy, and the enabling consequences of revolutionary information technology and communications (Gilbert 2000). This academic revolution needs to be understood in the context of the higher education industry and the emergence of new institutions that operate at the interface between knowledge production and knowledge application. These institutions are the essence of a mode 2 society.

As with revolutions in other industries, those who create knowledge in this new academic industrial order may not necessarily be those responsible for its dissemination and application. This applies in teaching as well as research. In teaching, global providers and integrators have introduced a separation between course design, course delivery, and course assessment. In research, industrially applicable research is undertaken through research centres created as joint ventures, partnerships and strategic alliances. Venture capital emerged as an asset class for the commercialisation of discoveries and inventions where knowledge can be captured and registered as Intellectual Property (patents, trademarks, designs, and copyright). Similarly, management capacity and capability has emerged as a skill required for ensuring successful performance in industrial research centres (Howard 2003b).

Education integrators, research centres, and venture capital investors represent institutions of engagement between higher education institutions and industry. These institutions allow researchers and educators to direct attention to the mission and purpose of their own institutions without having to compromise their core purposes. They do not have to interpret market demands and expectations, for example. This is the task of engagement institutions. It follows that pressures placed on higher education institutions, particularly by venture capital investors, to be more commercial in terms of responding to market signals is mis-directed and has the potential to inflict severe damage on their structure, routines and cultures (Bok 2003).¹⁷

Thus, the feature of industrialisation in higher education is a focus on knowledge production and the emergence of new forms of relationships between higher education institutions, industry, and more broadly, community organisations and government agencies.

¹⁷ In the original, or classic, concept of venture capital, the venture capital investor performed the engagement function between science and society, working at the interface between the research and commerce. They performed a new institutional role as entrepreneur in the market for knowledge. As venture capital became dominated by a culture of funds management, this engagement role has almost disappeared. The point here is that the idea of turning scientists into business people misinterprets and places at risk the institutional purposes and integrity of the research university.

Relationships are seen less in terms of transfer and more in terms of market based transactions and managed relationships. The processes of communication and interaction implied in the term transfer are still in evidence, but they are increasingly under-pinned by intermediaries (such as education integrators, technology transfer offices and venture capital investors) and organisational arrangements (such as research centres and centres of excellence).

In January 2003 the British Government released a White Paper, *The Future of Higher Education* that set out a policy framework directed towards: improving the funding of research and strengthening the work of universities in supporting regional economies; improving and rewarding excellent teaching; and enabling more people to enter higher education (Great Britain. Parliament 2003). The policy is now in the process of implementation.

In Australia, the industrialisation process has occurred over a 15 year period, commencing with a Government decision to introduce a unified national system of higher education. Change has been slow and progressive, but culminated in May 2003, when the Government introduced a range of initiatives set out in the policy paper *Our Universities: Backing Australia's Future* intended to provide a framework for change. The policy principles relate to sustainability of institutions, quality, equity and diversity. It is intended that the reforms will:

. . . establish a partially deregulated system of higher education in which individual universities are able to capitalise on their particular strengths and determine the value of their course offerings in the market place. There will be a renewed emphasis on teaching and learning outcomes, greater recognition of the role of regional campuses and institutions, and a framework for research in which all Commonwealth funding is either competitive or performance based (Australia. Minister for Education Science and Training (Hon Brendan Nelson MP) 2003).

By and large higher education institutions have embraced the changes, although there has been political and industrial opposition on a number of fronts, particularly in relation to employment terms and conditions. The changes encourage and stimulate the development of a differentiated higher education industry structure that is responsive to business and societal needs.

4.6 The emergence of an education industry structure

In a general sense, an industry is defined by a pattern of ownership, the intensity of competition and the economic power of industry participants. More specifically, however, industry structure involves the organisation of participating firms and their relationship to one

another, their strategic competitive advantages, market shares, sustainable rates of growth, costs and profitability, pricing power and tactics, as well as other marketing practices. It concerns the perceptions of companies, their products and services by customers, consumers, other businesses and government agencies.

The industrialisation of higher education has been associated with the emergence of new entities, the strengthening of existing ones and the disappearance of others. Strong vested interests can delay, but rarely prevent this process from working its way through. Contemporary management writers see industrialisation as involving a process of “creative destruction”.¹⁸ Following patterns in other industries, some higher education institutions will emerge as multidivisional conglomerates whilst others will develop as niche players associated with high quality in a particular line of product or service. There will be others that will balance low price with basic quality.

These considerations point to the need for higher education institutions to adopt a strategic approach to developing their knowledge products and serving their markets. In this environment not all universities can, or will be, the same. Not all universities will be equally good in producing the full range of knowledge products.¹⁹ This point had been made strongly in submissions to the recently completed Higher Education Review (Australian Industry Group 2002b; PricewaterhouseCoopers 2002).

The industrialisation of higher education should be seen as the beginning of the evolution of an industry rather than its culmination. According to Michael Porter “the grandfather of concepts for predicting the probable course of industry evolution is the familiar product life-cycle” based on the hypothesis that industries pass through a lifecycle of introduction, growth, maturity and decline. The stages are defined by inflection points in the rate of growth of industry revenues. The growth pattern follows an “S-shaped” curve reflecting the processes of innovation and diffusion of new product (Porter 1980).

Broadly, the flat introductory stage of industry growth reflects the difficulty in overcoming buyer and supplier inertia and gaining acceptance of the newly defined “products” and “services”. Rapid growth occurs as buyers rush into the market once the products have gained acceptance. In the maturity stage, penetration of the product to potential buyers has been

¹⁸ Reference is made to the Schumpeterian view that economic progress involves the restructuring of industries through processes of “creative destruction” (Foster and Kaplan 2001b).

¹⁹ The range of knowledge products is described in Chapter 7.

reached causing rapid growth to level off to an underlying rate of growth. Finally, growth eventually tapers off as new substitute products appear. As industries go through the cycle, the nature of competition shifts and industry structures configure and reconfigure (Porter 1980).

Porter suggests that instead of trying to describe industry evolution it is more useful to look beneath the cycle at the process to see what the drivers of change are and how they operate. He suggests that like any evolution, industries evolve because some forces are in motion that create incentives or pressures for change (Porter 1980).²⁰ Porter notes:

Every industry begins with an *initial structure* – the entry barriers, the buyers and supplier power, and so on which exist when the industry comes into existence. This structure is usually (though not always) a far cry from the configuration the industry will take later in its development. The initial structure results from a combination of underlying technical characteristics of the industry, the initial constraints of small industry size, and the skills and resources of the companies that are early entrants. . .

The evolutionary processes work to push the industry towards its *potential structure*, which is rarely known completely as an industry evolves. Imbedded in the underlying technology, product characteristics, and nature of present and potential buyers, however, there is a range of structures the industry might possibly achieve, depending on the direction and success of research and development, marketing, innovations and the like (Porter 1980).

Porter notes that the life-cycle concept has attracted substantial criticism. This relates to variation of the stages between industries, the sequencing of stages (some industries may skip stages altogether), firms can influence the shape of the curve through product innovation and positioning and that the nature of competition in each stage is different for different industries. Nonetheless, the concept is useful for describing a pattern of evolution rather than predicting it. What is important about the lifecycle for the higher education industry is that it is currently at the *introductory* stage. As the critics of the lifecycle concept would suggest, businesses in the higher education industry can shape its future through innovation, positioning and responding to competition.

The industrialisation of higher education has been evolutionary, rather than revolutionary. Industrialisation reflects a build up of forces and influences that have been at work for quite some time.²¹ It is not possible to point to some event, or series of events that caused the

²⁰ Porter proposes the analytic device of the “Five Competitive Forces” to address and analyse the evolution and status of an industry structure. These are: the entry of new competitors, the threat of substitutes, the bargaining power of buyers, the bargaining power of suppliers, and the rivalry among existing competitors

²¹ Similarly, the “Industrial Revolution” which involved a change from a society based on agriculture to one based on automation, scientific development, division of labour, the replacement of barter with a money exchange, and reflected in rising real incomes, is generally regarded as having occurred over the period 1750-1860. More thorough accounts suggest that the

industrialisation of higher education. It is possible, however, to identify the contributing factors. These factors include a range of external environmental factors, some driven by public policy initiatives and others driven essentially by demand for education services and multi-disciplinary research. A common thread in much of the change and reform process has been a desire by government for greater engagement between higher education, industry and regional economies. This is reflected in a series of papers, reports and policy initiatives in Great Britain, Australia and more generally in the OECD community.

The evolutionary process is reflected in the observed movement towards the new mode of knowledge production, “mode 2”, or the creation of knowledge in application (Gibbons, *et al.* 1994; Nowotny, *et al.* 2001) as discussed in Chapter 2. In the course of industrial evolution the traditional role of the university in the creation of disciplinary knowledge is now seen as sitting within a much more pluralistic system for the creation of scientific and technical knowledge. At another level there is a robust discussion of the “enclosure of the commons” of public knowledge created in a university environment through the processes of commodification and propertisation associated with the vesting of Intellectual Property rights and the marketing of those rights through institutions of engagement.

On the education side, and if the prognostications about the knowledge economy are correct, there will be an “explosion” in the market for learning associated with new learning technologies and lowering barriers to entry. Using Porter’s competitive forces framework (Porter 1980) it is possible to point to the prospect of substantial restructuring in the higher education industry:

- Entry of new competitors
- Threat of substitutes
- Bargaining power of buyers
- Bargaining power of suppliers
- Rivalry among existing competitors.

Individual universities will, in the new industrial climate, need to consider their positions in the light of domestic and global market considerations. In Australia the industry has started to undergo a segmentation process, based on a grouping of institutions with similar

underlying forces of change were at work perhaps 200 years earlier and the change process was more evolutionary than usually appreciated (Jones 1988). The “revolution” was a culmination of pent up economic factors whose translation into substantial industrial change was facilitated by non-material values (culture) and enabling institutions (Landes 1998). The observed Industrial Revolution also reflects demand influences, associated with demographic change, rising real incomes and an expansion of trading opportunities facilitated by intermediaries and entrepreneurs. It was also associated with the introduction of new firms and substantial competition that, together with new technologies, resulted in falling costs, new products, new substitutes and increased profits.

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characteristics. These segments have become defined progressively over the last two years.

They are:

- The “Group of Eight” universities, which constitute most of the oldest universities (except Tasmania) and have a very high commitment to research
- The “Innovative Research Universities” – a grouping of newer universities with strong research commitments and located in, or adjacent to, major metropolitan centres
- The “Associated Technology Network” (ATN) Universities – with a high commitment to applied technologies
- A grouping that refers to itself as the “New Generation Universities” – essentially universities that were created from former Colleges of Advanced Education and not included in the technology network universities
- Universities located in regional centres
- A group of small private and/or specialised universities.

Information on higher education revenue, according to the segments identified is provided in Table 2.

Table 2: Australian higher education institutions - Revenue 2001-2002 (\$,000)

	Common-wealth Assistance	State Government Financial Assistance	Higher Education Contribution Scheme	Postgraduate Loans Scheme	Student Fees and Charges	Other Earned Income	Other Income	Total Revenue
Major Research Universities								
Australian National University	292,421	2,851	25,631	2,327	27,302	57,636	53,554	461,722
Monash University	243,978	17,676	99,857	9,061	139,024	46,179	179,605	735,380
University of Adelaide	177,132	14,911	41,977	1,293	37,306	35,793	25,828	334,240
University of Melbourne	338,275	42,479	87,629	9,571	148,451	102,741	127,190	856,336
University of New South Wales	320,637	6,712	75,991	10,507	145,622	112,326	29,691	701,486
University of Queensland	269,928	19,999	95,538	7,369	73,841	134,060	213,715	814,450
University of Sydney	353,691	2,704	103,883	5,401	108,540	145,233	96,803	816,255
University of Western Australia	147,505	23,400	44,087	1,510	38,217	23,704	81,990	360,413
	2,143,567	130,732	574,593	47,039	718,303	657,672	808,376	5,080,282
Innovative Research Universities								
Flinders University of South Australia	91,943	5,544	32,120	721	15,904	17,941	12,984	177,157
Griffith University	137,009	13,608	71,862	3,857	57,430	23,978	42,952	350,696
La Trobe University	133,663	5,118	63,074	2,058	33,777	34,746	41,593	314,029
Macquarie University	93,084	1,769	48,583	8,119	83,176	36,395	24,726	295,852
Murdoch University	72,562	2,584	27,601	675	18,481	11,672	22,432	156,007
University of Newcastle	123,441	977	51,175	1,548	38,330	31,872	9,594	256,937
	651,702	29,600	294,415	16,978	247,098	156,604	154,281	1,550,678
Technology Network Universities								
Curtin University of Technology	117,310	13,844	58,309	3,962	98,675	22,709	46,065	360,874
Queensland University of Technology	152,930	4,645	89,434	4,399	71,588	15,123	27,066	365,185
Royal Melbourne Institute of Technology	120,699	65,948	61,250	5,277	144,160	33,920	46,993	478,247
University of South Australia	115,808	2,294	61,263	555	50,664	28,256	27,267	286,107
University of Technology Sydney	106,627	2,929	63,368	8,674	69,297	14,435	22,356	287,686
	613,374	89,660	333,624	22,867	434,384	114,443	169,747	1,778,099
New Generation Universities								
Australian Catholic University	50,239	1,020	26,162	445	8,766	5,658	12,083	104,373
Central Queensland University	54,014	806	29,932	741	85,914	14,258	24,928	210,593
Edith Cowan University	91,646	8,761	47,484	1,579	31,567	13,920	7,902	202,859
Southern Cross University	41,456	1,733	23,108	232	10,885	5,760	6,512	89,686
Swinburne University of Technology	49,974	59,839	23,687	3,368	48,224	37,126	10,996	233,214
University of Ballarat	32,055	24,281	13,968	332	6,883	24,124	5,297	106,940
University of Canberra	43,297	535	23,691	984	16,533	9,562	11,230	105,832
University of Western Sydney	141,116	317	85,675	3,627	44,326	7,674	13,989	296,724
Victoria University of Technology	71,027	65,637	52,563	609	32,577	34,389	20,995	277,797
	574,824	162,929	326,270	11,917	285,675	152,471	113,932	1,628,018

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	Common-wealth Assistance	State Government Financial Assistance	Higher Education Contribution Scheme	Postgraduate Loans Scheme	Student Fees and Charges	Other Earned Income	Other Income	Total Revenue
Regional Universities								
Charles Sturt University	67,523	170	51,900	1,950	21,390	19,822	24,618	187,373
Deakin University	105,654	1,833	61,867	0	47,052	55,240	54,192	325,838
James Cook University	89,073	1,618	34,688	744	12,576	24,716	10,054	173,469
Charles Darwin University	30,848	28,055	10,414	103	4,548	5,824	11,822	91,614
University of New England	80,040	878	30,951	607	10,335	18,912	6,548	148,271
University of Southern Queensland	51,043	2,493	30,279	1,041	20,521	4,288	8,948	118,613
University of Tasmania	111,742	6,166	35,655	724	16,230	16,160	12,998	199,675
University of the Sunshine Coast	14,327	200	10,088	13	4,537	1,499	1,824	32,488
University of Wollongong	85,400	1,891	35,069	1,558	45,115	35,572	5,485	210,090
	806,472	70,659	391,610	9,029	302,519	235,737	184,456	2,000,482
Other								
Australian Maritime College	10,884	0	1,353	24	1,803	3,435	3,364	20,863
Batchelor Institute of Indigenous Tertiary Education	21,432	9,169	1,237	0	0	403	16,299	48,540
University of Notre Dame Australia	4,515	437	1,186	496	9,324	1,299	2,964	20,223
All Institutions	4,655,949	465,831	1,833,589	106,061	1,878,891	1,268,360	1,405,452	11,614,134

The distinctive features of each segment, in terms of product characteristics, market positioning and performance are still in the evolutionary phases. However, the future of the higher education industry will be determined by how well these segments develop to meet demand for research and education services and how delivery is resourced. It will also depend on how each segment identifies and defines that part of the knowledge market in which it chooses to do business as well as the quality, integrity and credibility of the knowledge products and services. These aspects of the higher education industry have required the development of *engagement institutions* to operate at the interface between higher education, industry and society at large.

The data in Table 2 point to a substantial concentration in the industry, with the eight major research universities accounting for 44 percent of the revenue. There is also a major challenge for the smaller universities to be sustainable in this emerging industrial environment.

In the process of industrialisation some traditional not for profit institutions have created private affiliates that target increasing demand for education, particularly business education, on a for profit basis. These entities are generally separate from the core institutional structures, routines and cultures of a research university and represent, in effect, separate institutions of engagement. For example, Melbourne University Private Ltd (MUPL) was approved by the Victorian State government as a separate entity for a trial period of five years and on the condition that:

- Higher education award programs offered by MUPL be certified by the Academic Board of The University of Melbourne as being equivalent in standard to the University's higher education awards

- Acceptable research program be developed with at least three percent of its students in post graduate research
- Satisfactory progress be achieved in implementing the development plans in terms of structure and programs, schools, relationship with The University of Melbourne, commercial viability, business planning, and finance and ownership.

A number of professional associations have taken on an engagement and integrating role. For example, the Financial Planning Association offers courses that are developed and administered by universities (in this case, Deakin University).

In terms of entry of new competitors, there has been strong growth in the private “for profit” sector of the higher education industry in Australia. In 1997 there were 49 private institutions offering 196 accredited courses at diploma, graduate diploma, graduate certificate, graduate diploma, bachelor, masters and doctorate levels. These institutions included Bond University, University of Notre Dame, the Securities Institute, the Royal College of Medical Practitioners, the Mt Eliza Australian Management College, and several theological colleges.

By comparison, in the United States, there were at the same time 669 private, regionally accredited for-profit universities amounting to 15 percent of all institutions, accounting for 2.1 percent of all US enrolments (Ruch 2001). Some for-profits are new, whilst others have been in operation for many years. Strayer University was founded in 1892 in Washington DC and the DeVrey Institutes of Technology were founded in 1931. Although the for-profit model in higher education is not new, what is new is the creation of publicly traded holding companies that own and run universities in a tradition of “genteel businesses that existed even before the founding of the first American colleges” (Ruch 2001).

The emergence of for-profit institutions has been subject to strong critique, particularly from academics in the arts and humanities. There are some defenders of change. Former academic dean and chief academic officer Richard Ruch, who has worked in eight universities (including Michigan and Harvard) has observed that:

. . . many of the for-profit providers are actually doing a credible and even laudable job of addressing educational needs that are in high demand. That is not to say that these organisations are without faults or that there are not some for-profit education institutions that are substandard in quality and geared more to making profits than to providing education. Just as there is a wide range of quality among traditional, non-profit colleges and universities, there is a range of quality in the non-profit sector. Just as there has been fraud and abuse of public funds in the non-profit sector, there has been fraud and misuse of financial-aid funds in the for-profits (Ruch 2001).

A distinction needs to be drawn between the genuine for-profit universities that are regionally accredited and the “hundreds of diploma mills and fake schools” that sell degrees to any customer who can pay \$3,000 to \$5,000 (Noble 2001).

Competition in higher education is also global in orientation with students able to access courses and programs from a wide range of providers. Already, the main players in the global education market are not seen as the traditional education providers, but engagement institutions taking on a role as *integrators* using technology to combine delivery and distribution of content. Some of these developments are at this stage still controversial. At this stage there is still an emphasis on the opportunities created by the technology as distinct from how the service will actually be provided to the end user – who may be a student or a business that employs students.

Compared with overseas institutions, Australian universities are comparatively small. The University of Melbourne has observed that:

. . . in the longer term, retaining world class staff and maintaining internationally competitive research and teaching infrastructure will require a trebling or quadrupling of the University's current resource base. Only then will the University of Melbourne be resourced on a basis comparable with those of first rank, research-intensive universities in Europe, Japan and North America (IBIS World Pty Ltd 2002).

In 2001 Melbourne University had an enrolment of 35,694. Expansion in enrolments would come from either amalgamations of existing institutions or creating a substantial presence in overseas markets.

Although higher education institutions still rely on the Commonwealth Government as the major source of funding for the provision of education to undergraduate students they now receive substantial income from tuition fees paid by overseas undergraduate students and national and overseas postgraduate students. This market for higher education services is international and highly competitive. Demand is sourced from both individual students and corporations. At this stage, Australia is a relatively small player in that market compared with the US and Canada. Governments have sought to facilitate Australian entry through deregulation and support in obtaining market access. Several Australian universities have set up campuses in offshore locations (so far with mixed success) and two have joined the international consortium Universitas 21, a collaborative network of overseas universities. The University of Melbourne has committed to U-21 Global, an e-learning initiative of Universitas and a joint venture between 18 other universities and Thompson publishing.

Apart from tuition fees, universities also receive substantial levels of income from advisory and consultancy services and from research contracts and collaborative arrangements with businesses. This trend also has supply and demand dimensions; on the supply side, science based innovation is a critical aspect of biotechnology and materials technologies and on the demand side, businesses are looking more broadly than their own research laboratories for inventions to incorporate into product development and are moving away from a “not invented here” philosophy. Corporate research is being subject to market testing as part of broader technology acquisition strategies. This market is also global, and expanding, as corporations allow their research and development activities to move away from their headquarter operations and source capability according to where capability resides.

Some argue that this evolution has diluted the core business of teaching and learning, particularly for undergraduates. Many universities in Australia do not formally engage with their local economic and community environment, preferring to retain the traditional disinterested status and associated ivory tower image. The discussion of this Chapter suggests that this may not be a problem for higher education institutions *per se*, but reflective of an absence of effective engagement institutions. Institutions rarely change on their own volition. As discussed, they change in response to external threats and opportunities, but in a way that need not compromise their fundamental purpose and values. Community engagement is generally associated with strong community leadership and vision. This requires the commitment of university administrators, local government and regional business leaders.

The direction of industry evolution in higher education will also be impacted by the investment decisions of both incumbents and new entrants. Incumbents invest to take advantage of new research and teaching possibilities, new forms of delivery which shift entry barriers and the relative power among suppliers and between suppliers and buyers. Evolution depends on a combination of skills, resources, and, in particular, the performance of engagement institutions. These issues will be explored in later Chapters.

4.7 Universities as businesses in the production of knowledge

The current perception of the role of the university reflects its place in the socio-political economy. That is, the university is shaped and evolves with its environment. The forces that drive that evolution are complex and frequently misunderstood, with observers and commentators still seeing the institution in very traditional ways. The point is captured by the

following comment from a former President of the University of Michigan and Director of the Millennium Project:

The public still thinks of . . . images of students sitting in large classrooms listening to faculty members lecture on subjects such as literature or history. The faculty thinks of Oxbridge, themselves as dons and their students as serious scholars. The federal government sees the university as just another R&D contractor or health provider – a supplicant for the public purse (Duderstadt 2000).

Whilst the observation has an American twist it does also reflect an Australian context. The reality is that a modern research university is a “very complex, international conglomerate of highly diverse businesses” (Duderstadt 2000). They are, in fact, conglomerates managing very large budgets with increasing amounts of discretion. But they are far more complex than most industrial corporations, undertaking many activities - some for profit, some publicly regulated, and some operating in highly contested markets. In addition to teaching and undertaking research, universities provide publishing services (academic presses), health care (through teaching hospitals), collaborate with businesses in research and development, participate in economic development activities (including technology parks and precincts), stimulate social change, and provide sporting facilities and entertainment venues. Universities also have a wide range of investments in commercial property, securities and equities (Duderstadt 2000).

With increasing levels of income from commercial activities a great deal of recent attention has been given to the emergence of what has been termed the “entrepreneurial university” (Gallagher 2000; Slaughter and Leslie 1999). Whether these universities are in fact businesses, however, requires consideration of another set of issues. It is possible to be in the business of knowledge production without actually being in business in a commercial context – that is, to generate a profit. In specific situations and circumstances it is important to understand whether all, or only part, of the activities of a higher education institution are being operated on a commercial basis. To the extent that both types of activities are present the relationship between commercial activities (selling the work of a university for a profit) and core activities (research and teaching) becomes a major issue in overall strategy.

The concept of a university business is not necessarily or exclusively about pursuit of profit. It is about running a university in a *business like* way. It relates to managing large quantities of resources in an efficient and effective manner and ensuring accountability for results (Brown 1996). In being business like it is also important to make a distinction from being commercial, that is, generating profits and returns on investments. This issue points to an emerging duality in the role of a university, its outputs and how performance is assessed. That

is, universities were established and operate primarily as “not for profit” institutions, but a significant proportion of their activities is now directed towards a commercial outcome.

The distinction between a not-for-profit (beneficial) and a business (commercial) activity is important not so much in the process but in the outcome. That is, the purpose of a business is discharged when *customers* purchase products, pay for them and are satisfied. It involves selling a product and/or a service for a profit. In this sense, profit is the test of business viability, not the objective. By contrast, the purpose of a not-for-profit entity, or non government organisation, is discharged in the achievement of change – for example a cured patient in the case of a hospital, a repaired wetland in the case of an environmental agency, or an educated student or new understandings in science and society in the case of a university (Drucker 1990). (The purpose of government is discharged when public programs are judged, or demonstrated, to be effective).²²

To Drucker, the idea that businesses maximise profit is a major cause of the misunderstanding of profit in society and for the deep-seated hostility towards it as well as being responsible for the worst mistakes of public policy – which are “squarely based on a lack of understanding of the nature, function and purpose of a business enterprise” (Drucker 1993b). This issue is critical to addressing the changing management arrangements in universities. The main business driver in managing private, public and non-government organisations, and a common element to all, is a *plan* and a *budget*. Plans set the overall purpose, define intended results and specify the way in which they will be achieved. Budgets define how resources are to be sourced and applied. CEO performance is judged by their ability to deliver on plans and meet budget parameters.

In universities run along business lines, with revenues and expenditures running into hundreds of millions of dollars, plans and budgets are the key performance drivers. From this it follows that university managers must know about their costs, their commitments and the totality of their financial affairs and how they relate to business strategy.²³ This is not the same thing as a relentless pursuit of “profit”.

To create a business requires the investment of resources in management, marketing and working capital. Only a few universities have been prepared to make this commitment in

²² This distinction is discussed by Peter Drucker in a number of works. He argues that the practice of management differs little across institutions in that its primary function is to achieve the results of an organisation. See (Drucker 1990, 1999).

²³ It is of interest that recent significant CEO appointments have come from a finance background – BHP and the ABC are prominent examples.

relation to knowledge products, preferring instead to simply create a property right in discoveries and inventions and grant non-exclusive licenses for use. A small number of universities have resourced technology transfer companies to secure intellectual property rights and, in addition, actively market those rights to businesses and engage with the financial sector in the formation of companies to produce products based on those technologies in the form of start-up companies. Some universities have established their own venture funds for this purpose. In addition, numerous agents, consultants and brokers have emerged that seek to undertake the commercialisation activity on behalf of the university.

One of the most difficult issues in the marketing of knowledge products is determining the exchange value. The extraordinarily high valuations of dotcom companies at the height of the technology boom was an indication of the difficulties and uncertainties surrounding the valuation of knowledge products. Many of the products were in fact simply ideas or concepts that had little or no prospect of ever delivering revenues that exceeded the costs of production (the business validity test). The collapse of the technology boom in early 2000 indicated in sharp reality that, notwithstanding the ability to create pure knowledge products through the application of knowledge on knowledge, the capacity to derive a return relies heavily on the existence of complementary assets in marketing (including brands), production, distribution channels and management capacity.

For many knowledge products the exchange value is close to zero as a practical application has not been determined, reduction to practice research and development has not been undertaken, or a customer profile created. Moreover, exchange value is generally quite unrelated to the cost of discovery or invention. For most businesses, value is created through marketing – by making existing and potential customers aware, and convinced, the attributes of a product and the way in which it will deliver value *to them*. The value related to the scientific or technical aspects of a product will be heavily discounted due to the costs and the risks of getting to that end position.

Peter Drucker has argued consistently over many years that only an organisation that fulfils itself through marketing a product or a service is a business. He adds that the primary purpose of a business is to create a customer and this is achieved through the dual functions of marketing and innovation (Drucker 1988). An organisation in which marketing is either absent or incidental is not a business and should not be run as if it were one. It is the presence or absence of a marketing function that sets a business apart from other institutions and forms of human organisation. Specifically, the church, the state, and the university (in its traditional

formulation) have not generally been involved in marketing a product or service.²⁴ These institutions have stood back from the market and commercial world to provide stability, certainty and a supporting ideology for the conduct of trade, enterprise and social interaction.

In a business environment *customers* determine what a business is by being willing to pay for a product or a service. Businesses adapt and respond to customer wants. Thus a citizen is not a customer of the state or a parishioner a customer of the church, a prisoner a customer of a gaol, or a student or scientist a customer of a university.²⁵ Historically, universities have been organised as communities – as reflected in references to the “academic community” and the “community of science”. But these relationships are undergoing change. As the university becomes involved in commercial activities (that is seeking to sell its outputs for a profit) customer relationships become established and a businesses emerges. The scale and scope of that business in the overall institutional structure and the way in which it relates to it is an important issue for consideration.

Through experience both church and state, when involved in commercial operations and activities, have sought to separate the business and marketing functions from their integrating and regulatory functions. The way in which universities are resolving the balance between providing their core functions of teaching and research objectively and autonomously, with the commercial pressure to satisfy customers, is still evolving. Practices adopted in general government can be instructive in this regard. The instrument of the statutory authority for example, was created to separate commercial and trading operations from the functions of the state. More recently, the Australian Government has used the device of an *Executive Agency* to create a degree of independence from departmental management and facilitate a higher level of engagement with business, industry and other key constituencies.

Although universities are now charging directly for a range of products services, it does not necessarily mean they are businesses. The issue is whether they are actively *marketing* those services, the way in which they are being marketed and the extent of involvement of a “customer” in the design and delivery of those services. If universities merely assert property rights in discoveries and inventions and are not involved in marketing the asset created by this process, they are not really involved in a business. This is the preferred course of action for many research universities and is reflected in the very low level of resource commitment

²⁴ There are exceptions. The Catholic Church was in the business of selling “soul indulgences” prior to the Reformation.

²⁵ There have been some interesting learning experiences – such as the Australian Taxation Office once referring to taxpayers as customers.

allocated to technology transfer offices. Standing back from the market avoids the risk of conflicts of interest over the direction of research and scholarly inquiry. Moreover, research shows that very few universities have ever been successful in this sort of business (Johnston, *et al.* 2003).

It should not follow, however, that a person or organisation who pays for courses, or for research, directs the way the teaching is provided or research is undertaken – any more than a patient (not a customer) instructs a physician or a surgeon or a litigator tells a barrister about how to undertake their work. This is the nature of professional services in the knowledge economy and knowledge society. Fees are paid for process, not outcomes; in many professions, payment on the basis of outcomes (success) or commission is regarded as unprofessional and in breach of ethical standards. But fee for service does demand accountability, professional integrity, and ways to identify, assess and rank quality, and mechanisms to obtain redress for poor performance and conflicts of interest.²⁶ It also requires that teaching and research is not only excellent – it has to be relevant to end user needs.

One of the few areas where universities have been active in marketing is in the area of business education. The representations by universities and business schools of career advancement associated with completion of a MBA qualification have been brought into question (Crainer and Dearlove 1998). Business schools now have to take greater cognisance of the needs of students as customers who want a qualification that *will* provide opportunities for career advancement. To this end there is now a great deal of information, and rating systems, that publish information about the performance of business schools relating to the success of their graduates.²⁷

Global professional services firm PricewaterhouseCoopers, a major employer of university graduates has argued that an important consideration for universities, especially in light of the drive for deregulation of fees, will be how they manage the increased expectations of the customer. The firm suggests that this is not something universities have had to worry much about in the past. Processes to deal with marketing, business development, and managing

²⁶ The failure of the auditing and accounting profession to adhere to professional standards in relation to recent corporate collapses is an indication of conflicts of interest between managers and shareholders. The situation was driven in large part by excessive discounting of audit fees and boards making decisions on price alone, encouraging auditors to leverage their consulting colleagues into the businesses. Notwithstanding “Chinese walls” within the accounting firms, auditors and consultants shared profits and “cross selling” was a major criterion in performance appraisal. It is likely that the profession will lose its capacity for self-regulation.

²⁷ *Business Week* publishes an annual survey of business school performance and provides a substantial amount of information on its on-line website.

customer satisfaction are all areas where universities need to adjust their services to meet the changing requirements of students, business, and the wider community. The firm notes:

More collaborative approaches to learning are required, providing knowledge and skills to students when and where they need them. Greater competition in the higher education sector and a shrinking market place will place pressure on universities to become more customer-focused in their design and delivery of education services (PricewaterhouseCoopers 2002).

To perform in this context higher education institutions will have to give attention to the way in which they engage with organisations such as PricewaterhouseCoopers. They will need to commit to the generation of disciplinary knowledge, which lies at the basis of their legitimacy as higher education institutions, whilst at the same time responding to a customer demand for vocationally oriented teaching. Engagement may evolve along the lines of specialised teaching institutes and schools that stand at the interface between core institutional values and the demands of the marketplace.

Such institutes can only be successful if they have available a core of disciplinary knowledge that is created in an objective, credible and autonomous environment (academic excellence) but at the same time are capable of applying that knowledge to business and industrial situations (business and industrial relevance). In the research arena, the balance between research excellence and research relevance has been one of the major challenges for ensuring success in Cooperative Research Centres (Howard 2003b).

There has been a great deal of concern expressed in situations where businesses become customers in relation to research services, particularly in the pharmaceuticals sector (Bok 2003). The business purpose of satisfied customers (for example, a favourable outcome of a clinical trial) has the potential to undermine academic credibility and institutional values if research is biased. As argued above, resolution of this dilemma requires strong and effective engagement institutions that protect the values of higher education institutions and meet the needs of industry. This may involve the creation of ethics and probity organisations to develop standards (rules) and advocate their implementation. These standards and rules should form basic guidance for institutions of engagement.

Engagement institutions allow for the separation of the interests of business and the maintenance of academic integrity and values. University research offices currently perform this role but they are generally poorly resourced and do not have the capacity for monitoring and delivery of sanctions. There is a case for separate and independent engagement institutions for managing the interface between the requirements of business for commercial

outcomes of research and the need to preserve and maintain academic standards and values of higher education and research institutions.

These institutions require robust structures in order to operate effectively in knowledge markets and professional, expert management in joint ventures, alliance and partnership arrangements. It is at the interface that business is conducted: this does not necessitate or imply that higher education institutions lose sight of and commitment to basic institutional purpose.

4.8 Summary

The demand and the resources available for “disinterested” scholarly activity with no apparent application are not endless; there comes a time when priorities and frameworks have to be set and decisions about the allocation of resources made. This is a process that is currently underway. The increase in demand for student places, and the cost of research, has placed enormous financial pressure on universities. Governments are not inclined to meet the full cost of this commitment by either increasing taxes or extending public borrowing. Accordingly, this requires a greater focus on commercial issues and, as suggested above, managing to the discipline of a plan and budget. This is being business-like.

These observations provide an important base for thinking about universities in business terms. That is, successful university “businesses” will not achieve success and sustainability by a relentless pursuit of profit. They will do so by focusing on the needs and interests of their constituency – students, government, businesses and the broader community – and commit to a process of innovation in meeting those needs and requirements. However, many universities have come to realise that without some form of customer focus in a highly competitive industrial environment, they will cease to exist as sustainable organisations.

Universities are not the same as industrial corporations. They have different institutional characteristics in terms of structure, routines and cultures. The criteria for assessing performance are also different. There are numerous reasons why universities should not be directly involved in the knowledge business. These relate to threats to fundamental institutional purpose and integrity. However, it is essential that there be effective forms of engagement between universities and businesses as a way of achieving mutually beneficial outcomes, particularly in the area of mode 2 knowledge creation.

For higher education institutions to survive and grow as knowledge producing institutions they must maintain and build on their unique institutional purpose. This provides a basis for creating effective forms of engagement with business and government that are grounded in institutional strengths. The benefits to the economy and society of mode 2 knowledge creation will be achieved through the processes of engagement rather than attempting to imitate the institutional characteristics of a commercially oriented business enterprise.

Engagement occurs through collaboration in both teaching and research. Collaboration when structured as a partnership, alliance or joint venture, is a managed relationship requiring the input of experienced and competent joint venture managers who are capable of acting in the interests of all parties. Management skills in this area are in short supply. Engagement through commercialisation as in the sale of knowledge products and services (such as academic publications, technology licensing and full fee paying courses) also requires the skills, capabilities and commitment of market intermediaries. The capacity to build expertise, trust and maintain integrity in these exchange based relationships is a major challenge.

In the following chapter a detailed analysis is undertaken of the characteristics and market performance of a range of knowledge products and services and their impact on the institutional purpose of universities. The discussion takes up issues in relation to the balance between mode 1 and mode 2 knowledge production.

The development and implementation of strategies for collaborative and exchange based relationships are likely to have profound effects and impacts for the future development and structure of the higher education industry. It is clear from the analysis of performance to date that not all universities have the capacity to be heavily engaged in research commercialisation or to generate substantial income from overseas students.

Similarly in the area of community engagement, building knowledge communities requires strong leadership from communities and the commitment of universities and industry. There are few areas where achievement can be reported in community engagement in Australia. This issue will be addressed in Chapter 9.

Chapter 5. Trends and Directions in Industrial Innovation

It was argued many years ago in the work of Herbert Simon, James Thompson, Richard Cyert and James March (Cyert and March 1992; March and Simon 1958; Simon 1965; Thompson 1967) that organisations cannot be sensibly viewed as entities with personalities and goals like those of individuals. Firms are seen more in terms of shifting coalitions in which conflicting demands and objectives are constantly being reconfigured and reconciled.

The internal shifting of coalitions within the firm is now occurring to a much greater extent outside the formal and legal boundaries of the firm. There is a realisation among Boards and CEOs that in order to control an element of the value chain it is not necessary, or even desirable, to own it. Whereas historically corporations have sought to become vertically integrated and embarked on mergers and acquisitions this is now changing as corporations enter into a wide variety of strategic alliances, partnerships, joint ventures and market driven sourcing strategies.

Contemporary management analysis suggests that corporations see the best way to ensure survival is not to shore up their boundaries but to recognise that they exist within an ecosystem characterised a large number of complex relationships and the blurring of industry and organisational borders. Consistent with this pattern is the recognition coming from mode 2 thinking that innovation occurs at the “interface” between organisations and institutions. The current management literature is heavily oriented towards strategic alliances, partnering, joint ventures and the criteria for success within these arrangements. The concept of the charismatic leader is progressively being replaced with values of integrity and trust in a collaborative framework (Badaracco 2002; Mintzberg 1999).

This Chapter draws out evidence relating to the changing pattern of industrial research and the implications for engagement with universities and government. Regrettably, very little research has been conducted on this topic in Australia. It has been necessary therefore to draw on experience in the United States and Great Britain supplemented as appropriate with research undertaken by the author and contained in various publications and papers²⁸ and published submissions by business to recent inquiries and reviews (Australia. Minister for Education Science and Training (Hon Brendan Nelson MP) 2003; Australia. Parliament 2003).

²⁸ For example, (Howard 2001a; Howard and Johnston 2000; Howard, *et al.* 2001a, 2001b)

5.1 Changing business philosophies

Economist John Kay has argued that the main purpose of a large public company is to develop a business – in the interests of customers, employees, suppliers, investors and the wider community (Kay 1996). However, organisational and finance economists have promoted a view that a business organisation is simply a response to market failure and should, to the greatest extent possible, be set up along market lines. Consequently, recent finance thinking has emphasised efficiency, productivity, and individual performance contracts (Jensen 2000). The main focus in this situation is profit and shareholder value.

After the financial crises of the 1980s, resurgent investors rejected the notion of the professional manager developed by Galbraith in *The New Industrial State* (Galbraith 1967) and sought to establish control over what were seen as poorly performing oligopolies. A similar line of thought developed in relation to public enterprise. Economists in the field of agency theory put a compelling new image of the firm that very quickly shaped the thinking of investors, legal scholars and managers. This view rejected the view of the “soulful corporation” and saw the firm as merely a “nexus of contracts” too complex or risky to be left to managers. It also created a new “finance conception of the firm” – as a portfolio of activities to be assessed and revised regularly – the CEO is merely a portfolio manager and defined the relationship of managers to shareholders as that of “agent-principal” and a manifestation of the “agency problem” (Calomiris and Ramirez 1996).

These developments occurred as shareholding became increasingly concentrated in pension funds, mutual funds and insurance companies. As a result the “Wall Street Rule” became impractical (don’t argue, just sell your shares) as the power to vote the shares became concentrated with a few investors. Moreover, large investors could mobilize to challenge managers on their home turf – a counter to the Drucker prediction of the all-powerful manager. It was now possible for financial investors to hold managers accountable for their performance and to restructure their firms. Managers realised that even if they could dominate boards, their companies could be sold from under them.

Organisational economists, drawing on economic theory, organisation theory, and contract law, argue that organisations, whether, “formal”, “informal”, and “virtual”, exist because the cost of managing economic exchanges (transactions costs) across markets is sometimes greater than the cost of managing economic exchanges within the boundaries of an organisation (Barney and Hesterly 1996). In this line of thinking there are two issues that lead to organisational constructs. The first relates to managing uncertainty due to the existence of

“bounded rationality” – that is people have to know what to do because of imperfect information about what is to be done and achieved. The second concerns preventing “opportunism”, that is people taking advantage of exchange situations for their own, unrelated, benefit (lack of trust).

Market exchanges are considered to be the least costly form of transaction and are appropriate when the only concern is about minimising the cost of economic exchanges. Formal, or hierarchical structures are expensive – but appropriate – when the only concern is about minimising the impact of uncertainty and opportunism (Day and Wendler 1998).

In an influential article, three prominent management academics suggest that the focus of economists on efficiency, productivity, individual performance and contracts subverts the cooperation and collaboration that is essential for innovation, both internally and external to the business. They argue that:

In terms of static efficiency, much of what happens in a company *is* inefficient. That’s the point. It exists precisely to provide a haven and (temporary) respite from the laws of the market in which humans can combine to do something that markets aren’t very good at: innovating (Goshal, *et al.* 1999).

Additionally, they suggest that by thinking of companies in market terms, companies have become victims of the very logic that they have sought to live by – a logic that leaves little choice but to squeeze out more efficiency than was ever attempted. It is a focus on productivity improvement and cost reduction and control. But:

. . . market based organisations cannot create any value that is new – not because they don’t want to, but because the logic of the market that is adopted internally is not very good at anything other than enhancing the efficiency of existing activities. The sharp sense of self interest that is engendered and the uncertainties inherent in any innovative effort make people unable to cooperate among themselves or to pool their resources and capabilities in order to create new combinations – particularly new combinations of knowledge and expertise – that most innovations require (Goshal, *et al.* 1999).

This observation is reflective of a dilemma for industrial innovation in the current institutional framework. Many large corporations have evolved as integrators and traders in strategic assets and competencies. For many businesses in the fast moving product sectors (food, consumer electronics, for example) innovation is sourced externally more or less in the same way as manufacturing. However, as discussed below, innovation sourcing strategies are difficult to develop and few businesses are yet doing it well (Linder, *et al.* 2003a).

Successful and innovative businesses emphasise the non-market like nature of their company – encouraging people to work collectively toward shared goals and values rather than more

restrictively, within their narrow self interests. They can share resources, including knowledge, without having to be certain of how precisely each of them will benefit personally – as long as they believe that the company overall will benefit to their collective gain. It is the philosophical distinction about what a business is that allows successful corporations to create innovations through a spirit of collaboration among people that markets, and companies that think of themselves as markets, cannot engender (Goshal, *et al.* 1999).

The extent and application of this philosophy is at this stage emergent. Financial pressures, competition and globalisation, and shareholder value are still pushing businesses down the market philosophy. However, recent contributions in business publications are strongly advocating a return to corporate social responsibility and re-establishing the moral legitimacy of corporations as first addressed by Peter Drucker in 1945 in his study of General Motors and published as *The Concept of the Corporation* (Drucker 1993a). Even so, managers may find it difficult to return to the original concept of the vertically integrated and all embracing organisation that valued social relationships as much as the economic and financial.

It may be more fruitful to focus on building the institutions of engagement that link businesses through alliances, partnerships and joint ventures. This building process is concerned with management capacity building and in particular, the capacity to work at the interface between commercial imperatives of a business and the creative culture of a knowledge creating organisation. Recent research indicates that these capabilities are in very short supply (Howard 2003b; Howard and Johnston 2001b).

5.2 Changing emphasis on research expenditure between universities, business and government

The purpose of this Section is to provide some statistical information relating to the relative emphasis and commitment to research between higher education institutions, business and government. Reference was made in Chapter 2 to a changing emphasis on research effort between the sectors. The purpose of this Section is to draw attention to the magnitudes of research commitment.

The distribution of research activity in Australia among the four research performing sectors in 2000-01 is indicated in Table 3.

Trends and Directions in Industrial Innovation

Table 3: Expenditure on research and development by sector and activity 2000-2001 (\$'000)

	Pure Basic Research \$'000	Strategic Basic Research \$'000	Applied Research \$'000	Experimental Development \$'000	Total \$'000
Business	38,213	265,831	1,188,245	3,333,015	4,825,304
Government	107,477	533,104	1,405,251	322,535	2,368,367
Higher Education	847,358	665,769	1,047,741	213,696	2,774,564
Private Non Profit	73,945	121,572	65,438	22,245	283,200
Total	1,066,993	1,586,276	3,706,675	3,891,491	10,251,435

Source: Australian Bureau of Statistics, *Research and Experimental Development*, 2000-2001. Cat 8112.0

The data indicate that, overall, business accounts for 47 percent of total expenditure on research and development, higher education accounts for 27 percent and government accounts for 23 percent. The distribution of research activity within each sector differs quite markedly as is indicated in Table 4.

Table 4: Expenditure on research and development by sector and activity 2000-2001 (%)

	Pure Basic Research %	Strategic Basic Research %	Applied Research %	Experimental Development %	Total %
Business	3.6	16.8	32.1	85.6	47.1
Government	10.1	33.6	37.9	8.3	23.1
Higher Education	79.4	42.0	28.3	5.5	27.1
Private Non Profit	6.9	7.7	1.8	0.6	2.8
Total	100.0	100.0	100.0	100.0	100.0

Source: Calculated from, Australian Bureau of Statistics, *Research and Experimental Development*, 2000-2001. Cat 8112.0

Table 4 indicates that business undertakes most experimental development activity and higher education undertakes most pure basic research activity. The higher education sector is also a significant player in strategic basic research (42 percent) and applied research (28 percent). Government research organisations account for just over one third of strategic research and 38 percent of applied research. Nonetheless, higher education undertakes nearly four fifths of basic research. Information on levels of research expenditure across the four sectors according to the RFCDC Classification is provided in Table 5.

Table 5: Expenditure on Research and Experimental Development by Research Fields, Course and Disciplines Classification 2000-2001 (\$'000)

RFCDC Category	Higher Education \$'000	Business \$'000	Government \$'000	Private Non Profit \$'000	TOTAL \$'000
Natural Sciences, Technologies and Engineering					
Mathematical sciences	59,393	30,660	25,130	1,124	116,606
Physical sciences	112,025	51,397	93,257	617	257,296
Chemical sciences	127,196	173,654	95,298	2,628	398,776
Earth sciences	94,619	50,376	215,118	0	360,113
Biological sciences	324,509	122,002	259,787	77,133	783,432
Information, computing and communication sciences	113,136	1,259,291	216,803	2,940	1,592,170
Engineering, technology & applied sciences	330,903	2,653,703	384,762		3,369,368
Agricultural, veterinary and environmental sciences	204,513	153,700	773,263		1,131,476
Medical and health sciences	667,716	299,485	182,665	180,777	1,330,642
	2,034,010	4,794,268	2,246,083	265,219	9,339,879
Social Sciences and Humanities	740,554	31,035	122,286	16,518	932,226
TOTAL	2,774,564	4,825,304	2,368,367	283,200	10,251,436

Source: Calculated from, Australian Bureau of Statistics, *Research and Experimental Development*, 2000-2001. Cat 8112.0

Table 5 indicates that research in higher education is heavily concentrated in the medical and health sciences, biological sciences and engineering sciences. Business research is focussed in the information, computing and communication sciences and in engineering, technology and applied sciences. This has implications for research commercialisation as the prospects for selling the work of the university for a profit is directly related to how much research is undertaken in these areas.

In government research organisations, almost one third of research is concerned with agricultural and veterinary sciences and 16 percent associated with engineering and applied science disciplines. The high concentration of research activity in agriculture reflects the influence of funding provided by the Rural Research and Development Corporations that is directed mainly to higher education institutions and government research organisations and particularly the CSIRO and State government agricultural research institutes.

The distribution of funding in percentage terms is summarised in Table 6 below.

Table 6: Expenditure on Research and Experimental Development by Research Fields, Course and Disciplines Classification - Proportion of expenditure within sector 2000-2001 (%)

RFCD Category	Higher Education %	Business %	Government %	Private Non Profit %	TOTAL %
Natural Sciences, Technologies and Engineering					
Mathematical sciences	2.1	0.6	1.1	0.4	1.1
Physical sciences	4.0	1.1	3.9	0.2	2.5
Chemical sciences	4.6	3.6	4.0	0.9	3.9
Earth sciences	3.4	1.0	9.1	0.0	3.5
Biological sciences	11.7	2.5	11.0	27.2	7.6
Information, computing and communication sciences	4.1	26.1	9.2	1.0	15.5
Engineering, technology & applied sciences	11.9	55.0	16.2		32.9
Agricultural, veterinary and environmental sciences	7.4	3.2	32.6		11.0
Medical and health sciences	24.1	6.2	7.7	63.8	13.0
	73.3	99.4	94.8	94.2	90.9
Social Sciences and Humanities	26.7	0.6	5.2	5.8	9.1
TOTAL	100.0	100.0	100.0	100.0	100.0

Source: Calculated from, Australian Bureau of Statistics, *Research and Experimental Development, 2000-2001*. Cat 8112.0 and DEST publications

Table 6 confirms the concentration of R&D effort in business in information technology and communications and engineering (76.1 percent of the total) and the concentration of R&D effort in the life sciences in higher education (biological sciences and medical and health sciences making up 35.8 percent of the total). It is of interest that university research in commerce, management, tourism and services represents four percent of higher education research, around the same level as research in the physical, chemical and earth sciences. In an environment of growing interest in research commercialisation, research in management and commerce should complement research in the science and technology disciplines.

The recently released study of the *Impact of Academic Research on Industrial Performance* pointed to a growing imbalance in US federal research funding. It noted that current investments in life sciences far outpace investments in complementary disciplines of physical sciences, engineering and the social and behavioural sciences. Studies repeatedly demonstrate that the value of research results on one field often depend heavily on advances in complementary fields (National Academy of Engineering 2003). The current heavy investments and support provided by Australian governments in life sciences must be seen in this context.

The study suggests that higher education institutions must maintain a mix of basic and applied research to sustain their role as repositories of expertise and resources in many disciplines. Federal funding is now virtually the only source of support for basic research. The study identifies a challenge for higher education institutions in terms of not only maintaining a balance between basic and applied research but also to ensure that the basic research portfolio is sufficiently diverse to stimulate innovative thinking by academic researchers in many fields. In this context it is useful to look at available evidence and material relating to changing business strategies for investment in industrial research.

5.3 Changing business strategies for investment in industrial research

The traditional model for funding research has been that corporations “taxed” their business units and used revenues to give to an R&D department or laboratory, as a “subsidy” to pay for research. Some of this funding found its way to universities to tap into specific areas of competency and capability and was managed on a collaborative “laboratory based” model. The new knowledge created would be given away for free. When the R&D department (perhaps in collaboration with a university) came up with something it gave it back to the company – for free (Kurtzman 1998a). This process was, however, very expensive and resource intensive. That is:

The command control – tax, subsidy mechanism is not the perfect solution. While there are a billion haystacks in which there will be some very valuable needles, it is very expensive to look under every one. It is also the case that the research effort gets spread very thinly (Kurtzman 1998a).

With increased competitive pressures Boards and CEOs are committed to controlling costs; with increased shareholder control they are under pressure to meet the profit expectations of shareholders and market analysts. It follows Boards cannot just give scientists lots of money and let them follow their curiosity (although this does not imply that there is no value to

businesses in basic research). But if they do, the “tax subsidy” system dissipates efforts and does not lead to the highest return to shareholders. As a result, and consistent with the economic and financial paradigm, companies create market type mechanisms that impose market tests on research. Research units are increasingly being set up as profit centres, and in some cases outsourced or spun-out entirely as separate entities. As a result of these trends, the model under which businesses enter into open-ended relationships with universities to undertake discovery research is being superseded.

Industrial research is increasingly being approached on the basis of a capital expenditure/investment appraisal decision, and on a project-by-project basis, using a *business case* or stage gate model. Internal research unit now charge different business units for any of the results they produce and which other business units use. These divisions are also being “market tested” against independent research laboratories, including publicly funded research organisations and universities. In this process internal engagement institutions have emerged to guide the relationship between research and development and commercial outcomes. A common institution is a Board R&D Committee with cross organisational membership.

In this emerging corporate environment, research and development capability is no longer regarded as a critical strategic asset and a barrier to competitive entry in some industries. Large companies have traditionally done most of the research, including basic research, in their respective industries – DuPont, Merck, IBM, GE, AT&T. Now, these companies are finding strong competition from newer companies – Intel, Microsoft, Sun, Oracle, Cisco, Genentech, Amgen – who do little or no basic research on their own. They have innovated with the research discoveries of others. Research capability is acquired through acquisition of technologies developed in start-up companies (Chesbrough 2003).

An important aspect of industrial innovation is now based on encouraging start-up companies to develop and market new discoveries and “disruptive” technologies to end-users. These users may be a final consumer but, more likely, will be an established corporation further along the industry value chain. These features are apparent in the life sciences, information and communications industries. The creation of these start-ups, based on knowledge assets, and little in the way of complementary assets such as buildings, plant and equipment, has been facilitated by the availability of a new form of risk finance – venture capital.

The larger corporations that use these strategies in taking new products and services to market (for example, computer hardware, telecommunications and pharmaceutical companies) invest less in internal R&D and more in finding and acquiring technology and start-ups.

Alternatively, they can enter into meaningful strategic alliances with small and medium sized companies whose business model is to increase the value of the technology/discovery and sell it on fast. These outside perspectives and competencies flow into and out of organisations through many routes:

- Partnerships with universities
- Alliances and acquisitions
- External venture investments
- Recruiting and hiring
- Customers and suppliers
- Relationships and curiosity of individual employees.

These sources of external influence have played pivotal roles in all aspects of corporate innovation (Wolpert 2002). But, from a corporate point of view, these sources can also be unreliable. For example, from an IBM perspective:

- Academic cooperation usually centres on basic science – “looking for new business ideas in academia is like looking for marlin in a trout stream”
- Customers and suppliers have limited insight beyond the incremental
- More formal means, from venture capital arms to joint ventures and merger and acquisitions programs are rarely dependable sources of innovation; they tend to be deterministic - shaped by internal strategies, politics and secrecy concerns – and perpetuate an existing business rather than open up new opportunities (Wolpert 2002).

Many established companies have also found that much of their own basic research wasn't useful to them. They exited or abandoned projects – only to have them taken up by start-ups and turned into valuable new companies.

Within this overall context there appears to have been a broader trend of companies in many sectors to cut back on their long-term in-house research. This trend increases the importance of the role played by research organisations with close industry involvement as they build up the R&D corporate knowledge of a sector and put in place engagement strategies and arrangements. This requires a capacity to enter into and work within cooperative and collaborative arrangements. Like the institution of marriage, the formation, development and sustainability of cooperative and collaborative arrangements require commitment and hard work (Kanter 2002). Partnerships, alliances and joint ventures have specific institutional characteristics relating to structures, activities and routines.

Recent work in the management consulting sector suggests corporations are beginning to appreciate the interdependent systemic nature of the connections between businesses, governments, unions, non-government organisations, higher education institutions, and the

physical environment that contains them. New relationships are constantly being created and old ones strengthened or destroyed. Making the right connections is seen as a key to business survival. Moreover, new technology and the growing importance of intangible (knowledge) assets are pushing corporations to new levels of collaboration and knowledge sharing. This is also happening at increasing speed. Yahoo, for example, conducts two or three new corporate deals a week – from simple alliance to outright acquisition. Completion of these deals takes an average of between five and ten hours (Cullum, *et al.* 2001).

Research undertaken by Accenture indicates that between 1997 and 2000 the typical large company formed 177 alliances, although about half failed or underperformed. A quarter of corporations expect alliances to account for more than 40 percent of their market value by 2004. In chemicals the number of alliances has risen three fold since 1993. Information and communication technologies facilitate these alliances through interconnectivity protocols, including elaborate web sourcing, integrated eProcurement, supply chain management systems and the construction of electronic markets. These new types of connection are developing with the “unbundling” of the value chain (Hagel and Singer 1999b), the blurring of markets and the convergence of traditionally distinct industries.

New technology has also heightened expectations and attention in dealing with customers. This is seen in the reported exponential demand for seamless channel management, key account management and customer relationship management along with customisation of products and services. Some industries are moving to a concept of “the market of one”. It is a movement from customer focus to being customer driven – even to the stage where the customer does the integrating.

Paradoxically, information technology, electronic commerce and the Internet has actually *increased* the need for a specific customer focus. While they provide the opportunity to meet customer needs specifically and directly, customers can, and do, switch easily to alternative suppliers. In this environment of *mass customisation*, the task of management is not only to make a new product, and identify potential demand, it is also to identify how a product will be marketed and, where necessary, the substitute products that it will replace.

Increasingly corporations are giving more attention to corporate social responsibility. With the shift in power towards consumers and NGOs there are clear benefits to the corporation in proactively improving relations with the rest of society. Sixty years ago Drucker recognised that corporations are an integral part of society and their “legitimacy” depended on an earlier social contract (Drucker 1993a). The concept of shareholder value pushed attention to the

shareholder, but, going on recent articles in the *Harvard Business Review*, corporate social responsibility through philanthropy is again an issue (Porter and Kramer 2002).

As corporations become interested again in the way in which their activities contribute not only to their own success and prosperity but also to others in society they will enter into partnerships with the community if ways can be found of ensuring that these partnerships fit well with their core business needs - or where good use can be made of the corporation's resources. There is a realisation that sustainable, stable societies makes business profitable and corporations need to demonstrate that they are acting sensibly in the markets they operate.

5.4 Innovation sourcing

Peter Drucker in *Innovation and Entrepreneurship* identified seven sources of innovative opportunity (Drucker 1985):

- The unexpected – unexpected successes, failures and outside events
- The incongruity – between reality as it is and reality as it is assumed that it ought to be
- Innovation based on process need
- Changes in industry structure or market structure that catch everyone unawares
- Demographic change
- Change in perception, mood and meaning
- New knowledge – both scientific and non-scientific.

Drucker argues that the discipline of innovation follows from separate and systematic analysis of the causes and symptoms of changes in these source areas. The sources identified above are placed in descending order of reliability. He adds that:

. . . contrary to almost universal belief, new knowledge – and especially new scientific knowledge – is not the most reliable or even the most predictable source of successful innovations. For all the visibility, glamour, and importance of science-based innovation, it is actually the least reliable and least predictable one.

Science and technology based innovation is what people generally refer to when discussing innovation. It attracts publicity, money and is associated with substantial industry and economic change. It should not be overlooked, however, that application of non-scientific knowledge drawn from the social sciences and humanities is also an important source of innovation. The predominant and distinguishing features of knowledge based innovation relate to the time commitment, the high risk of failure, the difficulty in predicting customer response, and the management challenges.

With the increasing importance of science based innovation, as well as the forces of customisation and globalisation, business strategy is becoming based more and more on

information about new scientific discoveries and technologies as well as about new and emerging markets, about financing options and the economy generally. This information originates from *outside the organisation*. A change in strategy development follows from an acceptance that the important technologies that transform a business come not only from outside the business; they come from outside the industry itself.²⁹

Recent management writing suggests that only a few companies have built systems to gather and organise outside information to be used for the development of business strategy – including innovation strategies. Executives still tend to assume that business conditions must be what they think they are (based on their experience), or at least what they think they should be (Drucker 2001). This assumption is no longer valid – if it ever was. The successes of 3M, J&J and Hoechst are associated with their capacity to pick up and apply emerging technologies (Kanter, *et al.* 1997).

For businesses in the fast moving consumer goods sectors the shortening of product development life-cycles and the competitive pressures of globalisation has meant that they have had to look more broadly for new technologies. Few companies now retain in-house all of the necessary capacity and capability for innovation in their product areas. For example, Dr Joseph Miller, Chief Technology Officer at DuPont has observed:

For most of our history, we believed that we ourselves could handle all the necessary research. Now, DuPont's dedication to collaboration extends beyond the company itself, and that is something of a change. Our relationship with the university community, for example, once focused almost entirely on recruiting its graduates. But the world of science grows increasingly complex; we are no longer capable of doing everything ourselves, nor can we afford to. So we reach out. Some of the partnerships we form are for the purpose only of acquiring data for a specific project, but more often our goal is to sponsor research that will yield new ideas . . . External networking makes the difference between success and failure when we've confronted overwhelming challenges (Kanter, *et al.* 1997).

Increasingly therefore, businesses are relying, through linkages with publicly funded research, on access to well trained human resources and to new scientific knowledge to complement their own R&D efforts. A recent Accenture study reported that:

To ramp up their levels of innovation, companies have shifted more of their focus from internal innovation to a range of outside sources such as customers, research

²⁹ For example, molecular biology and genetic engineering were not developed by the pharmaceutical industry. Bell laboratories – a telephone company, invented the transistor. Many of these technologies were licensed to new and emerging businesses at a fraction of their economic value. This suggests why the “start-up” route for commercialisation, by licensing or assigning technologies to newly created companies, is attractive – not only for the science community but also for large innovative companies who use a venture capital “model” for new business investments.

companies, business partners and universities. Fifty percent of the executives we interviewed for this study assert that the percentage of external innovation will grow even further over the next three years (Linder, *et al.* 2003a, 2003b).

Executives note shifts in their industries with all of the players doing far less product innovation internally. They are entering a new growth area that involves the contribution of venture capital, alliances, and acquisition of technology. One said: “the last place we would look for innovation is in-house R&D”. Nonetheless, companies like Eli Lilly and Dupont still rely on internal sources for more than 70 percent of innovations.

Despite the growth of external innovation, it has been observed that many companies lack a sourcing strategy that guides them in managing it. Sophisticated companies have sourcing strategies for production processes and many functions have well defined processes for “make or buy”. But only a few companies have a sourcing strategy for innovation. Even fewer have a holistic way to manage diverse innovation sources to get the most out of the process. Corporations are being advised by their consultants and researchers to look for managed approaches to engagement in innovation sourcing (Quinn 1999, 2002; Quinn and Hilmer 1994).

It is reported that Eli Lilly, for example, looks at between 1,000-1,500 opportunities a year to acquire someone else’s Intellectual Property. At any one time it is managing 140 external partnerships with drug research firms at various stages of the drug development process. It looks to individuals using community sourcing to solve hard chemistry problems. It also has venture capital funds to invest in early stage biotech research. These strategies are reported in studies of Nokia, Microsoft and other technology based companies (Gawer and Cusumano 2002; Haikio 2002).

The Accenture research on innovation sourcing concludes that:

- Companies are increasing their reliance on external sourcing for innovation, but most lack an innovation sourcing strategy; they transact with a few familiar external innovation sources, but they are not getting the most out of the activity.
- Avid innovators create and manage a diverse set of innovation “channels”: that incorporates not only sets of sources but also well established processes for managing the interfaces; they cultivate multiple external sources and explicitly master a range of boundary spanning approaches in support of a clear innovation sourcing strategy.
- Leading companies manage the entire innovation sourcing network holistically – including both internal and external sources. In addition to accepted project and risk management techniques, they use big ideas to define agendas and drive new sources of value.

As firms mature in their ability to manage innovation they expand the types of innovation and the sources they use. As they increase sources, they integrate these sources into channels across different phases of innovation. The categories of innovation sourcing channels and their characteristics are summarised in Figure 6 below.

Figure 6: Types of innovation sourcing channels

Channel types	Attributes
Buying Innovation on the market	Organisations ranging from universities and consulting firms to private research labs offer innovation for hire. This type of channel is well established in most industries, although firms in different industries invoke it more frequently at different parts of the innovation chain. Some technology firms, for example, actively sponsor research at local universities. In contrast, retailers and automotive firms with strong brands and market power shift the onus of innovation onto suppliers through a process called "strategic procurement." These suppliers compete for purchase orders by investing in and offering differentiated products.
Investing in Innovators	Companies take equity positions in innovative firms to benefit from breakthroughs. Pharmaceutical companies have their own small venture capital funds or work with independent venture capitalists to seed technologies in the biotech arena and in the information technology space. Electronics companies also make heavy use of this channel. Some companies invest in innovators as a strategy to skirt entrenched business models, corporate inertia or top management resistance to investing in small markets. Through an equity partnership, a firm can participate in and nurture an emerging market.
Resourcing	Companies support their staffs by contracting with outside suppliers for on demand talent and innovative new tools. This provides flexibility in managing R&D and recognizes the increasingly global nature of a high quality research capability. Pharmaceutical companies also look outside for cutting edge technologies to improve product development productivity. They bring these in house when a clear leader emerges among competing technologies and its value for the internal efforts has been proven.
Co-sourcing	As innovation in some arenas becomes more expensive, firms band together to share the costs. In industries like oil and chemicals, these groups often include direct competitors. Automotive firms use co-sourcing to address regulatory requirements like emissions standards that affect them all. One leading high technology firm locates its own research laboratories inside universities. Partnerships across all segments of the innovation chain are also used to bring together the diverse skills and talents a project requires.
Community sourcing	Community sourcing involves tapping loosely connected communities of sophisticated users. This approach has been successful in the software industry, where one form of it is called the "open source" movement. NTT DoCoMo employs community sourcing for the information content it distributes over its I-Mode mobile data service by allowing any company or individual to set up an I-Mode compatible website. Nokia relies on community sourcing for the applications software for its Media Terminal, the centrepieces of the firm's wireless home entertainment system. (<i>see article in Technology Review</i>).

Source: Based on Linder, Jane C, Sirkka Jarvenpaa, and Thomas Davenport. "Innovation Sourcing Matters, 2003." Accenture Institute for Strategic Change, Boston.

From the typology presented above it is apparent, though not explicit, that innovation sourcing strategies require management attention and creation of engagement structures and routines as a way of ensuring that the outcomes of innovative activity can be captured and applied. Developing these engagement structures with higher education institutions in the investment and resourcing strategies form the basis of cooperative and collaborative research arrangements. Notwithstanding the opportunities in these areas for improving industrial performance, the extent of engagement is not substantial or universally adopted across industry. The demand for knowledge created in higher education institutions is addressed in more detail below.

5.5 Business demand for university created knowledge

Academics and observers in the area of science and technology management have noted that since 1980 US firms have expanded their funding for and relationships with university based

research. Financial support from industry has established a number of research facilities on university campuses to conduct research with potential commercial value. However, the level of research funding from US corporations is now only returning to levels attained in the immediate post-war period. The fields of research that hold out generating significant findings for industry are relatively narrow, being concentrated mainly in the area of biotechnology and computer science (Mowery and Nelson 1996).

Academics have welcomed the prospect of industry funding, but many have seen it as an opportunity to resource ongoing research programs and agendas. Policy makers tend to see industry funding as a substitute for government support. There are many academics and scientists who hold to the so called *linear model* of technological advance, seeing academic research as providing the basis for technological innovations in industry, with the process not calling for much industry influence over what researchers actually do (Rosenberg and Nelson 1996a). The failure to have discoveries and inventions transform into innovations is seen as a “gap” problem that calls for additional funding for commercialisation (see Chapter 3 above).

There are also many academics who are prepared to re-orient their work towards commercial outcomes: there are many who believe that “with financial support from industry, academic researchers can provide industry with a cornucopia of new product and process prototypes and restore the lost competitiveness of American industry” (Rosenberg and Nelson 1996a). This view has found its way into numerous public policy initiatives and programs that are directed towards making university research become what has been termed *investment ready*. What policy makers and researchers think of as investment ready is not always shared by technology investors and potential industry partners.

Rosenberg and Nelson point to considerable industry scepticism over the ability of academics to contribute directly to industrial innovation. Reporting on Roundtable interviews, they note that:

To a considerable extent the industry views expressed to the Roundtable were that the academics should stick with the basic research they are doing, and heed their training functions, and stop thinking of themselves as the source of technology (Rosenberg and Nelson 1996a).

From this perspective it is important to sort out when higher education institutions are capable of helping industry and under what arrangements. Rosenberg and Nelson suggest that if research is to be fruitful there must be close communication between those who do research and those responsible for product and process design and development. University-industry research centres are seen to be an important aspect of building those connections. However,

academics should not, it is observed, be put in the position of having to make commercial judgements. Research centres and incubator programs should be regarded as institutions affiliated with universities – not an integral part of them. This allows the division of labour between higher education institutions and industry to be preserved (Rosenberg and Nelson 1996a). The role of research centres as institutions of engagement is canvassed in Chapter 8.

In a study of seven industries over the period 1975 to 1985, it was concluded that very few innovations based on academic research were invented at universities. Whilst academic research often yields new theoretical and empirical findings and new types of instrumentation that are needed for the development of a new product or process, it seldom results in the specific invention of itself (Mansfield 1996). The author of the study suggested that this is unlikely to change because successful product and process development demands an intimate knowledge of particular markets and product techniques and the ability to recognize and weigh commercial and technical risks is a matter for business executives – a skill built up on the basis of experience.

Universities do not have this experience, and expecting them to do so is unrealistic. The essence of successful development is the ability to work effectively with production and marketing departments; the interface difficulties are well known – and at times formidable. It is also unrealistic to attempt to include universities as major players in this process – particularly given the importance of timely decision making. Industry stresses that the role of universities in the process of technological change is to provide well-trained students. It is in the education of students that industry looks for closer ties with higher education institutions (Mansfield 1996). This point has been made in industry submissions to the Australian Higher Education Review and in discussions and consultations undertaken for the Review of the Cooperative Research Centres Programme (Howard 2003b).

Notwithstanding the predictions from the academic arena about institutional convergence, the voluminous literature on business innovation makes little mention of universities *except in the specific context* of access to scientific and technological capability. There are some indications that corporations are concerned about universities moving into areas of applied research, particularly where this is undertaken in university research centres (Florida and Cohen 1999). The cause of concern relates to:

- A focus on profit in research areas will hurt the education function – as it is educated and knowledgeable students who are valued most by companies
- Companies consider they can get better results through one-on-one relationships and longer term research contracts with individuals

- Although research centres attract government support, the overheads are high and the results not always relevant to individual businesses
- Companies are concerned with universities “wrangling over Intellectual Property rights”
- Premature disclosure and the time delays involved.

There is a considerable amount of material to suggest that universities have been quite unsuccessful at commercial operations and that while they can make a contribution to industrial research and development, they have a limited role in the commercial areas of business – such as strategy, product development and marketing. It is important to constantly keep in mind that in highly competitive markets, *businesses* (both large and small) are in the best position to see a need or an opportunity for more competitive products – but they often lack time and resources to develop them. The only real alternative for many businesses is technology-licensing arrangements with universities and government research laboratories.

In all reality *universities* cannot be much help to companies that are struggling with their customer relationships and product cycles. University researchers should not be expected to push their findings into the product cycle; it is the responsibility of companies to pull knowledge into the process when it is needed. In this regard university researchers and their agents (technology transfer officers and brokers) need to move from a “tell” and “sell” mode of communication to one based on relationships and engagement (see Chapter 3 above).

Large companies, with their own R&D capability, take a great deal of care in acquiring underdeveloped technologies externally. They prefer to wait until technologies are “proven” to be marketable before making investments. However, in order to tap into the potential of emerging technologies, large companies are establishing relationships with university research centres and are tending to invest in a “portfolio” of small technology based firms that have been “spun out” of universities and public research organisations (Gross, *et al.* 2000).

A recent US study provides some insight into how businesses identify technologies for licensing purposes.

Table 7: Sources of information about technology licensing opportunities

Source	Percentage of Respondents	
	Extremely Important	Not Important
Personal contacts between corporate R&D staff and university personnel	45.7	5.7
Patent searches	24.0	9.0
Journal publications	19.6	3.9
Presentations at professional meetings	13.1	2.0
Marketing efforts by university technology transfer offices	12.0	24.0
Corporate licensing staff routinely canvass universities for new technologies	9.3	29.9

Source: (Thursby and Thursby 2000) p. 14

It is clear that the most important source of information about technology for business is the personal contact between corporate R&D staff and university personnel. What also stands out is the relative *unimportance* of university technology transfer office (TTO) marketing efforts. This conclusion is confirmed through discussions with investors, businesses and their advisers and is a matter of some concern in Australia (Howard, *et al.* 2001a). The US study noted, however that there is a very large proportion of industry licensing executives who regard marketing efforts as important.

The US study did not address the matter of the *reinforcement* of the different information delivery channels. Recent research indicates that businesses use multiple channels and that the impact is reinforcing. Use of three channels of communication, for example, is likely to have four times the impact (Rogers, *et al.* 2000). Technology Transfer Offices provide important back up, support and advice to the efforts of researchers. The importance of effective IP policies and scientists being familiar with problems relating to premature disclosure cannot be over-emphasised. Technology Transfer Offices also have a critical role in keeping close to and supporting scientists in this area.

Data collected by the Australian Bureau of Statistics indicate that in the manufacturing sector only 1.7 percent of innovators used universities as a source of ideas and information for technological innovation. The proportion increased to 2.9 percent in undertaking innovation projects. Two thirds of businesses undertaking technological innovation acquire the knowledge internally. Outside the business, the most common sources of ideas are from purchasing equipment, attending conferences, journals and publications and consultants (Australian Bureau of Statistics 1998).

There is now a growing recognition that there are different innovation processes, or pathways, in different industry sectors and components of sectors. In some industries aspects of the process are combined or they are skipped or omitted. In others there is a reverse dynamic as science is used to test, explain and enhance the characteristics and performance of products already in the market. The main differences in pathways between industry sectors arise because of differences in the *drivers* of the innovation process along innovation pathways. It is possible to classify pathways into three categories (Howard 2002a; Mowery and Rosenberg 1999):

- Innovation based on shifts in *scientific* knowledge - *science* based innovation – such as in drug discovery in the pharmaceuticals industry: discovery is linked directly to a product for an uncertain, untested but potentially highly profitable market. “Discovery”

research, using techniques of molecular biology, for example, is important in this process. The innovation processes pushes product and market opportunities.

- Innovation based on shifts in *technical* knowledge – *applications or engineering* based innovation – such as in plastics, chemicals, automobiles: product development is the main driver of innovation arising from commercial and market considerations. The innovation process pulls through basic research and new knowledge into technologies to create new and/or enhanced products.

This research relies, however, on the continual generation of new knowledge through discovery. But discoveries may take many years to become attached to a commercial application. From this perspective, it is important that intellectual property in discoveries is fully protected by a university.

- Innovation based on improvements in *market* knowledge – a *consumer* driven process flowing from greater knowledge of and responsiveness to consumer tastes and preferences arising from the capacity of technologies to track and model market segment behaviours (sometimes referred to as “mass customisation”).

There are no doubt other pathways. But the distinctions are important in terms of addressing ways in which information about discoveries and technologies is conveyed to and taken up by industry along the innovation pathway.

In recent years it has become apparent that in some scientific disciplines publicly funded basic research produces discoveries that have the potential to be developed almost directly into marketable goods and services. That is, scientific discovery has potential for commercialisation through readily apparent applications and products – such as in biotechnology-based pharmaceuticals. While this development is significant in its own right, what is more important is that innovation that stems directly from basic research often involves bringing the new applications and products to markets through new channels. Established companies have found it difficult to incorporate academic science-based innovation into their ongoing product development cycles – even within their corporate structures.

The study of the impact of academic research on industrial performance referred to earlier suggests that different industries illustrate a distinct pattern of collaboration with higher education institutions and have developed different ways of taking advantage of academic contributions (National Academy of Engineering 2003). For example:

- Network systems in communications and information technologies have a history of drawing on academic research for fundamental innovations as well as using higher education institutions as test beds for new networking concepts.
- In the medical devices and equipment industry, businesses have looked to higher education institutions for fundamental multidisciplinary research in the physical

sciences and engineering and the unique capabilities of academic medical centres for researching, developing and improving devices as well as conducting the clinical trials necessary for regulatory approval; - all in an atmosphere of close collaboration.

- In the aerospace industry academic contributions have been important for the development of tools including advanced non intrusive instrumentation, flow visualisation techniques and computational fluid dynamics. Contributions have also been made in specific technologies, such as heat transfer, combustion cooling and aeromechanics.
- In transportation, distribution and logistics, academic contributions have included optimisation models for shippers, software applications in decision support systems for routing, production scheduling, logistics and distribution management. Academic start-up companies have commercialised much of this software.
- In financial services, contributions of academic research in economics, engineering and mathematics have been important for the development of new financial models and instruments – despite the absence of a well developed research infrastructure in these industries (National Academy of Engineering 2003).

The study comments that in addition to the broad industry contributions identified above, individual companies benefit from university based research to solve discrete practical problems related to their businesses. The principal observation is that applied research through multidisciplinary collaboration among science, engineering and/or medical faculties is a unique strength of academia. In the US, most of the funding for applied research comes from federal agencies that want specific problems solved. Industry provides funds for applied research through research centres and specific contracts. However, the level of industry funding for academic research is, as in Australia, quite small (National Academy of Engineering 2003).

In an Australian context, research institutions consider Australian companies, particularly small to medium enterprises, to be reluctant to acquire research and development capability that is already available to improve product performance. According to some commentators Australian industry does not often look 20 or 30 years ahead to see the potential of “new” technology. It tends to be timid about exploring new opportunities and reluctant to stretch itself financially (Australian Research Council 2002). A study conducted by the Australian Industry Group in 2002 reported that only four percent of manufacturing companies undertaking R&D had used a Cooperative Research Centre as part of this activity (Australian Industry Group 2002a). Public policy is currently directed towards addressing what is perceived to be low industry receptor capacity through support to reduce the technical risks associated with commercialising research with research subsidies and investment incentives

There is a view that businesses do not understand the benefits of research and development. In other words, research and development is not seen as an investment for the future but as an expense that impacts adversely on the bottom line. Businesses are also often told by government they should recognise the benefits that a closer relationship with the science base can offer. For example:

Appropriate networks and linkages allow businesses to access skills and knowledge needed for the establishment of new products and processes. Industry leaders can gain immeasurable benefit from being in the communication loop with scientists and engineers engaged in basic research, and from using the instruments of knowledge translation – such as venture capital – to invest strategically. This depends on a finance sector that is able to respond effectively to innovation-based investment proposals (Australia. Department of Industry Science and Resources 2000).

Review of current literature and submissions to inquiries by industry indicates that industry places a very high value on education output and seeks to influence the quality and relevance of that output. It also invests directly in university based research. Global manufacturing corporations in information and technology and communications have established relationships with universities to source skilled engineers and technicians and to source research services. For example, as Nokia became more and more research intensive it built closer ties with universities and research institutions with the objective of influencing the orientation and level of teaching and research in those institutions.

At the same time, as the need for better-educated employees grew rapidly, Nokia lobbied strongly for the further development of education systems, quality of education systems and emphasis on educational programs. Nokia has preferred to direct public education systems towards its objectives rather than developing its own competing programs. Cooperation and collaboration with Finnish and foreign universities is a major strategy in the company's recruitment, research and development and education of its employees (Haikio 2002).

At Microsoft, research is organised in a university model in an open environment with aggressive publication of research results. The company also encourages university research with nearly 15 percent of its basic research budget directly invested with universities (Hinrichs 2002).

Notwithstanding these developments, there is a concern by industry relating to education and research relevance. The submission to the Higher Education Review from the Australian Industry Group, the Australian Chamber of Commerce and Industry and the Business Council of Australia noted that many enterprises are seeking to further industry links with the higher education sector to ensure the ongoing relevancy of course curriculum to industry, to explore the role of universities in relation to the development of generic skills and capabilities and the appropriate reporting mechanisms between employers and universities, to provide student

exposure to workplace learning environments, and link universities into regional development activities with industry where appropriate (Australian Industry Group 2002b).

There is a growing interest on the part of employers in seeing the establishment of clear and publicly understood minimum standards for degrees. There is recognition that this will require a significant change to current policy and practice. This is an important contribution to ensuring the higher education industry is of the highest quality and standard and able to compete effectively in the international arena.

5.6 Policy challenges and responses

In a submission to the Higher Education Review from PricewaterhouseCoopers (PWC) argued that the relationship between higher education and the business sector must be radically improved to foster the development of more meaningful working partnerships. In developing their submission, the firm interviewed business leaders and industry bodies associated with the business community and a cross section of leaders in the higher education industry. The conclusion was that:

The feeling within the business community is that Australia's universities produce students who lack vocational readiness, knowledge and confidence. Today's businesses want graduates to emerge from the universities with excellent technical skills and a great capacity for critical thinking, but who also have good business skills, excellent verbal communication skills and a strong customer focus (PricewaterhouseCoopers 2002).

PWC considered that universities do not see their role as training people for a specific job. Rather, they view this as being the role of the employer, industry bodies or the vocational education and training (VET) sector. However, universities are offering an increasing number of courses clearly targeted at specialised markets and as a result, business expects graduates to be able to demonstrate a comparative "readiness" to work in their specific sector. But this is not the case. Business must invest substantial time, effort and resources to bring its graduate recruits "up to speed" (PricewaterhouseCoopers 2002).

The business sector does not think that higher education institutions understand labour market demands and the needs of the business community. Instead, they tend to deliver courses based on the preferences of academics as opposed to what businesses may require. This is seen to be caused by a reluctance to include people outside the academic environment when developing curricula. Universities have been seen to be reluctant to appoint people from business to faculty on a contract basis. Industrial relations considerations reflect a concern about the "casualisation" of the academic workforce.

At the same time, however, business has failed to effectively define its needs and requirements. This is seen as a reflection of the quality of management in the business sector, and its lack of a vision about the changing shape of industry and society as a whole (PricewaterhouseCoopers 2002). This is changing in some universities as business people are appointed to adjunct positions, although it is not always clear what is involved with these appointments.³⁰

Universities are also seen to be over relying on delivering research services to sustain them both financially, and in reputation. As a result, many are seen as prestige research institutions rather than places of great teaching. This is exacerbated by the status of researchers within universities and their potential for promotion while teachers are viewed as “poor cousins”. While business benefits from the quality of research undertaken within universities, it also expects universities to deliver quality, well taught graduates. Any drop in the standard of teaching facilities in Australian universities would negatively impact business. Staking a claim. PWC argues:

Business wants a seat at the table alongside government and the education sector and play a role in strategic decision making. This will generate confidence that those who are making decisions that impact on business, are doing so effectively. Some good examples where business and HE are developing closer working relationships are seen, but these are too rare to be able to claim that a strong mutual understanding exists.

PWC also comments:

The image of higher education from a businesses perspective as being too removed, theoretical-based and poorly managed, demonstrates that we as a nation do not value HE as other cultures do. HE, on the other hand, feels that business is not much better at managing itself, and that it has trouble articulating its own needs. This only serves to underline the gulf of understanding between the two sectors.

Business must take a more active role to voice its concerns and interests as a key stakeholder in the HE sector – to not do so would reinforce the image of ambivalence. Based on the interviews and observations undertaken in preparing this paper, we are confident that this is not the case and that business is more than willing to contribute (PricewaterhouseCoopers 2002).

These observations from a leading professional services firm do not suggest convergence between higher education institutions and business.

In the study of the *Impact of Academic Research on Industrial Performance*, it is suggested that industries and universities need to continue to explore mechanisms and pathways for

³⁰ In many instances adjunct appointments are designed to give a research centre profile and credibility, and little else.

bringing the benefits of academic research to industry, keeping in mind that what works in one industry may not work for another. It identifies a challenge:

University-industry linkages must be adaptable, and universities should be on the lookout for opportunities to link up with new industries and explore leading edge industrial research activities and challenges. Cross sectoral movement and interaction between individual academic and industrial researchers are essential to promoting the effective two way exchange of knowledge and technology (National Academy of Engineering 2003).

In December 2003 the British Government released a report on business university collaboration commissioned by the Treasury. The Report made a series of recommendations aimed at smoothing out the path between Britain's science base and the business community. They include:

- A greater role for the Regional Development Agencies in facilitating knowledge transfer in their regions
- A new funding stream for business-relevant research, along with increased and improved "third stream" funding for knowledge transfer
- Universities to develop a code of governance and to demonstrate good management and strong performance in return for a lighter regulatory touch from Government and the Funding Councils
- Development of model contracts and a protocol for Intellectual Property to speed-up negotiations
- Encouraging new forms of formal and informal networks between business people and academics, including the establishment of a business-led R&D employers' forum
- Universities to provide more information on student employability, and businesses to take a greater role in influencing university courses and curricula (Great Britain. Treasury 2003).

Implementation of these recommendations will require building effective institutions of engagement between higher education and business. The structure, characteristics and routines of those institutions in the context referred to above is not clear. On account of fundamental differences in cultures, values and the basis for assessing performance between institutions, it is unlikely that the objectives sought in the report and the recommendations will be achieved without building institutional capacity and capability and the interface between higher education and business.

5.7 Summary

The material included in this chapter provides evidence to indicate that large companies are looking outside their boundaries for innovation. It does not suggest, however, that there is an institutional convergence. On the contrary, innovation sourcing is moving towards a more strategic approach as innovation becomes recognised as a critical component of corporate strategy.

The trends and directions in industrial innovation do not create opportunities for higher education institutions to initiate the creation of new businesses where established corporations have not taken externally generated ideas through to commercialisation. Commercialisation requires knowledge and experience in product development, manufacture and marketing. Higher education institutions should see their role as providers of knowledgeable and competent graduates and as a source of capability in the evolving system of innovation sourcing.

In this context universities are in effect knowledge suppliers in increasingly disaggregated industry value chains. The essence of value chains on an industry basis is how entities build and develop relationships and levels of engagement. These relationships are essentially market based (exchange transactions) or organisationally based (joint venture). They also reflect characteristics of community where high levels of trust have been developed.

In this environment the economy needs strong businesses that focus on creating wealth in a complex and highly competitive global economy. This is an area where higher education institutions do not have a core competency. In the following chapter the way in which higher education institutions engage with businesses through market based relationships is considered. This is followed in Chapter 8 by a discussion of engagement built around organisational arrangements.

Chapter 6. Market Engagement – The Marketing of Technology

Generating income from knowledge products - research, advisory services and specialised teaching programs - is now an important aspect of the “business” of universities in an increasingly knowledge based economy and industrialised higher education sector. For higher education institutions that seek to place a greater reliance on income from these sources and, in addition, if Intellectual Property is going to make the sought after contribution to economic, industry and regional development, then it is essential that these activities be appropriately managed and that stable markets emerge as sound engagement institutions.

To these ends there is a growing and critical role of Technology Transfer Offices (TTOs) and companies (TTCs). The performance of these institutions is impacted by the performance of financial intermediaries, locational issues and regional support, and the state based systems of rules that relate to matters such as corporations and taxation laws and the enforceability of the Intellectual Property System.

Reference has been made in earlier chapters to industrialisation of higher education and the emergence of market based transactions and managed relationships between universities and businesses. The purpose of this chapter is to describe and analyse the emerging market for knowledge. The emergence of managed relationships will be analysed in Chapter 8.

The transactions in the knowledge market relate to the sale of Intellectual Property, the sale of courses and programs, the provision of expert advisory and consulting services on a fee for service basis and the creation, management and sale of knowledge companies. The form of transaction in relation to knowledge companies will be heavily dependent on the nature of the technology and a range of other factors that influence the acquisition decisions and strategies of technology investors.

This Chapter will draw attention to market structure, the emerging market for knowledge, the market for ideas and the role and performance of market enablers including Technology Transfer Offices and venture capital investors.

6.1 Market structures and behaviours

Joel Kurtzman observed in the context of financial markets in *How Markets Really Work* that markets require institutional infrastructure, such as central banks, investment banks, stock exchanges and bond markets. He suggests that institution building is quite an intricate task

and takes time. In the United States, Britain and Europe the financial infrastructure of banks and markets has been in existence for decades, if not centuries. (Kurtzman 2002).

Over the last 20 years there has been a substantial growth in the scale, reach, complexity and popular legitimacy of market institutions and market players. The extension of markets is seen to flow from a complex of factors, summarised as scope, sophistication and legitimacy (Donahue and Nye 2001). Public policies of privatisation and deregulation have seen the expansion of markets in utility services (water, electricity, gas); education; health care; telecommunications; aviation; banking and insurance. In all of these cases, however, de-regulation has been accompanied by the introduction of more rules based systems to govern the operation of the markets created. Where rules have not been introduced, unexpected consequences have arisen and governments have quickly responded by re-regulating. New organisations have been established to advise on and administer rules.

Thus, while the actions of the state, through de-regulation have allowed new markets to emerge, the extension of markets carries with it an extension of rules. It has been noticed that freer trade, globalisation as well as technological advance, has been associated with a proliferation of organisations to create, set and monitor rules – and hand out sanctions when the rules are broken (Vogel 1996). This is reflected in a tightening of corporations law and consumer law and a greater effort to deliver sanctions for corrupt and dishonest conduct. In the area of corporations oversight, governance has become an issue and new rules are continually being introduced to monitor the behaviours and actions of directors. This has involved the expansion of existing, or creation of new, government organisations to monitor and enforce those rules. The role of the state as an enabler of the operation of the market is critical.

Markets are places where buyers and sellers meet for the purpose of trade. Economics textbooks deal with the determination of market prices, but discussion of the market itself is largely absent. This follows from the characteristics of markets as institutions that exist to facilitate exchange – to reduce the cost of carrying out exchange transactions. In an economic theory that assumes transactions costs are non-existent, and that the existence of these costs represents a *market failure*, “it seems perfectly reasonable to develop the theory of exchange by an elaborate analysis of individuals exchanging nuts for apples on the edge of a forest or some other fanciful example” (Coase 1988).

The context of economic exchange ranges from the simple and amorphous to the complex and highly structured as with global commodity and stock exchanges. Such exchanges set rules

for those who can trade, what can be traded, the responsibilities of parties, the terms of settlement, arrangements for the settlement of disputes and the imposition of sanctions and punishments. Coase argues that for anything approaching perfect competition to exist, an intricate system of rules and regulations would normally be needed (Coase 1988). This system operates in what is referred to as an *institution of engagement*.

The essence of a market, and attractive to libertarians, is that participations in the exchange is voluntary – both the buyer and seller can make their own decisions to the extent that either can veto any deal. The essential characteristic of markets in these terms has been summarized as:

Controlling their own resources, the participants in a market, in deciding how those resources are to be used, are not obliged to follow others' orders. They are free to make decisions – to buy and sell, to exert effort, to invest – that reflect their own preferences (McMillan 2002).

Buyers and sellers are constrained, however, by the limit of their resources and the rules of the market place. But if buyers and sellers lack autonomy, their dealings are not by the above definition market dealings. That is, if people are compelled to enter into an exchange, it is not a market transaction; it is a managed relationship driven by power, authority and control. More specifically, the providers of the service are not businesses and the buyers are not customers.

Competition is not a defining feature of a market, but its presence adds to autonomy and curbs power on the part of either buyers or sellers. The widening of competition is usually associated with the introduction of more rules (Coase 1988; Vogel 1996) – as the opening of trade under the World Trade Organisation umbrella attests. Rules can be classified as property rights (forms of ownership), governance structures, rules of exchange, and conceptions of control (Fligstein 2001). The configuration of these rules lies at the basis of the capitalist political economy.

It has been argued that markets are essentially social institutions and characterized by structured exchange in which actors expect repeated exchanges for their products and that, therefore, they need rules and social structures to guide and organise exchange” (Fligstein 2001). Actors in unstructured or haphazard exchange have little investment in the exchange and may not interact on a regular basis. It is only when participants continue to show up that markets become stable. But it is the sellers who generally lead the creation of the social structures as their existence may be at stake if a stable market does not appear.

The social relations between sellers in a stable market are such that one set of firms produces the cultural meanings for the market and the others fall into line. This does not imply that partners to any given exchange always have to be the same (Fligstein 2001). The role of industry associations and the contribution of lead players in giving knowledge markets stability is important in this context and is evidenced in the Association of University Technology Managers (AUTM) in North America and with Knowledge Commercialisation Australasia (KCA).

The idea of the emergence of leading sellers has been recently affirmed by research that suggests that “naturally occurring competitive forces - if allowed to operate without excessive government intervention – will create a consistent structure across all mature markets” in which three major players compete against each other in multiple ways (Sheth and Sisodia 2002). It follows from this perception that within the system of distributed knowledge production some dominant knowledge sellers will emerge. The major research universities in Australia are also the major knowledge sellers through their Technology Transfer Offices, which function as key institutions of engagement between higher education institutions and businesses.

6.2 The emerging market for knowledge

Economist William Baumol argues that market for knowledge has become widespread, pointing to IBM’s revenue from licensing fees amounting to 20 percent of the corporation’s profit in 2000. He refers to a market space characterized by a “profusion of conferences, websites and organisations devoted to technology transfer along with wide media coverage of licensing agreements between individual companies” (Baumol 2002). Baumol points out that the Licensing Executives Society has 10,000 members in 60 countries and that the Technology Transfer Society is active in disseminating information about licensing. He also points to a “profusion of Internet websites offering a range of resources for technology transfer and concludes that:

Surely all this implies eloquently that enterprising distribution of technology has become a widespread feature of business reality. Indeed the National Science Board reports that, for the period 1980-98, US, European and Japanese firms collectively entered into almost 9,000 strategic technology alliances (Baumol 2002).

Thomas Davenport and Laurence Prusak have argued that market forces power the movement of knowledge, working in a similar way to markets for tangible goods. Whilst their research is

based on internal organisational arguments, the principles apply to a more general market for knowledge. They argue that:

Like markets for goods and services, the knowledge market has buyers and sellers who negotiate and reach a mutually satisfactory price for the goods exchanged. It has brokers who bring buyers and sellers together and even entrepreneurs who use their market knowledge to create internal power bases. Knowledge market transactions occur because all of the participants believe they will benefit from them in some particular way (Davenport and Prusak 1997b).

Within an organisation the knowledge brokers are often identified as librarians, boundary spanners and informal communicators; the pricing system is cash, status and entitlements and the currency is reciprocity (a favour bank), repute and altruism. Other market making factors, reflecting a fundamental social dimension, are trust, informality and communities of practice. These values have been at the basis of relationships between university researchers and scientist and businesses for many years. With the codification and commodification of knowledge the relationships are becoming more structured.

As discussed in Chapter 5, corporate research and development is increasingly being organised on a market basis. Corporations are beginning to create market type mechanisms that impose market tests on research and development. R&D units are being set up as profit centres, and they charge different divisions for any of the results they produce that other divisions use. This can be in the form of formal licensing of IP or through intercompany transfer arrangements. This is seen as the classical break-up model of AT&T, IBM, GM and other large industrial corporations. However, when knowledge is priced, awkward situations arise where corporate knowledge is not being as widely used as it could be. The same issues apply to the propertisation and pricing of higher education research discoveries.

The knowledge market operates within an industry in which higher education institutions are involved in the production of knowledge and there is a focus of corporations on the acquisition of knowledge for use and application in the production of goods and services to satisfy a consumer want. As indicated in the discussion above about start-ups and the market for ideas, the processes for the transfer of knowledge from a higher education institution to a corporation are occurring in an increasingly sophisticated market structure. Markets emerge when there are buyers and sellers, and commodities and products to be exchanged. Just as higher education institutions and corporations reflect a range of specific institutional characteristics, so too do markets.

To fully appreciate the operation of the knowledge market it is necessary to go further than transactions and address the underlying structures and behaviours of the market. This is based

on a recognition that markets are in fact social institutions and are heavily influenced by the environment in which they operate. In particular, markets rely on a range of intermediaries and brokers to create sales and consummate deals. They also rely on accurate, relevant and timely information. The increasing sophistication in the knowledge market is seen in:

- The growing interest in the sale and/or licensing of Intellectual Property
- The emergence of the technology “start-up” as a vehicle for the marketing of knowledge products
- The emergence of a financial asset class for investment in knowledge companies
- The emergence of a business for knowledge brokers and technology advisers
- An increasing role for university Technology Transfer Offices within universities and research organisations
- A proliferation in the number and scope of data bases relating to discoveries and inventions that are thought to have commercial potential
- The increasing of third party agents in packaging and marketing programs for fee-paying students.

The operation of the knowledge market can be best understood in the overall context of the institutions involved in the production, distribution, exchange and use of knowledge. These are primarily, higher education institutions and corporations. The institutions of the state, finance and location *enable* the relationships between these institutions. Before going in to address these matters in further detail, it is useful to look at the emerging market for knowledge.

6.3 Market engagement through technology licensing

If market oriented institutions of engagement attached to higher education institutions, or parts of them, are to be run on a commercial, or business-like basis, the products and services that they provide must be seen as not only commodities but also *products* that can be, and are, actively marketed. For example, claiming Intellectual Property rights in discoveries and inventions does not imply that the products will be actively marketed. It requires a business established for that purpose. If products are not marketed the chances are that demand will not be forthcoming.

To create a business requires the investment of resources in management, marketing and working capital. Only a few universities have been prepared to make this commitment. Successful Technology Transfer Offices not only secure Intellectual Property rights, they actively market those rights and arrange transfer through licensing agreements and start-up companies. Marketing technology thus creates challenges for higher education institutions.

Whereas scientists and engineers focus on facts and truth, marketers focus on perceptions, attitudes and values. It is therefore critical that higher education institutions have access to a technology marketing capability, through an institution of engagement, that is able to effectively communicate with investors and end users. To do this, many turn to venture capital investors. In Australia the early stage venture capital community is still going through an evolutionary stage and has yet to shed its funds management orientation.

University interest in the formalisation of the technology transfer process through Technology Transfer Offices represents, in effect, a strategy to preserve the institutional integrity of the institution and identify “boundaries” between the “community of science” and the commercial business organisation. It is clear from the technology transfer strategies of universities they are not primarily directed towards raising revenue. The main reasons advanced for the formalisation of technology transfer arrangements in the United States are:

- Technology transfer capability is needed to recruit and retain the best faculty - the best and brightest faculty educated in the US are returning to their home countries - stimulated desires for technology transfer.
- In the United States the *Bayh-Dole Act* has been instrumental in creating closer relationships between universities and industry – each functions well in their fields – but are brought together to collaborate in transferring embryonic university technology into marketable goods and services.
- Academic technology transfer is an engine for regional, state-wide and national economic growth – states are raising expectations that university technology and its transfer to commercial goods and services will have a significant and direct impact on state and regional growth.

An incidental outcome is that of technology transfer will return money to the university (rather than individual academics) which can specify how it will be used.

From the 1980s Australian universities created Technology Transfer Offices with a mission to become much more strategic in identifying and managing their Intellectual Property portfolios. Most Australian universities with a significant research portfolio have a technology transfer capability, although the level of commitment, resources and expertise allocated to this function varies considerably between universities.

There is no single model for a Technology Transfer Office, and some universities do not have one at all. In general, however, they perform a role as technology brokers in a number of areas:

- Educating and creating awareness of IP processes and requirements amongst researchers

- Assisting researchers with their IP and patent protection
- Assessing market potential
- Identifying potential industry partners and collaborators
- Negotiating license agreements
- Forming start-up companies
- Finding investors and industry partners (Johnston, *et al.* 2003).

The structural arrangements for technology transfer appear to be directly related to the level of research income and research activity in the university. Thus, the major research universities have gone furthest in establishing formal responsibilities and accountabilities for commercialisation activity. A review of university *Research Management and Research Training Management Reports* supplied to the Department of Education, Science and Training indicate a variety of management and organisational arrangements:

- In many universities responsibility for technology transfer is located in the University's Research Office, with a relatively passive approach to commercialisation.
- Universities with a substantial level of research expenditure which forms the basis for generating significant levels of IP, have established separately resourced commercialisation offices and companies.
- In some universities responsibilities for management of research and consultancy contracts is combined with responsibility for research commercialisation - indicating a very high commercial focus on research contracts.
- Universities with a comparatively low level of research expenditure tend to focus their commercialisation activities on marketing courses and programs and commercial consultancy, sometimes managed through a corporate framework – IP issues are handled by the university legal office.
- There are several universities that do not appear to have a focus on any form of commercialisation.

Most of the major research universities (Group of Eight) have established professionally staffed Technology Transfer Offices or companies. In other research universities, responsibility for research commercialisation is generally managed through the university research office. The arrangements in the Associated Technology Network Universities vary considerably, but in a general sense, responsibility for commercialisation appears to be more centralised than in the major research universities, but more focussed than in most of the other research universities.

In the regional and other university categories, individual universities have adopted a diverse range of research commercialisation strategies. These strategies are often more in the nature of technology development and reflect a more opportunistic rather than strategic approach. Many of these universities emphasis the public good nature of their research, hinting that commercialisation is not a priority. For example, Charles Sturt university states:

CSU adheres to the principle that knowledge and ideas should be made widely available by publication and other means for public benefit. It is desirable that the special expertise and skills of staff at CSU should be available to the wider community and, in particular, to the regions CSU was established to serve. CSU aims to encourage an academic environment in which teaching, learning and research may flourish.

Universities also point out that they are not in a position to fund the costs of commercialisation. For example, Deakin university states:

The University is unable to fund the costs of full patents, and the purpose of the provisional patent is to give time to find commercial partners. Similarly the university is unable to invest more than nominal funds in the commercial venture to exploit the IP. The preferred model is to take some equity in the commercial vehicle by virtue of our involvement in the creation of the IP, and through assignments as appropriate to enable the inventors to be involved in the commercial vehicle on the same basis.

The position at Southern Cross University is:

The strategy most commonly used at Southern Cross University for commercialisation of existing IP is to find a logical commercialisation partner who has a specific interest in the IP, and forming a specific relationship with that partner. The partner then funds ongoing research building on the IP in return for a negotiated equity position. When the IP is ready for commercialisation, the partner is then the logical commercialisation outlet.

The favoured strategy is one of finding a partner to fund research to develop a good idea, with the preferred partner being one that will ultimately provide the commercialisation outlet for the IP. The university negotiates an appropriate equity position with the partner. A subset of this strategy is to conduct what would normally be considered “contract research”, but at a negotiated reduced rate in exchange for an equity position for Southern Cross University.

Another variation on this theme is to establish a relationship based on an ARC Linkage Grant with a partner, with an appropriate IP sharing arrangement. To this end, ARC-Linkage Grants are seen as an important part of the IP strategy for Southern Cross University.

The decision by a university to seek patent registration is heavily influenced by the “up front” costs. The costs are indicated in Figure 7.

Market Engagement

Figure 7: Costs of Patenting

Application Stage	Location	Years from Initial Filing	Approximate Cost (\$)
Provisional Application	Australia	0	1,500
Patent Cooperation Treaty (PCT)	Treaty Member Companies	1	9,500
International Preliminary Examination (IPE)		1.75	1,200
National Phase	Australia	2.5 – 5	4,200
	USA	2.5 – 5	10,000
	Japan	2.5 – 5	18,000
	Europe	2.5 – 5	30,000
	Rest of World	Varies	

Source: University of Sydney, Business Liaison Office

Overall, the cost of achieving patent protection could exceed \$100,000. There are additional costs in maintaining registration on an annual basis. Recognising this cost, there is a concern that there may be a substantial amount of IP in universities that will not enter the knowledge market because:

- Patents have not been taken out because university Technology Transfer Offices cannot afford patent registration and industry partners have not been found during the period of the provisional patent.
- Individual researchers do not have the contacts or linkages to find industry partners, or the funds necessary to secure registration on their own behalf.

One idea put forward to overcome this problem has been to more broadly disseminate outcomes of university research as a way of attracting venture capital investment. Recently the Australian Research Council explored the hypothesis that if more people knew about the research it funds, increased technology investment would be forthcoming. The reality is that there is an information *overload* problem. The problem is not so much a shortage of information – it is about attracting attention (Davenport and Beck 2001).

The increasing information overload means investors and businesses want filtered, useful, intelligible and short briefings of opportunities relevant to them. There are commercial opportunities in this area in the form of information brokerage. High-level repositories of knowledge are effective only if appropriate institutions are created, or are operating, which make full use of their specific meanings, values and perceptions.

Information can be provided through a number of communication channels:

- Printed media (articles, newsletters, reports)
- Supporting (sponsoring), attending and presenting at conferences and seminars
- Participating in technology and trade exhibitions and showcases
- Direct marketing to large and small businesses
- Personal contacts and networks of ARC funded researchers

- Technology advisers with responsibilities for technology transfer
- The Internet.

There has, nonetheless, been a proliferation of electronic information exchanges. As indicated in section 5.3 above, a paradox has emerged in that increased availability of electronic information actually makes personal, face-to-face contact even more important from a marketing and relationship perspective. Establishing face to face contact as a way of building engagement is resource intensive, and sometimes confronting. Few higher education institutions have invested directly in technology marketing where the task is to understand and engage with potential business users.

6.4 Technology licensing best practice

International best practice in research commercialisation assigns ownership of Intellectual Property created by a researcher while working for a university to the university. Stanford University research policy provides that:

To manage and minimise conflict over Intellectual Property rights, all potentially patentable inventions created or discovered by faculty in the course of their university activities, or with the use of University resources, must be disclosed to the university on a timely basis. Ownership of these resources must be assigned to the University regardless of the source of funding. Institutional management of the commercialisation of technologies developed using University resources guarantees that contractual obligations to sponsors are fulfilled. Stanford management of technology also reduces the potential for individual conflicts of interest, since the institutional managers of the assets do not have personal financial interests in the outcomes of licensing processes nor do they participate in making academic or future research decisions (Stanford University 1994).

The commercialisation management policies, practices and processes in Australian universities reflect the following elements (Howard, *et al.* 2001b):

- In all cases staff are required to advise their Deans/Heads of School of a discovery or invention as soon as possible for the purposes of protecting IP and exploring avenues for commercialisation. Available evidence is that the record on this aspect is uneven, but improving.³¹
- Creators are informed that they may not publish or communicate the results of their work until advised.
- Universities undertake to inform creators in a relatively short time whether they intend to exploit commercial potential.

³¹Industry seems to prefer one to one relationships with researchers rather than with disciplines, departments or faculties. This explains the strained and uncertain relationships that often develop with industry partners.

- If they decide not to exploit commercial potential, a university may assign rights to a creator who may decide to commercialise the invention through other channels. The university reserves the right to collect royalties.
- If the university decides to proceed, a provisional patent is sought.
- During the 12 months of currency of a provisional patent, industry partners are sought
- If after 12 months, an industry partner is not found, rights may revert to the creator; most universities require the creator to request such a transfer.
- In the absence of a committed commercial partner, some universities will lodge an International Preliminary Examination (IPE) if they believe that there is some commercial potential.³²

This will require work on the part of the researcher, and there is generally an expectation that a commitment will be made.

Australian Research Council funds are not available to support this work.

- If an industry partner is located, patent registration will be sought. Because of resource constraints, universities will require the industry partner to contribute to the funding of this process. During the process, IP rights would be licensed, or transferred, to the industry partner in whole or in part depending on the level of industry contribution.
- Economic benefits are distributed between the creator, the School/Faculty and the University. In many cases there is a formula – the proportions vary considerably between universities.

Once rights have been transferred, a researcher is free to publish findings and seek commercial partners. Information provided by technology transfer managers is that only in very rare cases has a creator been successful in commercialising a discovery where the university has transferred rights.

Australian university technology Transfer Offices are generally not well regarded by business people and technology investors. Businesses have a preference to go directly to the researchers. Only four or five TTO/TTCs have established reputations with business for a good commercial focus (Howard, *et al.* 2001b). The main concerns expressed by business representatives relate to a need for a greater level of commercial expertise and commitment. The reality is, however, that most Technology Transfer Offices are under-resourced and see their highest priority to protect the Intellectual Property of the university. The practice of researchers dealing directly with business and investors is still quite common – and exposes a university and a research organisation to very high levels of risk.

Technology transfer managers have observed that there are many people they deal with who call themselves ‘experts’ in the commercialisation area but, in practice, the level of expertise does not match up to the rhetoric. While there are some expert and highly competent firms

³² In the QUT, for example, this will be done on a *business case* basis.

and professionals, there are also others with limited experience and expertise. Many people from Technology Transfer Offices also made the comment that researchers need to think very carefully about the people they trust to commercialise their research (Howard 2003a)..

Due to a lack of resources to undertake post discovery verification, a significant amount of IP is transferred too early for higher education institutions, government research agencies and researchers to receive an appropriate economic return. Support and capacity building to undertake this work and developing the commercial potential of university IP is considered by many researchers and technology transfer managers to be a priority area. The “pre-seed” funding being made available through government programs should assist in this area.

It needs to be kept in mind, however, that the primary business of universities is not new product development; commercialising technology through technology marketing and creating start-up companies is a relatively new undertaking. These activities are undertaken alongside the more traditional functions of licensing to existing businesses, including small to medium businesses. A commercialisation “checklist” drawn from an assignment for the Australian Research Council is provided below.

Commercialisation best practice checklist

Research and studies of best practices in commercialisation have identified many factors as important to a successful technology marketing business (Howard and Johnston 2001b). They include the following:

- Recognise that a complete team will be necessary, covering off Intellectual Property, marketing, contracting and other important functions for each project. Sufficient time and financial support should be allocated to identify and recruit this skills base
- Commercialisation can be a resource-intensive effort, and payoff will take a significant amount of time. Expectations about results must be well documented
- Commercialisation teams should attempt to bring together both the inventor and a potential client or technology adopter as early as possible in the development cycle. If a client or adopter cannot be recruited, it may indicate a lack of market interest or the need to re-profile the target market
- Sources of early stage seed/risk money should be identified early to support technical and market feasibility studies, and the development of prototypes
- Appropriate disclosure processes should be put in place to facilitate the identification and screening of new technologies and to protect the university’s and the inventor’s Intellectual Property rights
- Fast cycle and stage-gate project technology management techniques currently employed in the private sector should be considered. This helps the screening and evaluation of technologies
- Minimize and reduce bureaucratic and regulatory barriers, and disincentives to commercialising technology. This applies to potential clients and to researchers and investors
- Foster regular interaction between the commercialisation team, the potential client community, financial organisations, and the researchers.

A great deal of technology transfer starts with the personal contacts of researchers attending conferences and through their professional bodies. This is quite apart from the active marketing of discoveries under confidentiality agreements by TTOs wishing to secure industry partnerships and/or licensing agreements.

TTOs provide important back up, support and advice to the efforts of researchers. The importance of effective IP policies and scientists being familiar with problems relating to premature disclosure cannot be over-emphasised. TTOs also have a critical role in keeping close to and supporting scientists in this area.

6.5 Market engagement through technology based start-up companies

Universities create *knowledge companies* as vehicles to market discoveries and inventions. A start up company is a holder or licensee of Intellectual Property generated within a higher education institution and provides the medium for attracting further investment to finance reduction to practice research, product development and pilot marketing. The knowledge company emerged as a result of the realisation that in some scientific disciplines publicly funded basic research can produce discoveries that have the potential to be developed almost directly into marketable goods and services.

Put another way, a scientific discovery may have potential to achieve commercial returns through readily apparent applications and products – such as in biotechnology-based pharmaceuticals. However, the likelihood of a biotechnology start-up becoming a global pharmaceutical company is remote given the need for complementary investments in manufacture, marketing and distribution. But start-ups have become important links in industry supply chains as providers of research and development services as well as production of key components in final manufacture.

The emergence of the start up as a “knowledge product” in the biotechnology field stimulated the growth of a venture capital asset class, and the venture capital investor as an intermediary and broker in directing finance to high-risk businesses based on investment in this form of knowledge capital. While this development is significant in its own right, what is more important is that innovation that stems directly from basic research often involves bringing the new applications and products to markets through new channels. The mechanism is a response to the difficulties that established companies have found in incorporating science-based innovation into their ongoing product development cycles – even within their corporate structures. Ratings agencies and institutional investors are also uncomfortable with high costs and risks associated with this form of innovation – and will mark down debt rating and share values accordingly.

Established companies often prefer to invest in (either directly, or through a corporate venture fund, or as co-investors with a venture capital investor) or purchase start-ups rather than develop an emerging technology internally (Howard 2002d). They may take a minority position in a start-up to gain access to the new technology it creates. This is a popular strategy for big pharmaceutical firms that lack a biotechnology development capability, but have necessary marketing, manufacturing and financing skills. Companies also support a “portfolio” of start-ups and exercise options for acquisition at an appropriate time. This avoids the larger risks in people, finance and technology.

In these ways biotechnology start-up companies perform an engagement role between higher education institutions and large pharmaceutical companies. Larger companies are often reluctant to look at very early stage discoveries and they wait until a biotechnology company has at least partially validated a potential drug before getting involved. Ultimately, however, it is the large pharmaceutical companies that take things forward (Fisher 2002). The capacity for biotechnology companies to vet potential drugs is influenced by the interest of early stage venture capital investors and the existence of a strong IPO market to finance clinical trials.

During the technology boom the IPO market funded much product development and high cost clinical trials. In the current climate, with the absence of a strong IPO market and more cautious investors, pharmaceutical companies have not stepped in to shoulder the cost of these trials. Moreover, the number of drugs with commercial potential in the biotechnology pipeline is considered by the pharmaceutical companies to be quite small (O'Connell 2003).

Very few start-ups are actually businesses in the sense that they are actively marketing their products and services. Quite often their viability depends on negotiating additional research contracts with research funding organisations and downstream manufacturers. Early stage corporate investment in a start-up is quite often contingent on the newly formed company receiving a government technology and/or business assistance grant. The imprimatur of a successful grant application provides some assurance that a technology has been vetted and validated. Very few university start-ups start out with real (paying) customers.

6.6 Facilitating engagement: financial intermediation and venture capital

Venture capital investment is a special form of market intermediation and has been the subject of a great deal of attention in relation to the commercialisation of research. Venture capital investors are required, in effect, to manage the uncertainty and the risks that exist between the creators of knowledge and purchasers. They are therefore actively involved in

managing their investments and are expected to bring substantial value to the process. In this regard, the growth of the venture capital sector is of considerable interest.

The emergence of science-based innovation and the development of the start-up company as a preferred commercialisation route flows directly from the exceptionally high risk of science-based innovation and the prospect of very high returns as a result of monopoly profits deriving from a business based on secure and protected Intellectual Property assets. Venture capital developed in the US as an asset class principally as a way of accepting and managing the risks associated with science (and more generally, knowledge) based innovation.

The Australian venture capital industry has matured over the last five years and there are many more experienced venture capitalists. The firms that specialise in early stage and technology investment are increasingly concentrating on industry sectors where they can deploy their expertise in depth. An increasing number of technology-focused funds are being raised. Technology funds focus on investee companies that exclusively own certain (but not necessarily all) proprietary Intellectual Property rights (patents, design rights, know-how) that are critical, fundamental and materially add value to its products and the business, and which, along with the products exploiting them, must have been developed in-house by the investee company's employees. Spin-out companies from universities, research organisations and corporations generally reflect these characteristics.

Successful technology investors have specialised knowledge of the science and technologies surrounding the company and the industry, and have strong linkages and trust based relationships with potential adopters and end users. With that knowledge they tend to concentrate their investments at the start-up stage to "capitalise" the business to allow for investment in product development and initial targeted relationship marketing. Over the last two years a number of specialised technology funds have been established in Australia, particularly in the biotechnology and information technology sectors.

Increasingly venture capital investment in high technology sectors is being seen as part of a product and industry value chain. The capacity of venture capital investors to facilitate entry into those value chains on the basis of their networks and reputation are key criteria for successful commercialisation. Venture capital investments in early stage biotechnology companies, for example, often involve consortia that include several venture capital funds and downstream manufacturers.

Market Engagement

It is in the early stage where genuine venture capital is required – to create the businesses, secure IP and establish a management team that can make an enterprise attractive for subsequent venture capital and/or corporate investment rounds to finance further application development, testing and trials. This requirement is also being addressed through public support for seed funds and investment readiness programs.

The total amount of early stage venture capital investment in Australia, over the eight year period 1995-96 to 2002-03, amounts to \$1,235.6m. Information relating to the total level of investment and the distribution by industry and stage of investment is set out in Table 8.

Table 8: Early stage investments 1995-96 - 2002-03 - summary by industry (\$m)

	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	Total
Agribusiness	0.0	0.0	0.0	0.7	0.5	0.7	0.0	0.4	2.3
Communications	1.5	2.0	1.0	5.2	26.5	283.9	30.2	6.0	356.4
Construction/ Housing	0.0	0.0	4.7	0.2	0.3	2.0	1.4	0.0	8.6
Distribution/ Transport	0.0	0.0	0.0	0.0	0.1	3.0	1.6	2.8	7.5
Environment	0.0	0.0	0.0	2.2	5.5	27.2	30.9	1.0	66.8
Etailing/ Retailing	0.0	0.0	0.2	1.7	19.9	4.0	2.8	0.0	28.4
Food/ Beverages	7.4	1.8	1.8	0.0	0.3	0.1	0.4	0.0	11.8
Health/ Biosciences	1.0	3.0	13.8	21.9	35.7	62.4	60.1	25.2	223.1
Information Technology/ Software	0.1	1.3	0.8	27.7	33.0	42.3	29.0	7.9	142.0
Manufacturing	0.0	5.5	12.1	2.9	7.5	7.5	1.0	11.6	47.9
Media/ Entertainment	0.0	0.1	2.0	0.3	11.2	9.3	10.4	2.0	35.4
Resources/ Mining	4.5	9.0	7.8	22.7	36.1	7.0	12.2	10.3	109.6
Services - Business/ Financial	0.0	0.3	1.7	3.7	41.3	40.4	13.7	6.0	107.0
Services - Consumer	0.0	0.0	1.5	1.1	12.7	7.6	2.3	0.0	25.1
Technology	0.0	0.6	0.0	0.5	10.5	10.8	27.5	2.3	52.2
Tourism/ Leisure	3.0	3.0	0.0	0.8	3.9	0.0	0.7	0.2	11.5
	17.4	26.7	47.3	91.4	244.8	508.1	224.1	75.7	1,235.6
<i>Of which</i>									
<i>Seed</i>	7.0	7.4	13.4	26.2	39.3	117.9	63.8	29.3	306.8
<i>Start up</i>	10.4	12.6	10.1	39.7	97.3	232.4	56.6	14.5	473.7
<i>Early Expansion</i>	0.1	6.6	23.9	25.5	108.2	157.8	103.8	31.8	457.7
	17.4	26.7	47.3	91.4	244.8	508.1	224.1	74.7	1,235.6

Source: Australian Venture Capital Journal-Howard Partners database on Australian venture capital investments

Of the total amount invested, \$498m has been directed toward the information and communication technology industries and a further \$223m to the health/bioscience industry. Taken together, these investments amount to 58 percent of all early stage venture capital investments over the period. One quarter of investments have been at the seed stage, 38 percent at the start-up stage and 37 percent at the early expansion stage.

On an annualised basis, investment increased rapidly in 1999-2000, peaking in 2000-01. Investment in 2002-03 had returned to its pre-1998-99 level. This pattern of investment coincides with the information and communications technology investment boom. It is also associated with several very large investments in early stage communication technology ventures over the period.

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In terms of the *number* of investments, Table 9 indicates that 34.4 percent of investments were at the seed stage. Over all, seed stage investments predominate in the information and communication industries, the provision of business services (much of which is built around business-to-business Internet applications) and in resources and mining. Again, the number of investments has declined substantially since the peak reached in 2001-02.

Table 9: Early stage investments 1995-96 - 2002-03 - summary by industry (number)

	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	Total
Agribusiness	0	0	0	2	1	2	1	1	7
Communications	1	1	2	6	16	30	16	11	54
Construction/ Housing	0	0	3	1	1	1	2	1	8
Distribution/ Transport	0	0	0	0	1	3	3	2	7
Environment	0	0	0	4	2	8	6	1	12
Etailing/ Retailing	0	0	1	2	7	4	2	0	13
Food/ Beverages	1	1	1	0	2	2	1	0	6
Health/ Biosciences	1	4	8	13	20	37	37	30	94
Information Technology/ Software	1	2	1	17	21	39	39	12	97
Manufacturing	0	3	3	5	8	9	5	3	26
Media/ Entertainment	0	1	2	1	6	5	6	6	20
Resources/ Mining	3	11	9	12	14	9	11	7	43
Services - Business/ Financial	0	1	5	5	25	26	13	2	67
Services - Consumer	0	0	1	2	9	4	4	1	16
Technology	0	1	0	1	3	13	15	6	26
Tourism/ Leisure	1	2	0	2	3	0	3	1	7
	8	27	36	73	139	192	164	84	503
<i>Of which</i>									
<i>Seed</i>	5	9	14	25	37	74	70	39	174
<i>Start-up</i>	2	13	9	25	53	58	46	27	183
<i>Early Expansion</i>	1	5	13	23	49	60	48	18	146
	8	27	36	73	139	192	164	84	503

Source: Australian Venture Capital Journal-Howard Partners database on Australian venture capital investments

The investment profile indicates that the level of venture capital investment activity in Australia is quite small. This reflects both the risk averse behaviours of Australian venture capital investors and the absence of investable propositions. The data in the above tables does not, however, include investments in Australia technology made directly by overseas based independent or corporate venture funds or technology investors. It is understood that these investments, in aggregate, could be substantial.

6.7 Venture capital and university research commercialisation

In the US the early stage venture capital sector developed from within the university and public research sector. Universities were, and still are, major contributors to early stage venture capital funds. At the same time, however, many universities prefer to establish relationships with early stage venture capital funds rather than run them “in house” (Lerner 1999). Early expansion deals are undertaken as follow-on deals by these funds to realise the “heavy lifting” that has been committed at the seed stage (Lazarus 2000).

In Australia, at the beginning of the information technology, communication and biotechnology boom, there was an absence of a substantial venture capital investment capability within the university sector. This situation has changed to some extent over the last four years as venture capital firms working in the life sciences and other technology areas have sought to establish linkages and relationships with universities, cooperative research centres and public research institutions. Relationships have been slow to develop, as they require high levels of trust, confidence and mutual respect. However, there are several fund managers who have made a very strong commitment to building these relationships, many of whom have come from a science and university background. Results are beginning to appear.

Nonetheless, many venture capital investors and advisers are still publicly critical of universities and public research organisations in their commercialisation strategies. This reflects in large part a *cultural gap* between the “community of science” and the “business enterprise”. Successful scientists and venture capital investors have learned how to cross and interact in this cultural divide. However, the dimensions of the “gap” are often overlooked; there is still a very wide culture gap between a research setting, a funds management (financial) situation and the overall business environment. People do not tend to work well across professional cultures. To illustrate, management writer Scott Adams, and creator of Dilbert, has noted:

Things happen based on how you're trained. Economics people can talk to engineering people because you're always looking for the cheapest, easiest, simplest, most elegant solution. You're looking at complexity and trying to simplify. Marketing people are trying to hide reality. They're trying to take, for example, long distance telephone service, which is exactly the same no matter who you buy it from, and convince people that one is better. All of your instincts as an engineer are to be logical and simple and reliable -- and in marketing, everything is to take what is clear and make it unclear. So when you put engineers and marketing people in the same room, it just doesn't work (Adams 1999).

In corporations, overcoming the culture gap is the focus of organisation and general management. In universities and research agencies the culture gap is a major constraint on the capacity to effectively commercialise research and development. It is a gap that cannot be “assumed away”: its resolution also requires skilled, capable and effective management. In any business setting there are fundamental cultural differences between scientists, engineers, finance managers, and marketing executives. Each has their own attitudes about people, work, money, time, technology and authority. There is an inherent conflict between them. Members of each consistently misunderstand each other – even when they earnestly desire to work together (Kleiner 2001). Management of teams that respects and accommodates cultures is an

essential task of management. Unfortunately, management is often seen as a residual in the commercialisation process when in fact it is very much at centre stage.

These observations point to the need to manage the interface with effective institutions of engagement in the form of strong and effective Technology Transfer Offices and skilled venture capital investors who do actually provide more than money.

It is of interest to note that the first venture capital firm, American Research and Development (ARD) was designed to focus on technology-based spinouts from MIT. This vehicle was seen as the best way to commercialise military technologies developed during the Second World War. Stanford University has also been a base for venture capital development. The North American venture capital industry has traditionally sought, and continues, to bundle capital with effective oversight of university based enterprises (Lerner 1999).

In Australia, five of the largest research universities have established early stage venture funds. This includes a consortium of the Universities of Melbourne and Queensland (Uniseed), and ANU Commercialisation (Venture Capital Fund with \$8m capital). The UNSW, through Unisearch, provides seed funding. These arrangements are supported by the government sponsored Pre-Seed funds.

In the United States 16 venture funds have been established by Universities. They also tend to be associated with the large research universities. (Lerner 1999 387). This is indicated in Table 10.

Table 10: Venture Capital Funds Established by Universities - US

Name	Location	Year Begun
Enterprise Development Fund	MIT	1972
Community Technology Fund	Boston University	1974
British Technology Group Venture Capital Fund	Various British Universities	1981
Centre for Biological Research	Stanford University, University of California	1982
BCM Technologies	Baylor College of Medicine	1983
Tennessee Innovation Centre	Oak Ridge national Laboratory	1984
Dallas Biomedical Corporation	University of Texas, South-western Medical centre	1985
A/W Company	Washington University, St Louis	1987
Triad Investors	Johns Hopkins University	1988
Medical Science Partners	Harvard University	1989
ARCH Venture Partners	University of Chicago, Argonne	1989
Technology Ventures Corp	Sandia National Laboratory	1993
North-western University Investment Partners (Evanston Business Investment Corporation)	North-western University	1993
Thermco Technology Ventures	Three US national Research laboratories	1994
JAFCO	Two Japanese Universities	1997
Southwest One	Virginia Polytechnic Institute and State University	1998

List compiled from Press Accounts. This table lists venture capital funds sponsored by or targeted toward investing in particular academic institutions. In some cases, the efforts were abandoned before any investments were made; in others the fund focus ultimately shifted to include other institutions or types of institutions.

Source: Lerner, Josh, "Venture Capital and the Commercialisation of Academic Technology: Symbiosis and Paradox", in Branscomb, Lewis M., Kodama, Fumio and Florida, Richard, *Industrialising Knowledge: University-Industry Linkages in Japan and the United States*, The MIT Press, Cambridge, 1999, p. 387

Venture capital analyst Josh Lerner has suggested that there are grounds for concern with universities becoming venture capital investors. He argues that university funds are similar in many respects to corporate venture funds.³³ In this respect the experience of corporate funds that have experienced instability and lack of success is instructive. In most cases instability reflected structural failings, including a lack of well defined mission, insufficient corporate commitment, and difficulty in killing off failing investments. There is also evidence to suggest that corporate programs are less stable than independent funds and that they frequently cease after a few investments. Their success closely related to fit between corporate parent and the portfolio firm (Lerner 1999).

Thus, it is not clear what a university fund can "bring to the table" aside from money – as a university would find it difficult to offer a portfolio company the strategic benefits that a corporation investing in an area of its core business can (Lerner 1999). Lerner concludes that university and technology transfer managers may be better served by investing in strong relationships with the venture capital sector, both at the local organisation level and with leading national firms. Successful seed funds undertake this task when acting as "lead investors" with an understanding that larger funds will become more involved in later stage investments. The problem with this approach is that the seed equity can be substantially

³³ Lerner notes that the Boston University Biotech Venture Fund invested \$90m between 1987 and 1992; at end of 1997 the University's equity was only \$4m.

diluted with the prospects for little return should the start-up become commercially successful.

6.8 Information and knowledge exchanges

Information is a critical resource in linking organisations with markets. It not only assists in the traditional marketing function, it facilitates production and market access through distributed organisation arrangements based on corporate disaggregation and alliances and partnerships through the value chain. Information and communication technologies transaction costs which, argue organisational economists, assist in resolving the agency problem inherent between owners and managers.

High-level repositories of knowledge (eg universities) are effective only if appropriate engagement institutions are created, or are operating, which make full use of their specific meanings, values and perceptions. The implication is that if academics, scientists, bureaucrats and financiers are going to work together effectively, that is collaboratively, they have to understand and share a common language. Language conveys meanings, values and beliefs – and ways of working – that need to be mutually understood and as a basis for communication.

The need for information brokers has arisen as a consequence of a realisation that the Internet is not, on its own, an effective communication or marketing channel. From a communication perspective, the Internet *must* be supported by other channels. It is limited in its ability to make real time linkages and portray complex relationships and subsequent knowledge based analysis and interpretation.

A listing of knowledge exchanges is provided below.

Figure 8: Knowledge and technology exchanges

Strategis	Industry Canada launched an Internet Portal, <i>Strategis</i> , located at http://strategis.gc.ca/engdoc/main.html , in 1996 to harness the power of the Internet to provide business and consumer information to all Canadians without the constraints of time and geography. Ten percent of users are outside Canada.
Sci Tech	The US Government SciTech Resources website, http://www.scitechresources.gov/scitech-about.htm has been set up to provide scientists, engineers, and technologists with easy, one-stop access to key U.S. Government resources. Thousands of web sites are being reviewed to select sites that will provide valuable links to government expertise, services, laboratories, information centres, and other resources.
TechEx	TechEx, located at http://www.techex.com is an Internet-based exchange for buying and selling biomedical technology. Founded at Yale University, TechEx is used by technology transfer and research professionals to exchange information relating to licensing opportunities and innovations available for partnering. TechEx is a major source of information for emerging technologies in the biomedical field. There are currently 290 research institutions (including several Australian) and 619 companies registered on the site.
UVentures	The UVentures.com Web site, http://www.ventures.com/servlets/UVMainPage joins those seeking cutting-edge technologies with the universities and institutions that are developing these innovations. It is intended to create a conveniently accessible market for new technologies and provides a comprehensive source of information for the technology transfer industry. Australian companies and universities use the site.

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Yet2.com	<p>yet2.com, http://www.yet2.com/app/about/home is a global forum for buying and selling technology on the Internet. A virtual technology marketplace, yet2.com offers companies and individuals the opportunity to conveniently and privately purchase, sell, license and research intellectual assets.</p> <p>Many of the world's premier research and development companies currently provide proprietary technologies on an exclusive basis to yet2.com, creating a robust marketplace where "the world's most coveted inventions are listed, sold and, ultimately, applied".</p>
Patent and License Exchange	<p>The Patent & License Exchange, Inc. http://www.pl-x.com/xhtml/homepage.jsp has partnered with global industry leaders to offer the most innovative, secure, and efficient environment for the management, valuation, marketing and monetization of intellectual property. Universities of Sydney and Queensland are listed as members</p>
Cordis.com	<p>CORDIS, the Community Research and Development Information Service, is a free service provided by the European Commission's Innovation/SMEs programme. It is located at http://www.cordis.org/en/home.html</p> <p>Australian universities are partners in some of these projects</p>
Cos.com	<p>Community of Science, Inc. (COS), at http://www.cos.com/ is a leading Internet site for the global R&D community. COS brings together the world's most prominent scientists and researchers at more than 1,300 universities, corporations and government agencies worldwide. COS provides tools and services that enable these professionals to communicate, exchange information and find the people and technologies that are important to their work.</p> <p>Australian scientists and research institutions are included in, and make use of, the site.</p>

The Australian Innovation Exchange is an Australian intermediary service that was established for bringing business and the research community closer together to form potentially useful alliances. The venture is funded by the Australian Industry Group, the Australian Government and the governments of NSW, Victoria and Queensland.

John Wolpert from IBM has argued that there is a need to find ways for companies to share ideas and technologies actively and early. This is seen as the best way to protect projects from the swings in interest and funding that inevitably occur in individual organisations. "If we could find a way to do this without risking the unauthorised appropriation of Intellectual Property, businesses would be able to more quickly spot and exploit new growth opportunities" (Wolpert 2002). When innovation becomes part of commerce, it is argued, money and attention flow naturally to where they're needed and when they're needed. The problem is how to break down the barriers to sharing information across companies so that they can create more generalized sustainable innovation markets without giving your competitors an advantage.

IBM sees the answer in the use of independent intermediaries to facilitate the exchange of sensitive information among companies in what is termed "innovation markets". These are not markets in the sense described earlier, but have characteristics more akin to communities. The example is provided of intermediaries in the capital markets where financial innovation flourished in the context of close relationships and powerful intermediaries that tempered the competition but protected easily copied ideas and products. Innovation markets have attracted the attention of anti-trust authorities in the US (Morse 2002).

Already individuals and organisations play intermediary roles in facilitating innovation – management consultancies operate innovation labs where clients can share ideas and discuss

technological advances. However, most consultancies regard sharing of perspectives and competencies among clients as inappropriate and in any event are looking to capture fees for service. Consultants are not likely to be the main source of innovation intermediaries. But other players are identified (Wolpert 2002):

- Venture capitalists and lawyers often learn from competing and non competing companies
- Trade show organisers and industry associations that conduct high level meetings between buyers, suppliers and partners, and identify opportunities for synergy
- Investment bankers who are often called on to find new applications for technologies
- Baby boomer retirees with knowledge and expertise of industries and technologies and hold the trust of the companies they work for.

IBM suggests that in the increasingly complex world, the biggest growth opportunities will come more often at the intersection of multiple companies rather than single visionaries acting on their own. Companies will need to break out of their own innovation boxes and find ways to link their innovation efforts. In the years ahead the greatest corporate innovation may be the innovation process itself.

6.9 Business advisers, consultants and good management practice

In the context of the current innovation debate there is pressure being placed upon managers in existing businesses as well as scientists working in universities to be more entrepreneurial. However, being entrepreneurial means much more than expanding or setting up a new enterprise. *It also means taking risks.* The effective management of risk is one of the most important drivers of business success.

The impact of globalisation, technological advances and new forms of competitiveness are increasing the level and complexity of business risk. Risks can be managed, and mitigated, through management action. A priority for managers is to develop skills in this area. More and more, however, managers require assistance and support in the form of expert business advice to supplement their own skills and capabilities.

There is a popular view that risks can be transferred to venture capitalists (i.e. “risk capital”). However, venture capitalists *manage* risks by close involvement in a company, setting milestones and closely monitoring performance. They also spread risk by investing on a portfolio basis. Interestingly, the venture capital model is being applied by companies for internal investments in new products and technologies. But finance is only one component of

risk. There are also risks related to technology, Intellectual Property, products, markets, people, systems, suppliers and creditors.

Over the last 10 years there has been an explosion in the publication and dissemination of advice for managers and businesses leaders on acquiring new skills and capabilities to cope with this changing environment. This material comes from the general management literature as well as business law, corporate finance, science and technology, organisational economics, and public policy. Whilst comprehensive, this material lacks an integrating paradigm and linkages to important contributions in organization theory, particularly in relation to informational, behavioural and technical aspects of organizational decision-making.

The quality of the current advice for managers on business learning is thus very uneven, even within “market segments”. There is a lot of advice being offered as solutions to problems that do not exist. Moreover, a great deal of advice is simplistic, contradictory and often wrong (Argyris 2000). A critical issue for managers and business leaders is knowing where new skills and competencies are required, and why, and the base from which they are starting.

In the context of globalisation and the opportunities for application of new and emerging technologies combined with continual pressure for bottom line performance, managers and business leaders look for clear messages about what constitutes good management practice. They are continually searching for new ideas, new interpretations and “corporate cures”. Managers are aware of the need to continually update their knowledge (Crainer 2000). Where to look, and how to acquire *applicable knowledge* is, however, a major issue. It is made doubly difficult as management is a practice based discipline where knowledge is transferred through learning by doing.

Effective learning involves reading, observing, listening combined with experience, and interaction. But, deciding what to read, who to listen to, where to gain experience, and how to interact through networks, alliances and partnerships are areas where managers seek assistance and, above all, good advice. Nonetheless, in the changing business environment, relying on practical and hands on experience may no longer be sufficient for continuing business success. Knowing when, where and how to seek assistance and advice are attributes to develop in a business learning environment (Howard and Johnston 2001b).

In response to the growing need for expert professional advice, there has been a spectacular growth in the number of firms providing professional business advisory and consultancy services. Services are becoming highly specialised and increasingly knowledge based. There

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is an exceptionally wide divergence in the competency, capacity and integrity of this sector. The categories of business advisory services provided by professional services firms include:

- Audit services – internal and external, including preparation of financial statements for audit
- Business improvement - business process re-engineering, cost reduction, work measurement, value analysis
- Business information and intelligence – competitor analysis, economic and industry research
- Corporate finance - investment and financing strategy, structured finance, mergers, acquisitions, due diligence, share registry
- Electronic commerce – Internet strategies, advice and solutions, web site maintenance
- Environmental advice and strategies – energy efficiency, environmental impact
- Financial management – including financial planning and reporting, management accounting, cost accounting, costing including activity based costing, budgeting
- General management: - corporate planning, strategic positioning, portfolio management
- Human Resources Management - HR planning, executive search, recruitment, job analysis and design, performance management, salary review, training, management development, change management
- Information Technology - data processing and management; systems analysis and design, systems delivery, contracting
- Insurance advice and brokerage – workers’ compensation, public liability, professional indemnity, business loss, general insurance
- Legal services - contracts, Intellectual Property, litigation, etc
- Marketing management – market research, sales planning, media planning, market research, pricing, communications and awareness
- Product development – research and development, technology acquisition, technology “due diligence”, testing and prototyping
- Taxation advice – tax planning, R&D audit, tax lodgement.

There are imperfections in the market for professional advice, particularly for small to medium businesses. In most areas of professional advice, some assurance of competence and credibility is provided through certification provided by a professional association (lawyers, accountants, engineers, for example). In other areas, such as marketing and management consulting, it is very much buyer beware. There are also high costs and risks in protecting Intellectual Property. Many businesses contemplating entry into global markets and investing in new technologies are put off by the cost of professional advice. Investments are not made, or alternatively, managers take a risk and go it alone – often with devastating consequences for their businesses.

The manner in which value is created through advisory mechanisms and the way in which business leaders and managers capture it, is not pre-ordained. In particular, managers may not be able to correctly articulate their expectations – particularly when they have never experienced the service involved:

- The relationship can evolve in ways that are difficult to predict – and people define problems and issues differently
- When “buyers” experience what they thought they wanted, they often find that it is not what they really wanted at all

- As projects develop, the concept of what managers want also develops
- When a project is concluded and what a client thought it wanted is delivered, they can almost always find ways in which it could have been improved.

In previous research a need has been identified for independent and honest brokers in the area of business advice (Howard and Johnston 2001b; Howard, *et al.* 2001b) supported by targeted management education and training that builds management capacities and capabilities. Growing a business is a task for managers, not consultants whose main interest is in generating fee income and economic rents. This relates, in particular to growing new technology based firms seeking advice in the areas of finance, management, employment, and Intellectual Property. Under present arrangements, finding good advice often relies on word of mouth and an element of luck.

Business schools have been targeting this market but have received little support in public policy or in funding. The initiative under that National Food Industry Strategy is a significant exception (Australia. Department of Agriculture Fisheries and Forestry 2002). Policy is directed towards supporting consultants and advisers rather than directly targeting managers through education and training. Management education should be seen as a critical *institution of engagement*.

6.10 Summary

The institutions of engagement in the knowledge market between higher education institutions and business are complex. University Technology Transfer Offices perform a key role in this process, but they are generally under-resourced and often lacking in critical expertise. The key sellers in the market are endeavouring to improve these capacities and stabilise the market, but access to resource is limited.

Notwithstanding the expectations in science and innovation for the commercialisation of university research, there is very little public support for the institutional development of technology transfer capacity and capability. Consultants in this area, both publicly and privately supported, cannot be expected to act in the best interests of knowledge sellers, particularly if their fees are being paid by purchasers. There is an urgent need for what has been referred to as *honest brokers* who have the confidence of both sellers and buyers in the knowledge market.

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The capacity of the early stage venture capital industry to lift capability in the knowledge market is limited if not for the only reason that its own capacity and capability is still evolving.

In the following Chapter the capacity of higher education institutions to generate income in the market for knowledge is addressed.

Chapter 7. Knowledge Products and Commercial Outcomes in Australian Higher Education

The purpose of this chapter is to present information about income from commercially oriented activities in Australian higher education institutions and to identify the sources of that income in relation to the knowledge products defined in Chapter 4. The scope of those products in terms of commercial potential is also discussed.

A knowledge product was defined in Chapter 4 as an idea, a concept, a method, an insight, or a fact reflected in a patent, copyrighted material or some other form of ownership. The production, marketing of and sale of knowledge products is the essence of commercialisation that has attracted so much attention in public policy and in the strategies of universities. The main categories of knowledge products are:

- Academic publishing – sale of books, papers, electronic material
- Courses, qualifications and certifications – sale of courses and programs
- Technology licensing – sale of Intellectual Property
- Advisory and consultancy services – sale of explicit and tacit professional knowledge
- Establishment of knowledge start-ups (or spinouts) – sale products and services created in a company.

Features of knowledge production, drawing on Australian data are analysed below.

7.1 Data on “earned income”

Very little data is available on the extent to which universities actually generate income or make a profit on their commercial activities. There is publicly available information on “earned income” by universities which can be used as a proxy for income from commercial activities. There is not information however, on the *costs* involved in generating that income.

Information on earned income for Australian universities, derived from information provided by universities to the Department of Education, Science and Training is provided in Table 11. The information relates to operating revenue and does not therefore include dividends from incorporated technology transfer companies such as Unisearch (University of NSW), Uniquist (University of Queensland) and Anutech (Australian National University), and from the sale of assets, such as Intellectual Property assets. Incorporated technology transfer companies return profits from transfer activity to the university in the form of dividends

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reflecting a net result after costs of managing the commercialisation process have been taken up. Such returns would be included in “investment income” in Table 11.

Table 11: University earned income – Australia 2001-02 (\$'000)

	Student Fees and Charges	Royalties, Trademarks and Licenses	Consultancy and Contract Research	Investment Income	Other Fees and Charges	Total "Earned" Income	Earned Income to Total Income (%)
Major Research Universities							
Australian National University	27,302	0	32,246	24,878	512	84,938	18.4
Monash University	139,024	0	0	10,703	35,476	185,203	25.2
University of Adelaide	37,306	564	22,036	114	13,079	73,099	21.9
University of Melbourne	148,451	0	0	40,223	62,518	251,192	29.3
University of New South Wales	145,622	0	39,643	14,281	58,402	257,948	36.8
University of Queensland	73,841	721	105,978	2,424	24,937	207,901	25.5
University of Sydney	108,540	3,708	67,829	45,638	28,058	253,773	31.1
University of Western Australia	38,217	0	4,565	13,307	5,832	61,921	17.2
	718,303	4,993	272,297	151,568	228,814	1,375,975	27.1
Innovative Research Universities							
Flinders University of South Australia	15,904	282	8,340	3,368	5,951	33,845	19.1
Griffith University	57,430	259	3,937	1,640	18,142	81,408	23.2
La Trobe University	33,777	0	22,327	2,592	9,827	68,523	21.8
Macquarie University	83,176	158	3,151	6,063	27,023	119,571	40.4
Murdoch University	18,481	0	0	1,049	10,623	30,153	19.3
University of Newcastle	38,330	0	20,574	2,031	9,267	70,202	27.3
	247,098	699	58,329	16,743	80,833	403,702	26.0
Technology Network Universities							
Curtin University of Technology	98,675	0	8,696	1,995	12,018	121,384	33.6
Queensland University of Technology	71,588	1,283	9,175	-1,407	6,072	86,711	23.7
Royal Melbourne Institute of Technology	144,160	0	17,567	401	15,952	178,080	37.2
University of South Australia	50,664	367	14,873	4,778	8,238	78,920	27.6
University of Technology Sydney	69,297	52	6,799	4,216	3,368	83,732	29.1
	434,384	1,702	57,110	9,983	45,648	548,827	30.9
New Generation Universities							
Australian Catholic University	8,766	0	1,198	775	3,685	14,424	13.8
Central Queensland University	85,914	317	532	3,006	10,403	100,172	47.6
Edith Cowan University	31,567	3,917	1,216	1,644	7,143	45,487	22.4
Southern Cross University	10,885	62	2,850	698	2,150	16,645	18.6
Swinburne University of Technology	48,224	210	9,118	3,001	24,797	85,350	36.6
University of Ballarat	6,883	0	4,297	987	18,840	31,007	29.0
University of Canberra	16,533	0	2,322	941	6,299	26,095	24.7
University of Western Sydney	44,326	0	983	3,037	3,654	52,000	17.5
Victoria University of Technology	32,577	0	5,556	2,035	26,798	66,966	24.1
	285,675	4,506	28,072	16,124	103,769	438,146	26.9
Regional Universities							
Charles Sturt University	21,390	18	1,200	2,216	16,388	41,212	22.0
Deakin University	47,052	3,902	10,730	3,645	36,963	102,292	31.4
James Cook University	12,576	114	9,655	2,526	12,421	37,292	21.5
Northern Territory University	4,548	0	2,751	728	2,345	10,372	11.3
University of New England	10,335	251	502	1,019	17,140	29,247	19.7
University of Southern Queensland	20,521	0	0	523	3,765	24,809	20.9
University of Tasmania	16,230	259	6,174	1,798	7,929	32,390	16.2
University of the Sunshine Coast	4,537	13	552	295	639	6,036	18.6
University of Wollongong	45,115	1,625	10,530	171	23,246	80,687	38.4
	182,304	6,182	42,094	12,921	120,836	364,337	18.2
Other							
Australian Maritime College	1,803	0	1,011	544	1,880	5,238	25.1
Batchelor Institute of Indigenous Tertiary Education	0	0	0	0	403	403	0.8
University of Notre Dame Australia	9,324	0	43	175	1,081	10,623	52.5
All Institutions	1,878,891	18,082	458,956	208,058	583,264	3,147,251	27.1

Source: Department of Education, Science and Training.

The data indicate that earned income amounted to just under \$3.2 billion in 2001-02. This amounts to 27.1 percent of total higher education income. Fee-paying students contribute \$1.9

billion or 59.6 percent of earned income. Consultancy and contract research, at \$459m, amounts to 14.6 percent. Income from technology licensing, amounting to \$18.1 represents only 0.6 percent of this total. The latter figure differs from the \$99m cited in the recently completed *National Survey of Research Commercialisation* (Australia. Australian Research Council, *et al.* 2002) (see Table 15 below). The reason for the difference reflects the accounting treatments of incorporated companies and the *sale* of Intellectual Property, which would be recorded as a balance sheet item as a sale of an asset. The amount of \$99m includes the proceeds to Melbourne University of the \$50m one-off sale of Melbourne IT.

An important issue to address in this overall commercialisation context is whether technology licensing should be approached as a revenue raising strategy or whether more attention and recognition should be given to the broader contribution concerning the dissemination and application of knowledge in an economic, industrial and regional context. While there will inevitably be some “blockbuster” technology licenses, there is a considerable amount of evidence that indicates that universities do not generate substantial returns on their technology licensing activities (Johnston, *et al.* 2003).

The main source of commercial revenue for universities is generated from selling contract research, consultancy and postgraduate teaching for fee paying international students. However, the licensing of technology and its subsequent general availability is important for economic, industry and regional development. A major focus of technology licensing is to manage the process on behalf of researchers, industry and the economy as well as protecting the university from risks. There is, however, no public program or policy to support universities in this engagement role.

The absence of such support reflects a commonly held view that there is a “treasure trove” of Intellectual Property assets sitting in universities waiting to be commercialised, but university Technology Transfer Offices and scientists do not have the competency to bring it to market. This has been a line pushed by the Australian Institute of Commercialisation, a body established by the Queensland Government to establish businesses out of the scientific discoveries and technological inventions created by researchers in universities and publicly funded research institutions. The creation of the Institute is a reflection of the overarching “science push” foundation of Australian science and innovation policy and misrepresents the institutional engagement role of Technology Transfer Offices.

Comments on the characteristics and features of knowledge products and services, their commercial potential and the role in the institutions of engagement are listed below.

7.2 Academic publishing

Academic publishing represents the most traditional way in which the outputs of a university are communicated. This area of activity has already been heavily commercialised as academic publishers seek to earn substantial profits from this area of activity. The evolution of academic publishing provides an important background to discussion of other aspects of commercialisation in universities and the way in which a commercial orientation impacts on the work of the institution.

The University in its traditional formulation has existed for the purposes of scholarship, covering both independent and disinterested discovery research that creates new knowledge, and for teaching. The research outputs in the natural sciences, the classics and liberal arts were generally regarded as contributing to a body of “common knowledge” - knowledge that is freely available and accessible to all through various transfer mechanisms, including publication and teaching. Up until very recently these outputs were not marketed – at least not in the commercial sense of the term.

From the 17th century, and the invention of the printing press, academics sought to share their knowledge and discovery with peers, partly as a contribution to the “public good”, or the “knowledge commons” through publication in books and scientific journals published by their professional societies. Universities established academic presses to meet the objectives of sharing knowledge and discovery with peers and students and inviting debate and discourse.³⁴ Publication was also important to industrial users of knowledge in that they could adopt and apply research discoveries and findings in their own research programs and product development strategies.

Publication in peer reviewed learned journals and respected academic presses enhanced the reputation and standing of the authors. Career advancement for academics is still dependent upon publication and peer review. However, universities and authors earned little, and generally expected little, in the way of income from this process. But over the last 150 years most academic publishing, especially its prestigious titles, has moved from learned member-

³⁴ Cambridge University Press has been operating continuously as a printer and publisher since the first book was published in 1584. It is an integral part of the University and has “similar charitable objectives of advancing knowledge, education, learning and research”. The press has extended the research and teaching activities of the University by making available worldwide through its printing and publishing a remarkable range of academic and educational books, journals, examination papers and Bibles. It currently has 24,000 authors in 108 countries, including 8,000 in the USA and over 1,300 in Australia. (<http://uk.cambridge.org/information/introduction/default.htm>). Similarly, Oxford University Press is a Department of the University of Oxford and has the purpose of “furthering the University’s objective of excellence in research, scholarship and education by publishing worldwide” (<http://www.oup.co.uk/>)

based societies and academic presses to commercial ownership. Concurrently, and partly if not mainly as a result, the prices of academic journals, textbooks and reference material have risen steeply – well above rates of inflation (Council of Australian University Librarians 2002). Academic publishing has emerged as an important institution of engagement between higher education institutions and the end users of academic knowledge.

Coinciding with the expansion of university research the volume of academic publishing has increased, almost exponentially, to keep pace with academic output. Paradoxically, the returns have not been captured by the academics, but by the key institution of engagement – the commercial publishers.³⁵ This arises as a result of the contemporary features and peculiarities of academic publishing:

- The creator of content (the academic or researcher) gives away their Intellectual Property (copyright) to the publisher as a condition of publication. They rarely receive payment from the publisher
- As employers of the authors, universities and research institutions still pay for the production of the content
- The incentive to publish (the reward) for the academic is the prospect of career advancement
- The labour which gives the product value in the marketplace - peer review and editing - is also provided free by scholars, since this activity too advances careers
- The profitable market for the product (the journal) is not the end user (or reader/author) but collectively, the higher education and research sector (the employers of the authors) through their libraries and the students who pay exceptionally high prices for journals and textbooks (Council of Australian University Librarians 2002).

This pattern of commercialisation of copyrighted materials is being paralleled in the commercialisation of Intellectual Property reflected in patents. It is the intermediary, usually a venture capital investor, who is motivated to capture the profits from patented discoveries and inventions. The critical issue in this area is the *value added provided* by the entrepreneur and the level of economic rent that is considered to be academically and socially acceptable and that would cover the cost and reward the risk that is being taken.

Commercial publishers, concentrated in increasingly few hands, have been able to take advantage of the peculiarities of the system and their control of the journals most valued by

³⁵ If a University owns the press, then profits are returned to the University. But apart from the global university presses such as Cambridge, Oxford and Harvard, academic publishing is highly concentrated in public companies. These include Addison Wesley, McGraw Hill, Pearson, Sage, Routledge and Wiley. Academic publishing by universities in Australia operates mainly as a service to academics in the domestic market rather than as a substantial business. Academic presses are associated with the University of Melbourne, RMIT, Southern Cross University, University of Queensland, the University of NSW and the University of Western Australia

the scholarly community, to make sizeable profits. It has also given rise to some significant problems in obtaining access to knowledge: university libraries pay more for journals at a time when the number of significant journals being published has risen dramatically. It has been argued that, because of financial constraints, universities have to cancel subscriptions with the result that their collections now represent a much smaller proportion of the world's research literature and scholarship. To the Council of University Librarians:

This has serious implications for research, which must begin where current knowledge ends. The record of the world's knowledge is in its scholarly literature, and the most recent advances are recorded in its journal literature. Australian researchers' access to that literature has been declining (Council of Australian University Librarians 2002).

Thus, it cannot be said that creation of peer reviewed academic context automatically enters the public domain through publication.³⁶ That domain has, to a large extent been captured by commercial publishers. The ease with which this has occurred is due in no small measure to the way in which authors have been able to negotiate copyright individually with publishers, avoid working through their own university presses (as well as the commercial capabilities of those businesses) and their inexperience in commercial matters. It is also the case, however, that some academic authors have been quite successful in commercial publication in their own right, earning substantial individual royalties from publications, particularly textbooks.³⁷

There is much to be learned in this context in relation to the management of Intellectual Property in scientific discoveries and inventions. In particular, it cannot be assumed that making information about scientific discoveries generally available will result in a public benefit. The chances are that institutions of engagement, such as venture capital investors and a range of other brokers, will capture the greater part of the benefit as a financial return. Moreover, returns to academic inventors and creators of Intellectual Property are likely to be less if they work outside their own Technology Transfer Offices. Finally, creation of Intellectual Property brokerages beyond the influence and control of the university is likely to see returns flow to the brokerages – not the university.

With the growth in the potential applicability of scientific research in the production of marketable products, the orientation of research agendas and the influence of those agendas on the findings of research is something that must be watched closely. Already there is a

³⁶ There is, of course, a vast amount of material that enters the public domain via the Internet that is not subject to quality checks.

³⁷ Success in publishing, particularly in a popular market, is often frowned upon by academic peers and not seen as serious academic output.

major concern that commercial pressures have distorted research programs and reports. Such a process creates greatest risks – for the integrity and scholastic standing of the university itself (Bok 2003). This points to a need to ensure that these institutions of engagement involve both creators and users of knowledge and that they are managed in the interests of all parties. The requirement to introduce rules to modify market behaviours is addressed in Chapter 8.

To gain some further insight into these issues and trends, it is instructive to look at academic publishing in the field of management.

7.3 Academic publishing in the field of management

Some commentators have argued that commercial publishers are having a major impact on the course of scholarly inquiry by matching the knowledge production process to end user demand. This is seen to be reflected in the production of management knowledge where commercial publishing, consultancy, and executive education has worked to configure the organisation and management of knowledge in that area (Prichard 2002). That is, the academic framing of research questions has trended towards the concerns voiced by publishers interpreting the interests and concerns of practitioners. To many practicing managers, however, this may actually represent a benefit in that it assures relevance. But the impact on scholarly inquiry and institutional objectives may well be compromised.

The commercial orientation of academic management research is seen in the academic management literature which is seen to have become more functional and directed towards securing resources and a larger audience for the work of the authors, who benefit financially from “best seller” management books. Management academics, turned consultants, from the major business schools have been major players in this market. Thus, important links are seen to exist between economic processes and the creation of academic and practitioner knowledge. It is suggested that these linkages are located in the social dynamics that surround search for legitimacy and forms of revenue and may be strong enough to co-opt a field of academic research for practitioner and publisher concerns (Prichard 2002).

The management consulting industry is seen to exemplify the impact of this form of knowledge production. Global consulting firms have had a substantial influence on the discovery, packaging and sale of the latest management technique. Over the last decade, these techniques, often referred to as “fads” have included total quality management, business process engineering, and knowledge management that have emanated from and been strongly marketed by consulting firms. More recent fads, include risk management and governance.

These fads have been the subject of extensive review and critique (Micklethwait and Wooldridge 1996; O'Shea and Madigan 1997; Pinault 2000; Webber 2002).

It has been argued that the management consulting industry is driven to a large degree by a need to turn out fashionable management knowledge that is in turn “accepted by business schools sycophantically and uncritically” (Prichard 2002). That is, it is argued, publishers of management books work under full market conditions and mediate the organisation and presentation of academic, practitioner and consultant management knowledge. Moreover, the demands for commercial returns drive the updating of key texts and expansion of publishing into new fields that creates an impression of constant “newness” and change.

The commercial orientation of management knowledge has also reached a stage where production is no longer seen as cumulative. Authors have every incentive to either ignore or criticise everything that has gone before and offer their “brand new” perception and insight (Kay 1994). The strong commercial orientation in the creation of management knowledge conflicts directly with a scientific basis.³⁸ The result is that management knowledge tends to be non cumulative in its development and application.

Publishing entrepreneurship also involves shortening the product life cycles of business prescriptions, developing new markets, codifying and extending work. These observations are made notwithstanding the considerable contributions that have been made to the practice of management in the last ten years. There is now a business in writing management books about management books as a way of assisting users differentiate worthwhile material from the dross (Crainer 1997, 1998; Dearlove 2000).

While there are clear benefits in terms of the creation of applicable knowledge in the context of a mode 2 framework, there are risks that commercial orientation will shift academic endeavour towards creating and sustaining management fads and that research will be redirected away from more serious and longer term problems and issues where *disinterested* research and creation of new knowledge can be of substantial long term value (mode 1). For example, management has yet to develop an integrated body of disciplinary knowledge that can guide, inform and contribute to applicable research in specific problem encounters (mode 2).

³⁸ According to John Kay, “The traditions of scholarship demand that each author should explain carefully how his contribution relates to all that has gone before; the dictates of profit suggest that each consultant should dismiss as bunkum the theories of his rivals and proffer his own nostrums and the one true solution”.

In a more general sense, scholars should become more vocal in validating management knowledge that is created and disseminated purely for financial profit. But, apart from the interests of management fashion setters (consultants and publishers) in realising commercial returns, there are practitioners' demands for techniques capable of narrowing performance gaps. There is also an argument that management academics who are not involved in the commodity production process should concentrate their efforts in developing sound, theory based, knowledge of management in the contemporary organisation (mode 1 knowledge). Consultants and practitioners look to the base of disciplinary knowledge in management and come away disappointed (Van de Ven 2002).

The involvement of academic researchers in production of commercially oriented knowledge creates a situation where universities are competing with businesses, but without having made the investments in building business capabilities. In the area of management practice there is a need for a clear institutional separation between roles and functions. Academic research should be objective, independent and relevant. There is in these circumstances a case for stronger *engagement* through partnerships and alliances based on institutional strengths and capabilities. Many of the global consulting firms have established collaborative research institutes with North American university based business schools and publish though leadership studies in both monographs and journals.

The experience in the production of management knowledge is a response by more commercially oriented management academics and university presses to generate commercial returns from academic publishing driven by the demand for solutions in this area. They have understood the importance not only of asserting copyright but also of active marketing and promotion of their product in application. They have, however, lost sight of the disciplinary base in organisation theory and organisational behaviour. Similar problems arise in other fields of academic endeavour where there are prospects of substantial commercial returns.

7.4 Courses, qualifications and certification

As indicated in Table 11, Australian universities generate a very large amount of income from overseas students who pay full fees for courses delivered in Australia or at overseas campuses. Many universities prefer to direct their commercial attention to this area as opposed to commercialising discoveries and inventions. Some private universities have targeted the overseas student market for a large proportion of their total students. These students pay full fees regardless of where they study and are currently not eligible for student

assistance.³⁹ Overseas students make a substantial contribution to university income and reflect the focus of commercialisation efforts by higher education institutions. Higher education is now a significant Australian export earner.

Universities have used engagement institutions to develop these relationships and in so doing have created an effective interface between the university and student “customer” demand. IDP Education Australia, a company equally owned by all Australian universities, provides course information to people overseas and assists people from overseas in applying for courses in Australia. IDP has 405 staff in its 39 offices in Australia and overseas, and has a turnover of around \$50 million per year (IBIS World Pty Ltd. 2002).

The growth in the number of external students has been boosted by strong growth in post-graduate student levels. Growth in demand for post-graduate education has been driven by innovation and regulatory changes in the economy (requiring people to update skills) and by competition for higher paid employment. Demand is particularly strong for management education and MBA degrees. The low growth experienced in full-time enrolments has seen institutions increasingly focus on attracting post-graduate students, which include a large proportion of part-time and external students. Many of these students pay full fees.

The number of post-graduate students as a proportion of total enrolments increased from around 30,000 students or seven per cent of total enrolments in 1988 to around 142,423 or 20.5 per cent of total enrolments in 2000 (IBIS World Pty Ltd 2002). This has had the effect of changing quite significantly the culture of the university undergraduate population. It also reflects a growing demand for skills updating and provides evidence of the trend towards “lifelong learning”.

In the five years to 2000 the number of overseas students enrolled in higher education institutions increased at an average annualised rate of 14.9 per cent per year. This large increase can be largely attributed to the growth in Asian students as a result of economic development in many Asian countries, as well as to more active overseas marketing by Australian universities. In 2000 the major sources of overseas students were Malaysia (13.6 per cent), Indonesia (12.8 per cent), Singapore (11.9 per cent), Hong Kong (8.9 per cent) and India (6 per cent). India was seen as a prime target for additional foreign student intake due to

³⁹ As research grants distributed by the Australian Research Council are allocated to individuals, those working in private universities are eligible to apply for grants.

the undersupply of university places in that country. China is now being actively targeted where there is increasing demand due to visa restrictions being imposed in the US.

Australian universities have also opened overseas campuses. Monash has a full campus in Kuala Lumpur and at Roodepoort, South Africa. A Monash Pro Vice-Chancellor is located at each of these in order to promote research partnerships, among other responsibilities. In addition, there is a strategic partnership with King's College in London and a Centre at Prato, Italy providing the opportunity for conferences, joint research proposals and summer schools. There are staff and student exchanges with a variety of universities worldwide, including the University of Waterloo in Canada and the University of California at Berkeley.

A consortium of five mainland universities was formed to compete in management education with the National Graduate Schools of Management located at the Universities of New South Wales and Melbourne. The universities involved in the consortium are Queensland, Sydney, Western Australia, Adelaide and Deakin. The university run system links half of Australia's universities through a company called UniPower Group. The system covers the five administrative areas of: human resources; physical resources; finance; student affairs; and research and consultancy.

A number of universities have entered into agreements with corporations to award corporate MBAs and other certifications.

7.5 Technology licensing

Much of the discussion and analogy about the knowledge economy relates to the creation of Intellectual Property in inventions, designs and plant varieties. The level of patenting activity is considered to be a primary indicator of knowledge economy performance.

Higher education institutions seeking to adopt a strategic approach to the commercialisation of their technologies require a strong and enforceable IP policy and strategy and to plan, organise and manage the function as a business. This may require some investment by universities, or alternatively, the development of soundly based strategic partnerships with advisers and adviser panels. Technology licensing in universities is by no means an exclusive university function. It is, in fact, a brokerage function, and many universities have chosen to assign responsibility for licensing to third parties. These include specialised technology companies that have commercial expertise. They manage the engagement between the university and the commercial world.

All higher education institutions claim and/or assert a common law right to ownership of the Intellectual Property arising from work carried out by staff in the university. All Australian universities have an IP policy. A number of IP policies set out clearly articulated policy objectives. Several Universities make specific provisions for IP arising from the work of visitors. Arrangements in respect of IP created by students vary. A summary of Australian university IP policies and practices is provided at Appendix 2.

Following the lead of the *Bayh Dole Act* in the US, Australian governments and research funding agencies have been keen to ensure that Intellectual Property created with public funds is captured for the benefit of the institutions. Moreover, there is an expectation that commercialisable Intellectual Property will be promoted by universities and research organisations for national economic benefit. The current Australian policy is contained in the document *National Principles of Intellectual Property Management for Publicly Funded Research* (Australia. Australian Research Council, *et al.* 2001).

The ownership, control of, access to, and returns from the sale and/or licensing of IP is a major issue in public policy. It also occupies a great deal of the time of corporate lawyers and taxation accountants in the negotiation of agreements between universities and businesses. Much of this negotiation is premised on the prospect of substantial income and/or capital gains flowing from the commercial application of IP and how those returns should be distributed.

The reality is that most patents are worth very little and it is hard to know in advance which patents have any value. Discoveries and technologies embedded in IP only have value when adopted in a business model (Chesbrough 2003). Much of the work involved in managing IP created in a higher education institution or public research organisation context assumes that there is some objective value for a technology separate from how it is commercialised. The result is that proactive IP management misses some key issues. Specifically:

Technologies acquire economic value when they are taken to market with an effective business model. When research discoveries are driven by scientific inquiry and not connected to any business purpose, the commercial value of the resulting discoveries will be serendipitous and unforeseeable. Unsurprisingly, most of these discoveries will be worth very little, although a few may be worth a great deal – once they are connected to the market through some viable business model (Chesbrough 2003).

Researchers often need to be educated about the way in which research relates to the business models of the research users so that researchers can understand the potential connections early on in the process. At the same time, research users become concerned when researchers

endeavour to develop business models that do not fit the models of the participants, or in which participants see no economic or commercial merit. These issues call for improved performance and increased effectiveness in the institutions of engagement.

The *Bayh-Dole Act* encouraged universities to protect the Intellectual Property created from Federal funds and license it to the private sector. This initiative has largely been seen as a success. A number of problems have emerged in the biotech-health sciences area, however, where researchers are getting too dependent on the provisions of the Act and are “torquing their research”, keeping their results to themselves and not discussing it with other researchers because they do not want to do the patent work up front (United States. Department of Commerce Technology Administration 2002).

Policy makers are seeing a need to get the best out of the *Bayh Dole* provisions but not impede the science by keeping it bottled up and not getting an outcome.⁴⁰ It is thought that resolution requires some leadership – on the basis that it is good business and good science to have *non exclusive* licences to various gene technologies and charging a modest amount of money and making these tools readily available. It is considered that this will create a better outcome than holding it exclusively (United States. Department of Commerce Technology Administration 2002). The lesson from agricultural innovation was that patenting let inventions out in the field and they moved at a very high rate.

In Australia, the Rural Research and Development Corporations have been at the forefront of this process. This is now being put at risk as publicly funded research organisations, who have worked in partnership with the Corporations, hold up the process by seeking to make money from the sale and licensing of Intellectual Property – quite often in situations where the value is highly uncertain.

There is a need to think about non-exclusivity and reasonable pricing and to operate in a regime of true innovation rather than the tools under which it operates. This is a trade off between maximising revenue, the advancement of knowledge and promoting adoption and use. A serious problem emerges, however, when a researcher finds an opportunistic venture capitalist and they decide to put a lock on cascading events. The lesser institutions and

⁴⁰ For example, because of the many ways of gene expression, a company may have to license many Intellectual Properties making the royalty requirements to universities wipe out any profits. Some patents –eg a gene sequence – create a bottleneck and anything done beyond that requires a license. Some universities cannot do their work or they have to license a patent to do so. Thus, the problem with the Bayh Dole provisions is that it is possible to patent essentially the tools of research – gene line, cell line, a gene, or a way to manipulate the gene. This has worked to hinder biomedical research.

venture capitalist sector are seen to be pursuing IP protection, in the hope of finding the blockbuster – but according to the evidence are really wasting their time and money (Rogers, *et al.* 2000). Few universities make money out of licensing IP.

There are many issues concerning the question of who should own the IP developed in universities that has been funded from public funds where there are collaborating arrangements. Collaborating companies and organisations frequently expect to own the IP on the grounds that they are paying for research services under a contract.⁴¹ The universities generally take the view that only if a company is prepared to share the entire risk can it share the rewards. The university therefore seeks to share the benefits of the development of IP under a collaboration arrangement. But collaboration arrangements and strategic alliances are much more than contracts, although lawyers have tended to reduce them to this.

In many university Technology Transfer Offices staff are active in marketing of discoveries under confidentiality agreements. There is, however, a general shortage of skills in technology marketing. Where separate offices do not exist, research management offices provide back up, support, training and advice for researchers in IP identification and management. Marketing IP is not generally addressed under these arrangements. The importance of effective IP policies and scientists being familiar with problems relating to premature disclosure is a major emphasis.

For companies, acquiring a technology is not like buying a book. They will not acquire a technology on reading a paragraph or two in an IP prospectus or an entry on a technology website. Businesses generally want to get to know the scientists and researchers to learn how their technology works, what the technology can accomplish, and what types of products and services it might yield. A technology cannot be presented to a team or to customers if a research manager does not know how it works. This creates a challenge of university TTOs in not only protecting a discovery or technology but also being able to market it effectively. If they are going to be in this “business”, it needs to be managed and resourced appropriately.

Data from the *National Survey of Research Commercialisation* indicates that the largest proportion of technology licensing is to established medium to large companies. This is indicated in Table 12.

⁴¹ Rarely does the contract cover the full cost of the research.

Table 12: Licenses Executed by Australian Universities and Medical research Institutes - Year 2000

Licences Executed to:	Universities	Medical Research Institutes	Total
Start-up Companies	35	6	41
Small Companies	48	1	49
Medium Companies	22	5	27
Large Companies	99	3	102
Total	204	15	219

Source: Source: Australian Research Council, *National Survey of Research Commercialisation*, 2002.

Despite the glamour of entrepreneurship, the most of the effort in technology licensing relates to large, established companies – not start-up companies.

Technology licensing activity tends to be concentrated in a relatively few departments and faculties at each university. This is reflected in the results of the *National Survey of Research Commercialisation* (Australia. Australian Research Council, *et al.* 2002). The concentration of licensing in the health and life sciences is indicated in Table 13, which indicates that these categories accounted for 61 percent of licensing in 2000.

Table 13: Distribution of licenses by originating areas of research - Year 2000 (percent)

Field of Research	Licenses Executed
Biological sciences and biotechnology	42
Physical, chemical and earth sciences	10
Mathematics, information and communication sciences	7
Engineering and environmental sciences	17
Health and clinical sciences	19
Social, behavioural and economic sciences	2
Other	1
Total	100

Source: Source: Australian Research Council, *National Survey of Research Commercialisation*, 2002.

The success of technology licensing in the life sciences has in many ways provided a foundation for current public policies and programs for the commercialisation of all university research. These are based on a view that the universities can be used to change industry culture and an assumption that universities and scientists, with the right incentives, will drive new knowledge into on-going wealth creation processes in industry. This view lies at the basis of arguments from the science community for more funding for scientific research. It is uncertain, however, whether the experience in the life sciences can be generalised across all university research.

Much of the enthusiasm for active technology licensing strategies derives from experience in the United States. However, the OECD pointed out in its 2000 *Science Technology and Industry Outlook* that governments should take care when looking to the United States as a benchmark for patenting and technology licensing activity (OECD 2000). The Organisation suggested that:

- Revenues from technology licensing do not reduce the need for other sources of funding - as indicated above, very few universities make any significant amounts from licensing technologies and when considered against the costs, the returns are very small indeed.
- Patenting is not a reliable indicator of scientific output – the distribution of patents is highly skewed to the biotechnical sciences and the bulk of revenues come from a few “blockbuster” inventions.
- The role of government in promoting commercialisation of public research has to be seen in context – the *Bayh-Dole* initiative built on a long tradition of university-industry collaboration, facilitated by the autonomous status of research universities, as well as institutional developments including the professionalisation of Technology Transfer Offices, and industry *demand* for new technology related discoveries.
- The main contribution of technology licensing to innovation is not to make public sector research more commercially relevant but to improve information and existence of commercially relevant research results.
- Technology licensing should be seen as a parallel to other forms of industry engagement, including collaborative research arrangements (OECD 2000).

The economics of university licensing seems to rest on true technological advances that are commercially valuable such as the discovery of new drugs that cure disease – or new ways to find or make them. Notwithstanding the perception of riches, even the most successful universities see licence income as a happy bi-product. TTO managers see their role as providing a service to the faculty – to help get ideas into practical use. Academic reputations are earned by creating something that has value to an end user; this may not generate a lot of money from licenses. It may generate revenue from the sales of the products where the IP is embedded – for example a patent or a book containing ideas.

Creating and marketing products is a task for businesses. This is probably why academics, or even academic institutions, do not publish books themselves, preferring to leave that task to commercially oriented academic publishers. These perceptions have not yet been fully translated into the culture of technology licensing.

To be successful in commercialising Intellectual Property means turning one’s mind to running a business that addresses customer needs – a different story altogether. Universities were not set up to perform this function. This does not mean that industry should be free to plunder or exploit the Intellectual Property riches of universities. Resolution requires effective forms and institutions of engagement between the creators and users of knowledge products.

7.6 Contract research, expert advice and consultancy services

Universities generate a substantial amount of income from research provided under contract with business. This ranges from the use of testing and modelling equipment to complete research projects undertaken over many years. The scope of services covers expert advice, research, general consulting services, product testing, continuing education and exports of commercial services (Gallagher 2000). Substantial benefits may be derived for business from having an expert academic as a Board member. There is a group of “Guru” professors who write prolifically and consult at very senior levels in corporations and make a contribution in the form of new perspectives and ideas.

The packaging of knowledge services is occurring at a time where companies seek to acquire knowledge on a contract and consultancy basis. Service contracts with knowledge professionals, as either individuals or in teams, are becoming commonplace for a broad range of business functions. Many public higher education institutions have established private subsidiary companies to undertake research and consultancy projects and conduct professional development courses on a fee-for-service basis. These arrangements have been established either through their technology transfer companies, or within schools and faculties. These businesses are, in effect, part of the professional services sector offering services to business and compete with private sector providers.

Higher education institutions encourage senior academics to undertake advisory and consulting services as a means to supplement academic salaries and bring prestige to the institution. Most universities have policies and guidelines that seek to ensure that such activities do not conflict with the interests of university. Guidelines also generally define rights and obligations of staff and the university and detail procedures intended to protect both the university and staff from legal liability and other risks. However, the cultures of academic research and commercially oriented advice differ in relation to process, client relationships and outcomes. Over commitment among academics to consultancy can compromise teaching particularly where junior faculty are assigned to teaching responsibilities while senior faculty are committed to consulting.

Many businesses and government agencies like to think that university based consultancy will yield objective and independent analysis and results. However very few universities manage their consultancy services appropriately through effective engagement institutions. Moreover, there is substantial revenue leakage as academics operate independently and/or exceed the provisions of their contracts that usually allow one day per week of their time for consultancy.

In some of the new generation universities, where research performance is not highly prioritised, academics are effectively full time consultants providing base load teaching services. The extent of university subsidy to the private consulting academic has attracted the interest of commercial providers and government in relation to competitive neutrality. In 2002 the NSW Auditor General expressed an opinion that:

. . . whilst all universities have developed policies to manage paid outside work and to protect IP rights, many of those policies are outdated and require urgent review. Many of them do not adequately protect the universities or provide adequate compensation for the use of their resources or their name. There also seems to be a lack of clarity for accountability to monitor and enforce the policy (New South Wales. Audit Office 2002).

Academics are motivated to undertake outside work to supplement their incomes. A better solution and approach might be for universities to increase salaries to encourage academics to make a full time commitment to their academic responsibilities and ensure that all outside work was channelled through and managed by an appropriate engagement institution established to respond to market needs and also to protect the integrity and credibility of the institution.

7.7 Knowledge companies

Over the last five years there has been a high level of interest, and in many instances advocacy, for universities to create start-up companies to commercialise the research. There is a perception among consultants and commentators that there is a wealth of research sitting in universities waiting to be identified and converted into products that consumers will be prepared to buy and pay for. Studies based on limited data and restrictive assumptions have been used to draw attention to this possibility (Allen Consulting Group 2003). The reality is that most research results in universities are too premature to be considered for commercial exploitation in a start-up company, or are of no interest to technology investors or businesses as a business model has not been established (Howard, *et al.* 2001b).

On the basis of research undertaken by the author during mid 2003, a total of 50 companies in the Australian health/biosciences sector received venture capital funding in excess of \$1m over the period 1996 to 2003. There were many more that received less than this amount. However, only 11 of these companies would appear, on the basis of the *publicly available evidence*, to have evolved into sustainable businesses, reflected in the existence of marketable products and a customer base (Howard and Howard 2003). Most investments in very early stage technology companies fail. Success is determined by a range of factors that have little

relationship to the level of investment. They include the connections and track record of managers and the capacity of the investment team to build linkages and relationships through industry value chains.

Universities and researchers often become frustrated when their “breakthrough” discoveries are not taken up by established businesses or venture capital investors. Increasingly, universities are going beyond the creation of the start-up as a repository of Intellectual Property to becoming actively involved as early stage investors in the new entity. Public programs support this process. Several Australian universities have accessed public investment ready programs, such as the Commercialising Emerging Technologies (COMET) Program, to launch start-up companies. The main business of many of these companies is to own, develop and license a technology (Howard 2002c).

One of the major difficulties, however, is finding managers who can also bring the knowledge, skills and experience to develop and nurture a company from the earliest stages to a situation where it will be attractive to follow-on investors. There are also situations where researchers, convinced by the commercial viability of their discoveries, and having entrepreneurial capabilities, leave the university and create their own businesses.⁴² Ownership and licensing of IP is an important issue in these circumstances.⁴³ These businesses may contract with the university to undertake further research.

For universities and scientists, the publicity surrounding the venture capital asset class has, in turn, stimulated a great deal of interest in using the start-up product across *all* research fields. However, in technology-based disciplines, such as engineering, the more traditional forms of technology transfer through licensing and consulting still tend to predominate. These technologies are associated with substantial investments in physical capital. A requirement to commit substantial amounts to investment in physical assets does not attract the interests of venture capital investors or university Technology Transfer Offices.

The start-up product is much more likely when: the innovation (i.e. commercial application) arises directly from basic research; it is a “disruptive technology” – that is, the technology is not yet being applied in industry; there is no readily identifiable receptor; there are opportunities for integration with established companies should the technology be of

⁴² Many of the successful Internet companies (e.g. Yahoo!) fall into this category. These “entrepreneurs” were successful in attracting the interest of venture capital investors – who invested in the “knowledge” or idea.

⁴³ Technology Transfer Offices have a critical role in this area. This matter is discussed further in Chapter 8.

commercial value – for example a biotechnology start-up with the potential for downstream take up by a pharmaceutical company. In all reality, these situations are quite rare.

Following US experience, some universities seek to derive more income from equity injection and subsequent sale or listing rather than direct licensing of the technology to the new company. These arrangements involve a high level of collaboration between universities, business, venture capitalists and other financial intermediaries. Some companies established to develop technologies in this way have received assistance under government technology assistance programs (for example, R&D Start). Investment decisions by venture capital fund managers are often conditional on a technology development grant being received.

7.8 Returns from technology licensing and investment in start-up and spinout companies

In the United States, available data indicate that returns from technology licensing are not a major contributor to university income. In 2000, licensing income amounted to 4.2 percent of total university research expenditures. This is concentrated in the University of California system and the large private universities. This is indicated in Table 14, drawn from the 2002 Association of University Technology Managers (AUTM) survey.

Table 14: United States University Revenue from Commercial Activities 2000

Institution*	License Income \$'000	Research Expenditure \$'000	License Income as % of Research Exp.	Licenses & Options Yielding Income	Licenses Generating >\$1M in Income	New Patent Applications	U.S. Patents Issued	New Start-ups
University of California system	261,522	2,084,623	12.5	781	10	432	324	26
Columbia University	138,562	311,122	44.5	143	16	96	78	7
Dartmouth College	68,427	91,698	74.6	54	1	11	17	1
Florida State University	67,497	136,284	49.5	12	1	33	16	2
Stanford University	34,603	444,275	7.8	378	6	162	98	8
MIT	30,235	727,600	4.2	362	3	180	152	31
University of Washington	30,213	652,100	4.6	385	4	72	59	6
University of Pennsylvania	26,493	529,555	5.0	45	1	84	50	6
University of Florida	26,268	294,700	8.9	37	3	121	56	6
Georgetown University	26,000	123,000	21.1	8	1	24	16	2
Michigan State University	25,721	227,734	11.3	47	1	37	50	1
Caltech	23,660	376,000	6.3	65	4	236	108	14
University of Wisconsin-Madison	22,790	554,361	4.1	202	6	112	92	6
University of Minnesota	22,690	411,380	5.5	248	2	78	65	11
SUNY system	16,486	448,525	3.7	147	1	111	72	4
Johns Hopkins University	14,376	1,033,802	1.4	166	3	259	106	10
University of Rochester	13,400	204,050	6.6	25	2	50	14	2
Harvard University	12,195	430,781	2.8	163	2	64	56	1
Emory University	10,672	217,400	4.9	46	2	37	28	0
Baylor College of Medicine	9,415	288,424	3.3	115	0	33	19	5
	881,225	9,587,413	9.2	3429	69	2232	1476	149
Other	195,000	16,122,864	1.2	4133	33	3391	1796	219
	1,076,225	25,710,276	4.2	7,562	102	5623	3272	368

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Table 3 indicates that the 20 largest research universities generate license income amounting to 9.2 percent of research expenditure. In the remaining universities, the proportion is 1.2 percent. Even in the top 20 universities, license income exceeds ten percent of research income in only six institutions.

In Australia, data obtained from the *National Survey of Research Commercialisation*, included in Table 15, provides the following comparable data (Australia. Australian Research Council, *et al.* 2002). The survey indicated that 23 of all Australian universities received income from licenses.

Table 15: Australia. University Income from commercial activities (2000)

Institution*	License Income \$000	Research Expenditures \$'000	License Income as % of Research Exp.	Licenses & Options Yielding Income	Licenses & Options Executed During 2000	Licenses & Options Active to 2000
The University of Melbourne	52,000	270,767	19.2	40	25	
The University of Queensland	6,675	268,030	2.5	7	63	63
The University of New England	5,823	41,709	14.0	62	11	
The University of NSW	4,446	203,002	2.2	12	12	42
The Flinders University of SA	4,223	57,799	7.3	4	3	8
The University of Sydney	1,621	255,155	0.6	32	31	163
University of Wollongong	1,810	62,983	2.9	2	2	8
Queensland University of Technology	1,283	58,824	2.2	6	2	39
University of Technology Sydney	1,257	53,527	2.3	6	9	22
Macquarie University	1,065	53,699	2.0	8	3	10
Swinburne University of Technology	850	37,264	2.3	2	2	3
The Australian National University	626	284,391	0.2	8	8	26
The University of Adelaide	480	119,770	0.4	17	1	26
Monash University	320	124,259	0.3	3	16	15
University of Western Sydney	206	30,320	0.7	3	3	
Griffith University	185	75,140	0.2	17	19	11
Royal Melbourne Inst. of Technology	175	41,287	0.4	3	1	17
University of South Australia	113	45,586	0.2	6	2	20
University of Newcastle	44	75,239	0.1	4	3	9
The University of Western Australia	62	168,332	0.0	4	9	41
La Trobe University	44	74,229	0.1	1	5	13
James Cook University	24	33,228	0.1	4	1	
University of Tasmania	5	72,846	0.0	1		
Other	0	1,957	0.0		5	25
	83,341	2,703,068	3.1	252	234	561

Source: Australian Research Council, *National Survey of Research Commercialisation*, 2002.

According to *National Survey of Research Commercialisation* data, license income constitutes 3.1 percent of research expenditures. However, the revenue for Melbourne University from the public listing of Melbourne IT during 2000 heavily impacts this proportion.

Material collected for the recently completed evaluation of the Cooperative Research Centres (CRC) Programme provides additional insight into the technology licensing and/or transfer activities of Australian universities (Howard 2003b). Data are provided in Table 16.

Table 16: CRC Programme Outputs - Technology Transfer/Commercialisation 2000-01 - 2001-02 (Total)

	Total
Number of technology commercialisation agreements	474
Number of licences or options on intellectual property contracted	233
Number of agreements on outright sale of technology to industry and other end users	8
Other commercial agreements	60
IP maintained in Australia (patents)	709
IP maintained Overseas (patents)	59

Source: Howard, John H. 2003. "Evaluation of the Cooperative Research Centres Programme: A Report to the Department of Education, Science and Training." Howard Partners: Canberra

Up until 2001-02 collection of information relating to technology agreements has been aggregated. More recent collections break this down into income from licenses and options on intellectual property contracted, income from spin-out companies, and income from other commercial agreements.

Between 1991-92 and 2000-2001 CRCs generated only \$32m in income from technology agreements. The distribution across industry is identified in Table 17.

Table 17: CRC Income (000s) from Technology Agreements exceeding \$100,000 (1991-1992 – 2000-2001)

	Total
Mining and Energy	16,103
Manufacturing Technology	1,500
Information and Communication Technology	1,583
Agriculture and Rural Based Manufacturing	106
Environment	3,440
Medical Science and Technology	8,037
Total all CRCs	32,805

Source: Howard, John H. 2003. "Evaluation of the Cooperative Research Centres Programme: A Report to the Department of Education, Science and Training." Howard Partners: Canberra

Between 2000 and 2002, 23 of the 70 CRCs reported income from licenses and options on Intellectual Property. The total income for the two years combined was \$10.2m. Forty two percent of this income was sourced to the Photonics CRC. CRC income from other commercial agreements amounted to \$1.2m over the same period. Seven CRCs received income from this source.

Research undertaken for the CRC Association by John Yenken of Karingal Consultants reports a total of \$30.4m in sales in 2001-2002 for CRC spinout companies. Projections, supplied by the CRCs are for sales to reach \$944m. The estimated time frame for the sales revenue to be realised is not available. Atmosphere Networks, a company created from the CRC for Telecommunications to produce copper loop broadband networking is reported as having been sold for \$88.5m (Cooperative Research Centres Association 2002).

7.9 Summary

Universities generate significant amounts of income from selling knowledge products and services, particularly their teaching outputs in overseas markets. They do not, however, generate a great a great deal of income from selling their research outputs. They generate even less income from establishing businesses that manufacture products and services on the basis of discoveries and technologies created.

The marketing and sale of courses and IP is reflective of the industrialisation of higher education. But it does not suggest that universities are becoming fully fledged businesses. The income from these commercial activities relates to only a small proportion of their operations. It does not suggest that their roles and functions amount to a movement across established categories and institutional boundaries and the blurring of professional identities.

The development of relationships and interactions between higher education institutions and business does suggest a need for institutions that are separate from the core functions and activities of higher education institutions. These institutions are reflected in the creation and operation of technology transfer companies, research centres and teaching institutes and schools that specialise in the marketing of courses and programs with a specific customer focus.

Many universities have adopted an engagement strategy for marketing their courses and programs, either through the IDP network or through integrators that provide an organisational framework between the university and the users of knowledge products. Integrators have a responsibility for developing and packaging the products in a market environment.

Universities are unique institutions. Their output is knowledge and changed (educated/knowledgeable) individuals. This is achieved through the processes of research and teaching. There is a need to keep doing this well. There is, however, a need for effective engagement where that research and teaching is relevant and applicable to industry.

It is only by being able to provide teaching and research at world class standards will universities be in a position to provide value to businesses and government agencies. Businesses need first class research and top graduates. Many are prepared to pay for this through bequests and foundations and joint projects. But taking on the tasks of industry in creating new businesses is another matter.

Chapter 8. Managed Engagement – Industrial Research Collaboration

The purpose of this Chapter is to discuss engagement from the point of view of managed relationships between higher education institutions, business and government. These relationships are embedded in various forms of collaboration reflected in partnerships, strategic alliances and various forms of joint venture. The feature that is unique to all of these arrangements is that they require careful and effective management.

The Chapter identifies emerging forms of collaboration in the industrial research environment, the pattern of collaboration in the Australian context and the differences between collaboration and contracting. Attention is drawn to the central role of management in collaborative relationships.

8.1 Emerging forms of collaboration in industrial research

Trends in the public funding of higher education, new approaches to R&D management within corporations, a changing culture of learning, and the growth in small service and high technology industries, has led to the emergence of new forms of research that require close working relationships between people located in different institutions – not all of whom need be scientists. It has been observed that:

. . . there are formally designed interactions of university-based researchers with business people, venture capitalists, patent lawyers, production engineers, as well as a research engineers located outside the university. This has invariably involved shared use of academic and industrial facilities. Under these conditions, technology, is more likely to be trans disciplinary, and to be carried out by people who are able to rise above disciplinary and institutional loyalties.

These and similar changes and transformations are advancing so rapidly that their impact on traditional institutions and attitudes has just begun to be understood (Ganguly 1999).

These interactions have moved from an opportunistic, “bottom up” form of collaboration based on the sharing of knowledge in a gift based institutional environment to a more structured and integrative form of relationship. As interaction moves from the opportunistic to the interactive, there is an increasing formality of collaborations and associated requirement for management. The management of interactions creates important management challenges.

The movement from opportunistic to integrative collaboration can be seen in terms of a continuum. The features of this continuum are summarised in Figure 9. The emerging forms

of knowledge production reflect a movement from an opportunistic form of collaboration to a more integrative form referred to in earlier Chapters.

Figure 9: Features of collaboration relationships

	Opportunistic	Transactional	Integrative
Nature of the relationship	“Gifts” are made to support the “good work” of a research organisation – based on the reputation, past achievements, perceived importance of the research and promotional capabilities of the researchers and sponsorship managers.	Resource exchanges through specific activities and formal agreements in relation to support provided and research services that are to be provided.	Missions, people, and activities are more collective and organisationally integrated – a joint venture that is central to both; strong personal interactions – at director level; processes and procedures to manage growing complexity.
Collaboration mindset	Gratefulness and appreciation Minimal collaboration in defining activities. Separateness.	Partnering Increased understanding and trust.	“We” mentality in place of “us” vs. “them”.
Strategic alignment	Minimal fit required beyond a shared interest in a particular issue area.	Overlap in mission and values Shared positioning at top of organisation.	Broad scope of activities and strategic significance. Relationship as a strategic tool Shared values.
Collaboration value	Generic resource transfer Unequal exchange of resources.	Core competency exchange More equal exchange of resources. Projects of limited scope and risk that demonstrate success.	Projects identified and developed at all levels in the organisation, with leadership support. Joint benefit creation; need for value renewal. Shared-equity investments for mutual “return”.
Relationship management	Corporate contact person usually in R&D department; university contact person usually directly involved in research; corporate personnel have minimal personal connection to cause. Project progress typically communicated via written status report. Minimal performance expectations.	Expanded personal relationships throughout the organisations Strong personal connection at leadership level. Emerging infrastructure, including relationship manager and communication channels. Explicit performance expectations. Informal learning.	Expanded opportunities for direct employee involvement in relationship. Deep personal relationships across organisations. Culture of each organisation influenced by the other. Organisational integration and execution, including shared resources. Incentive systems to encourage partnerships. Active learning process.
<i>Funding/ financing</i>	<i>Grants</i>	<i>Conditional, specific purpose</i>	<i>Investment</i>

Based on and adapted from James E Austin, *The Collaboration Challenge: How Nonprofits Succeed Through Strategic Alliances*. San Francisco: Jossey Bass, 2000, pp.36-37

Relationships move along a “continuum” from the opportunistic to integrative. The progression is not automatic: it results from conscious acts and efforts.

8.1.1 Unrequited collaboration: gift based systems

Sociologists have made much of the idea that scientists freely share information and data and give credit to their colleagues where credit is due. An assumption surrounding the “community of science” is that scientists happily give away and share their knowledge on the basis of mutual recognition. Researchers go to conferences, for example, to “give” papers and to achieve recognition for their efforts from peers for the contribution they have made to the advancement of knowledge. Publication in a scholarly journal is also recognition of the contribution of research to the advancement of knowledge. Researchers also recognise the

contribution of earlier work by others to their research, findings and conclusions (citations), which in turn adds to the recognition profile. In this process, knowledge creation is cumulative.

Recognition and credibility, as conferred by peers, provides the basis for grant funding, which in turn supports research which in turn leads to publication, and results in greater recognition (Latour and Wolgar 1982). This system is coming under scrutiny as research granting agencies look for knowledge that has use and application.

It has been argued that scientists collaborate with other scientists on the basis of “credits” - the amount of time that a scientist is prepared to divert to the work of others - such as reading others’ work, citing in own work, and committing research under another’s’ research agenda. Scientists sharing behaviour amounts to paying “protection money” so that their colleagues will not deny access to grants, spread slander or ignore their work altogether. Acts of giving are undertaken in fear of what might result if the relevant gifts *are not* given (Fuller 2002).

When research is motivated by a commercial incentive there is less incentive to recognise the work of others – in fact researchers may go to considerable lengths to distance themselves from earlier work by criticising its quality, relevance and applicability, or simply ignoring it (Kay 1994). Industrial research management requires careful attention to motivation, incentives and the allocation of rewards as between individuals and groups. To the extent that innovation is associated with group performance, effective motivation and leadership comes at a premium (Bennis and Biederman 1996).

Much of the literature on knowledge management in organisations has assumed that people would freely share knowledge with their colleagues. Knowledge management systems, developed by information technology professionals, designed to be “repositories” of all corporate knowledge, overlooked the political nature of information and its use as a source of power and influence (McGee and Prusak 1993). Unrequited collaborations do not work well in a business environment where behaviours are driven by bottom line performance.

8.1.2 Transactional collaboration: purchasing, contracting and outsourcing

As outlined in Chapter 6 businesses have moved to source capability for innovation from external sources because they want to leverage the innovation capabilities of other firms and research organisations. Outsourcing strategies are increasingly being focused to:

- Obtain higher value, more flexible, and more integrated services than internal sources can offer
- Improve capacities to stay current and to innovate by interacting with “best in world” knowledge sources
- Achieve cross-divisional coordination that the organisation - for structural or political reasons – could not otherwise achieve.

Strategic outsourcing can substantially lower costs, risks, and fixed investments while greatly expanding flexibility, innovative capabilities, and opportunities for creating higher value (Quinn 1999). On the basis of research in the public policy context, outsourcing works best where the attributes of what is to be outsourced must be capable of being specified as a specific “problem” or “opportunity”, the technology to measure those attributes is reliable and accessible, and the impact on the rest of the system is known and manageable (Howard 2001b).

When organisations go down the outsourcing track, they expect that the provider has (hopefully) more knowledge than the buyer. Some people may not be able to communicate their expectations effectively and may not be all that clear about whether they are getting the best deal. It is often impossible to specify the desired outcomes precisely in advance. Recognising this feature of market based contract relationships industrial organisations are moving back to joint managed relationships in the form of joint ventures, and in particular, public-private industrial research partnerships (Howard 2003b).

Research and development outsourcing and contracting can present some other problems. The way in which the solution comes out cannot always be addressed in advance because quite often it is a learning process. The nature of research and development means that organisations may not be able to correctly articulate their expectations in advance - particularly when they have never experienced the outcome involved. Nonetheless, there is a tendency to approach partnering with a commodity based purchase or procurement orientation. The “public-private” partnerships for the provision of infrastructure reflect this course, as do government contracts for research services and program evaluation.

Purchase and procurement contracts generally prescribe a detailed “statement of work” - on an assumption that if this is performed a successful outcome will be ensured. This may not necessarily be the case in all circumstances: following a pre-determined and highly structured set of activities may actually reduce the scope for innovation. Innovation, by its nature, is a problem solving and exploratory driven activity – and is often inspirational. It involves the

application of knowledge – both tacit and explicit – and tends to work best under collaborative arrangements.

8.1.3 Strategic collaboration: partnering, alliances and joint ventures

In the corporate world the advantages of the large vertically integrated organisation are being challenged on both cost and performance grounds. The dynamics are shifting to partnerships and alliances based on non-market forms of cooperation and collaboration. In the public sector, the tasks of creating and developing strategic alliances with the business sector involves very difficult and complex managerial challenges. An assumption that there are simple, standard steps that one can follow rigidly cloaks the inherent complexity of partnering and courts disaster.

Partnerships and strategic alliances link specific aspects of the “business” of two or more organisations. The main characteristics are: the strategies of the participating organisations are linked through mutually beneficial relationships; relationships cover functions such as research and development, application and use of technologies, skills, or products based on them, on a continuing basis; partners agree to pursue specific goals but remain independent after formation of the alliance; and partners share the benefit and control over performance of assigned tasks – the most distinctive feature, but also the most challenging.

There is a growing literature of partnerships, strategic alliances and joint venturing in business, the advantages and contributions. Much of the work is prepared by management consultants and academic consultants. It has a strong element of advocacy but as yet, as is the case in much management practice, there are few clear guidelines and basic theory that guides action.⁴⁴

At this stage the most useful guidance comes from thinking about innovative organisation. That is, first and foremost, organisation arrangements under a joint venture, strategic alliance or research partnership should provide an environment for innovation. This environment allows for the formation of forms of organisation that are characterised by continual adjustment and redefinition of tasks through interpersonal interaction, a *network* structure of control, authority and communication, a culture of cooperation and collaboration reflected in

⁴⁴ Some of the most significant contributions come from the not for profit sector. See for example, (Austin 2000). Other important contributions are reflected in (Doz and Hamel 1998; Harbison and Pekar 1998; Kanter 2002; Pekar 2001; Spekman and Isabella 2000)

internal teamwork and external alliances and an overall emphasis on the importance of people working *collectively* with an overall sense of mission and purpose (Burns and Stalker 1994).

In this environment, the essential management tasks are to lead, motivate and communicate. These organic forms of organisation are seen to be appropriate to changing conditions that “give rise constantly to fresh problems and unforeseen requirements for action which cannot be broken down or distributed automatically to functional roles defined within a hierarchical structure” (Burns and Stalker 1994). Nonetheless, creation of organic forms of organisation in joint venture arrangements has proved to be difficult. Success relies on the management capacities and capabilities of joint venture managers. This capacity and capability is in relatively short supply, and the future of industrial research partnerships is highly contingent on the availability of this form of management expertise and experience (Howard 2003b).

8.2 Collaboration in university research

The emergence of new forms of knowledge creation has seen the emergence of the university research centre as an organisational and management vehicle. It is an institution that sits at the interface between higher education institutions and industry. Research centres have facilitated interdisciplinary research that has been the hallmark of knowledge based industrial innovation.

During the 1990s, with government-supported initiatives, the business-university alliance emerged as a way to cultivate expertise in early stage research that might not bear fruit for many years. The impact of these arrangements in the United States has been described in the following terms (Buderl 2000):

By bankrolling academic projects, firms saved much of the equipment and overhead costs of maintaining their own research group in risk areas. They got a leg up on identifying and training future hires while cultivating a wider breadth of knowledge about fields outside, but related to, their main businesses. Such alliances were sent into orbit by the rise of biotechnology, as witnessed by Monsanto’s unprecedented \$23 million research grant to Harvard University in 1974. But the trend expanded throughout the next two decades into just about any field. Hewlett-Packard was just one firm that took up this practice in the early 1990s, initially funding a few studies at Stanford University’s Science Centre. By 1998 the company supported seventy projects at thirty-six universities in eight countries.

These developments have been associated with the emergence of new forms of organisation and new ways that managers and entrepreneurs go about acquiring knowledge inputs as discussed in Chapter 5. There is no longer any presumption that the productive factors and

capabilities that a business needs to produce goods and services will be owned and controlled directly through horizontal or vertical ownership through the value chain.

Businesses decide what they want to undertake internally, on the basis of their distinctive capabilities, that is capabilities that they have and which are hard to replicate, and acquire the rest through various sourcing arrangements. It is not, however, always a simple “make or buy” decision under a contract arrangement. It is now recognised that contracts must be supported by deeply embedded trust based relationships that take time to establish.

The relationship between universities, research organisations and businesses are complex, and often drawn-out. Commercial success does not come quickly or easily. Success in collaboration often relies very heavily on commitment, deep cooperation and collaborations, networks and effective supply chain linkages. This was clearly evident in the commercialisation of the Radiata Technology project, for example (Matthews and Frater 2003).

The United States Council on Competitiveness argued that a nation that can foster an infrastructure of linkages among and between firms, universities, and government gains competitive advantage through quicker information diffusion and product deployment (United States. Council on Competitiveness 1998). The Council argued that companies and research organisations that can increase their ability to learn about alliances and develop systems for creating and managing them will be able to move more quickly and effectively to take advantage of new opportunities.

The demand for research outcomes from government and industry over the last 20 years prompted governments to increase funding for basic research. The strong defence and space drivers which ended in 1989 with the end of the Cold War were replaced with a concern that Japanese industry was jumping ahead. Government through the NSF, NIH, Energy and Defence increased funding for research centres that focussed on applied research. Universities also increased in kind support to centres that emphasised applied and interdisciplinary research. There was a presumption within government that applied research would lead to industrial applications, new technologies and economic development.

During late 1980s and early 1990s several government inquiries in the United States called for the establishment for multidisciplinary research centres. The NSF for example, established its Engineering and Science and Engineering centre programs which by 2000 took 13 percent of NSF budget. The NIH and NSF increased support from comprehensive centres that

combined research with clinical trials, technology transfer, and education. Centres were supported by universities ostensibly as a means to attract research funds. By 2000 federal budget support for universities reached \$18 billion – with URC support at \$3.6 billion. A further \$720m was provided by industry and state governments.

Many new centres were created in the early 2000s that focussed on new fields such as nano-technology, nano-scaled science, biomaterials, lasers, photonics, environmental ecosystems, supercomputing and biomass convergence to biologically safe fuels. The URC had become a major university mechanism for undertaking large, complex research projects and are seen to be highly adaptable to undertake research projects for industry and defence applications. The research centre has modified the single discipline approach to research and training and focussed in multi disciplinary research that better suited the needs of industry. Centres have been defined in the following terms:

University Research Centres are flexible, comprehensive research and education organisations. They offer a research climate that focuses on development, product design testing, new pharmaceuticals, as well as the traditional basic research discovery activities. They also focus on interdisciplinary research, technology transfer, and technical assistance to industry and agriculture. Many centres are dedicated to conducting large and complex projects that contribute to industrial, defence, social, and environmental missions. Contrary to general opinion, centres perform nearly equal amounts of basic and applied research, and provided a substantial amount of time to undergraduate and graduate research. They are, however, increasingly expected to bridge the gap between academic applied research and the more narrowly focussed technology activities that hopefully lead to economic development in their own states and even the global economy (Tash 2002).

Despite the interdisciplinary rhetoric, without strong and effective management, centres can tend towards a focus on single disciplines and an orientation towards curiosity research and disengagement with industry partners. There have been problems encountered in a lack of financial and infrastructure support from the host universities, red tape in hiring personnel and management support, lack of space for expansion, inferior instrumentation, absence of faculty rewards for participation, poorly trained science managers, inappropriate director appointments that lead to obsolescence on research creativity, competing demands for research and teaching (Tash 2002). However, centres are one of the factors causing the growth of research universities, but their continued expansion requires more, rather than less, university support.

Staff in centres have advantages in relationships with industry scientists. They have time to increase their contacts and get to know the key personnel. Faculties involved in centres are usually more involved in technology transfer. They have become an important resource for finding employment for non tenured scientists and post doctoral students until they find

permanent employment. They also encourage scientists to become more involved in “thrust” areas of research – cutting edge technologies and interdisciplinary research. They provide faculty to strengthen their research portfolios and allow universities to become major players in national economic strategies. There is advantage for students in participating in hands on research and for later careers in industry. These observations place an emphasis on the benefit for the research organisations. There is a presumption, rather than an expectation, that research outcomes will provide economic benefit to participation businesses.

The projected trends in research centre activity in the US are (Tash 2002):

- Greater research centre influence on university wide policies and curricula revisions to match societal needs and government policies and regulations
- University adaptations - administration will offer increased support and attention to centres as national rankings of research universities become increasingly dependent on research centre funding
- Economic development - there will be increased pressure to strengthen regional economies and global markets; industry funding is expected to double from 10 to 20 percent
- A larger share of university’s R&D – at least 50 percent – up from 33 percent in 2001, much of it based on fixed price contracts
- Centre durability - more permanent, sustained funding from government, universities and industry
- Faculty involvement increasing – close to 80 percent of the science and engineering faculty will be involved in research centre research; faculty joining centres to increase publications and have access to more costly but essential equipment; faculty merit raises and tenure linked to research centre URC funding
- Student involvement - at least 80 percent of graduate science and engineering students will be involved and close to 50 percent of undergraduate science and engineering majors
- Greater interdisciplinary focus, less emphasis on single discipline dominance.

The key to success in university-industry partnerships is seen to depend on the primary motive of each partner. That is:

If the universities value the partnership as a means of exposing faculty and students to leading edge technical issues that are driving innovations of benefit to society, and are not basing their expectations primarily on revenues from patents, a stable, productive relationship may endure. If the firms see universities as sources of new ideas and as windows on the world of science, informing their own technical strategies, rather than viewing students as a low cost, productive source of near term problem solving for the firm, they too will be rewarded. Each partner must understand and accept the other's priorities. The money and services exchanged should be seen as the means to broader ends (Branscomb 2003).

A recent trend has been for large business enterprises to enter into *long-term developmental research agreements* with universities that involve “umbrella agreements” with mechanisms

for the selection of specific projects. Proprietary considerations, principally involving patent rights and rights to publication, tend to be rather detailed and complex and require formal mechanisms for management and review.

The research centre structure and operation in the Australian context is canvassed below.

8.3 Australian context

Simon Marginson and Mark Considine in *The Enterprise University* notes that there are “many research centres, many kinds of research centre and no apparent limit on the functions that can be located in these structures” (Marginson and Considine 2000). They observe that they range from the “big budget Commonwealth subsidised key centres, special research centres and Cooperative Research Centres (CRCs) with postgraduate training undertaking research and development, often creating Intellectual Property, to small dedicated units consisting of a couple of people and a title on the door”.

Some research centres are corporate entities with substantial autonomy, others have some autonomy in relation to a faculty/school and others fall within departmental organisation but are separately identified (Marginson and Considine 2000). It would appear, however, that the key driver in creating centres is providing a focus for channelling resources, from internal and external sources, for specialised research and teaching purposes. Marginson and Considine comment:

When a centre is created it is usually expected to attract outside funding. Normally it is specified, by both government and university management, that the core funding of a new centre is temporary and it is expected to become self-sustaining. Time and time again, these hopes are disappointed. On the whole, the research centres with the best prospects of long-term survival are those able to attract a significant level of postgraduate student load. Research on its own does not earn enough money. Even centres producing saleable Intellectual Property and their significant consultancy work are rarely able to finance all their salaries and overheads from these sources (Marginson and Considine 2000).

Research centres are important to both the larger and smaller universities. For smaller universities they provide a vehicle for increasing the range of sources of external income to support the research of the University, in particular from non-government and international agencies. Information provided by the Department of Education Science and Training indicates that there are 323 designated research centres at Australian universities.

Table 18: Australian Research Centres, Institutes classified by Field of Education, 2000 (No.)

Field of Education	Number of centres
Agriculture and environmental studies	48
Architecture and Building	9
Engineering	60
Health	80
Information Technology	37
Natural and physical sciences	89
	323

Source: Department of Education Science and Training, 2003.

The University of NSW, in its 2001 *Research Training and Management Report*, indicated that it sees its 56 University research centres as “incubators for nationally and internationally significant research activities, characterised by effective cooperation between researchers and efficient use of research resources. The centres are considered to play an invaluable role in the university’s research and teaching activities, from fundamental investigations through to technology transfer. Proposals to establish centres are assessed by the Committee on Research and approved by the Academic Board.

Indications are that universities are reviewing their policies and practices relating to the creation and support for research centres. A Review by the University of NSW of its commitment to research centres concludes:

From the first reviews, it is clear that UNSW needs to reassess its guidelines for the establishment, operation and review of research Centres. This exercise will ensure that the Centres do and will continue to add value to the University’s research effort; will disestablish those which do not; will ensure that Centres have effective management practices and development plans; will enhance opportunities for synergy between Centres and across the University and wider community; and will refine the University’s capacity to respond to emerging national and international opportunities for innovative training, research and development.

At the QUT University research centres undergo a rigorous review process comprising external peer review and external membership on the review committee. At the same time, University Research Centres are assessed and benchmarked according to the criteria developed for the QUT Research Quality Index, and in terms of international research competitiveness based on the UK Research Assessment Exercise (RAE). The University is currently reviewing the existing QUT Centres Policy in terms of major changes and recommendations contained in recent national research policy reviews, where strong consensus exists on the need for heightened collaboration between academic researchers, industry and end users. The Centres Working Party is reviewing existing strategies and structures for clustering research strengths with a view to identifying initiatives to bring together cross-disciplinary expertise and provide further opportunities for broader research synergies.

From a smaller and regional university perspective, the James Cook University has pointed out:

One of the greatest challenges facing regional universities is establishing the necessary critical mass to address major research issues of regional importance. In the case of JCU this problem is compounded by our distance from major metropolitan centres. A key strategy to address this problem is capacity building via partnerships and other collaborative arrangements. It is for this reason that JCU over a number of years has adopted a proactive and strategic approach to collaboration in research.

La Trobe University commented in its *Research Management and Research Training Report* that, in recognising the need to broaden the funding base for the research of the University, an Industry Strategy was adopted in 1996 to improve the performance of the University in attracting non-government support for research. The University Reported:

The growth in income from research contracts from \$1.4 million in 1995 to \$6.18 million in 2000 indicates that the Industry Strategy is being effective. Furthermore, funding from non-government sources (DETYA Category 3) represented 29.8% of the research income of the University in 1999 compared with a low of 4.3% in 1993. With the changes that are occurring in the research profile of the University and the opportunities presented through the Industry Strategy (see Section 2) it is realistic to set a target, to be achieved by 2005, of 50% of the total external research funding to be received from industry and other non-government sources.

This sets an ambitious target. However, a strategy to attract funding from industry will involve the development of managed relationships where funding is associated, if not directly tied, to research outcomes. Thus a strategy to increase research income from non-government sources should also be accompanied by a strategy to provide value added services in the form of applied research and product development with that funding.

As research centres move from opportunistic conduits of funding to sustain the research interests of academic participants to organisations that deliver research benefits and outcomes to their participants, attention becomes focussed on governance arrangements. This aspect of research centre management and performance has been largely ignored, particularly in the design of public programs to support research centres and centres of excellence. In addition, the management of research centres imposes costs on the central administration of higher education institutions, particularly in terms of providing management and administrative infrastructure.

There are further issues relating to the constraints that collaborations with commercial firms bring to freedom to publish their work, pressures on university research to shorten the time horizon for their technical vision, and the pressure that commercial financial interest may

place on faculty duty to colleagues and students. The most significant barrier that inhibits effective research partnerships relates to Intellectual Property concerns and specifically patenting rights.

Features of the Australian Cooperative Research Centres Programme are outlined below.

8.4 The Australia Cooperative Research Centres Programme

The CRC Programme was established in 1990 with the first CRCs being announced in 1991. It is the Government's major program for promoting collaborative research links between industry, research organisations, education institutions and government agencies. The Programme supports research and development and education activities that achieve real outcomes of national economic, environmental and social significance. Over the life of the Programme, a total of 158 CRC applications, including renewal and supplementary applications, have been supported from a total of 529 applications.

The CRC Programme is distinguished from a range of other public programs designed to foster closer links between research users and research providers by the size of the Commonwealth payment – ranging from \$12m to \$30m – and the timeframe of commitment – typically seven years. The Programme also differs in that it requires the formation of a *managed* relationship between CRC participants in the form of a formal joint venture partnership. This differs from the *gift*-based (or unrequited) relationships that underlie many other research grant programs.

The Programme has been associated with a profound change in Australia's research and innovation culture since the Programme was introduced. There has been, for example:

- A widespread recognition of the role of public-private research partnerships, based on the generation and utilisation of “applicable knowledge”, in industrial innovation.
- In the context of the “knowledge economy”, an acceptance of a role for the public sector in supporting new business development through the commercialisation of publicly funded research.
- A greater understanding of the contribution of science to the design and implementation of public programs, particularly relating to the environment and public health.

The emergence of public-private research partnerships reflects a fundamental change in the way in which knowledge is generated and applied as well as changes in approaches to the management of industrial research and development. The CRC Programme sits well in the

developing system of industrial research built around the production of “knowledge in application”, or “applicable” knowledge (Gibbons 1998; Gibbons, *et al.* 1994).

The CRC Programme, which started as a “bottom up” collaborative venture between researchers provided a strong basis for developing trust-based relationships between participating organisations. With increasing internal resource constraints and the need to set priorities, the Programme has now moved to the next level where collaboration between universities, publicly funded research agencies, business and government is being approached at a more strategic level. Moreover, with greater interest in returns from Intellectual Property and commercial activity the management of a research joint venture is now a much more critical issue.

The CRC Programme has been reviewed several times over its lifetime. In general terms, industry sees the Programme as an extremely effective policy instrument, which has been recognised around the world for fostering collaboration between industry and researchers. Discussions and consultations during the Evaluation of the Programme confirmed that most stakeholders agreed with this sentiment. This has been a vanguard Programme that has tried to do new things in new ways. It has attracted international attention and has become one of the notable features on Australia’s distinctive science and innovation landscape (Howard 2003b).

At the same time, however, CRC participants and stakeholders agree that it is now necessary for government to act decisively to build upon the strengths of the Programme *and* to adapt to some of the recent developments in the industrial research and the research commercialisation framework. Many stakeholders, particularly those in the private sector, considered that the Programme had been too focussed on research with an insufficient emphasis upon meeting industry and other end-user needs through attention to adoption and application of research results. It is in this context that the Evaluation recommended that the Programme should be clearly positioned as an investment vehicle in which research is seen as a means to an end (“an end use”), not an end in itself.

One of the most important issues thrown up in the Evaluation was the task of managing a joint venture arrangement, particularly an unincorporated joint venture. It became clear during the evaluation that one of the most important criterion of success was the capacity to manage a joint venture in a very complex institutional environment.

8.5 Commercial outcomes of industrial research collaboration

Governments in the OECD community have provided support in various forms and formats to higher education institutions, publicly funded research laboratories and industry to assist in the commercialisation of discoveries and inventions through collaborative arrangements. These programs have included support for Collaborative Research and Development Agreements (CRADAs) in the United States and the Cooperative Research Centres Programme in Australia. Both programs were initiated in the early 1990s.

Recent studies in the United States have indicated that very few projects initiated in CRADAs had led to commercial outcomes. One of the reasons suggested is that laboratories were under pressure to increase the number of CRADAs in which they were involved in the early 1990s with the result that there were a large number of unviable projects supported. Government financial incentives may also have contributed to the execution of a number of CRADAs that had significant operational problems (Mowery 2003). Other problems related to:

- Legislative and administrative requirements producing long delays in negotiation and approval which imposed serious handicaps on projects – exacerbated by the inability of laboratory research teams to begin work before final approval.
- The transition from laboratory prototype to high volume manufacturing is difficult as participants terminated involvement as budgets ran out; transition from prototype to commercially desirable product and manufacturability requires extensive technically demanding work.
- Inflexible internal budgetary allocations and high unit costs of the laboratory's R&D – especially when overhead charges were included.
- Commercialisation of the results of a technology co-development requires considerable technical sophistication and managerial competence within the private firm partner which may be particularly scarce in smaller firms; such weaknesses produces an unrealistic set of project goals that impeded execution of the CRADA and contributed to a commercially unsuccessful product.
- R&D consortia in high technology industries such as SEMATECH have found that small firm collaborators need more than technology; they require in addition to technology collaboration or assistance, they require that management, marketing and manufacturing skills in the participating business must be improved. This requires a more ambitious and multi-disciplinary effort than most Laboratories can support within a CRADA.

The political salience of CRADAs in the early 1990s and the associated efforts to expand the number of them is seen to have undercut their effectiveness. The financial incentives to laboratory managers have been associated with aggressive promotion to prospective industrial partners. This is considered to have reduced their effectiveness for collaboration and technology transfer. Greater success in the CRADA framework is associated with situations

where private firms provide all of the operating budget as well as contributing some of the laboratory equipment. The strength of government laboratories (and by implication, higher education institutions) is in their unique facilities and research skills. These are seen to be best provided in a capacity of a research contractor rather than a collaborator with a significant degree of control over the agenda or budget (Mowery 2003).

Industry collaboration with higher education institutions as contractors would avoid the pitfall associated with the strong incentive for researchers to market their facilities and capabilities and in so doing create unrealistic expectations among private firm participants about the size, cost and likely time horizon of the technical and commercial benefits of the relationship. That is, public subsidies encouraged laboratory personnel to pursue activities that were too distant from their historical strengths (Mowery 2003). A similar conclusion can be drawn from the processes leading to the creation of Cooperative Research Centres in the Australian context where industry partners became disenchanted with the capacity of the researchers to deliver envisaged outcomes following the creation of the relationship. This has been associated with researchers changing the research agendas towards more basic and description driven research following the formation of the Centre (Howard 2003b).

With private firms providing the operating budget and unambiguously in charge of research agendas, and continued financial support dependent on researchers addressing the challenges of the foundation research agenda, these incentive conflicts are reduced. In addition private funding enables projects to ramp down more gradually into prototype and production. More ambitious technical goals set out in industry led consortia contrast with previous CRADAs that encouraged researchers to focus on shorter term projects with limited technical benefits for the institutional missions (Mowery 2003).

The differences between research and industry perceptions about the value and contribution of cooperative research undertaken with the support of government incentives are reflected in the evaluation of the Australian Cooperative Research Centres Programme. In the *Outcomes Survey* undertaken as part of the evaluation, all research users were asked a number of questions in relation to the extent to which their organisations had taken up research results coming from a CRC. Information in relation to adoption in a commercial context is provided in Table 19.

Managed Engagement

Table 19: Cooperative Research Centres Performance Indicator: Adoption in Commercial Application

To what extent do you think CRC research outcomes has resulted in your business / company commitment to:	Very High %	High %	Moderate %	Low %	Very Low %	Not Sure/missing %	Total
Develop new and/or improved products	8	24	-	24	16	28	100
Develop new and/or improved production processes	4	16	20	12	16	32	100
Develop new and/or improved supply chain practices	-	8	16	12	20	44	100
Develop new and/or improved methods of service delivery	-	8	12	20	16	44	100

Source: Howard, John H. 2003. "Evaluation of the Cooperative Research Centres Programme: A Report to the Department of Education, Science and Training." Howard Partners: Canberra

The responses indicate that only 32 percent of research users rated the contribution of CRC research to new or improved products as high or very high. Forty percent rated the contribution as either low or very low. A similar pattern emerges in relation to adoption in production, supply chain practices and service delivery. A very substantial proportion of respondents indicated that they were "not sure" or did not answer the question. This might suggest that the research results are too early to be reflected in a business context and a motivation for CRC participation beyond direct commercial return. This explanation would relate to why 50 percent of research users indicated that they would remain in the CRC Programme. CRC user participants who are focussed primarily on national benefit outcomes would also provide responses in this category.

From a CRC manager perspective, the perception of levels of commitment to adoption is much higher. This is reflected in Table 20 where 42 percent of CRC Managers rate as high or very high the level of adoption of research in new products and 52 percent in new production processes. The difference in perception between research users and CRC managers might reflect differences in time horizon and CRC manager perception of user commitment based on *potential* for adoption rather than demonstrated adoption.

Table 20: Performance Indicator: Perceptions of commercial adoption by CRC Managers

To what extent do you think your CRC research outcomes has resulted in business and / or Gov't. commitment to:	Very High %	High %	Moderate %	Low %	Very Low %	Not Sure/missing %	Total
Develop new and/or improved products	18	24	26	10	-	22	100
Develop new and/or improved production processes	24	28	16	6	-	26	100
Develop new and/or improved supply chain practices	6	12	16	14	2	50	100
Develop new and/or improved industry support programmes	8	16	26	10	6	34	100

Source: Howard, John H. 2003. "Evaluation of the Cooperative Research Centres Programme: A Report to the Department of Education, Science and Training." Howard Partners: Canberra

These survey results point to a significant gap between what industry thinks about the contribution of publicly supported collaborative research and what research managers think about the likely take up. The results add weight to the findings of the US studies that suggest

that projects undertaken in a publicly funded collaborative research environment, are too far from the market and early for commercial adoption and application.

8.6 Management matters

There are no pre-defined management and organisational structures for any joint venture arrangements once established. The issue of partnership relationship management in joint venture arrangements is now receiving increased attention in the management literature. A recent study concludes that in order to maximise a joint venture's potential over the course of its life, participants "must pay more attention to the impact of partner relations on the performance of their offspring" (Buchel 2003).

The linkage between relationship management and joint venture success, as indicated by achieving the results intended by participants, is now recognised as a subject worthy of serious study (Buchel 2003). There have been many studies that canvass issues in relationship management, and particularly the potential to create value through collaboration; but the matter of *how* this is done and the management skills and capabilities required in managing the joint venture has received much less attention. See for example (Doz and Hamel 1998; Spekman and Isabella 2000).

Notwithstanding all the advantages and benefits of partnering and alliance arrangements, current thinking lacks an integrated perspective. Part of the problem stems from the little acknowledged, but very real differences inherent in the wide range of perspectives, proponents and motives involved. Views and prescriptions from economics, accounting, law and general management produce an ambiguous situation about what alliances actually mean for managers - how to actually *manage* an alliance arrangement. For example, a lot of material about managing a Cooperative Research Centre joint venture arrangements is about governance, compliance and control (authority) – rather than about working together and building trust among the joint venture partners and researchers.

Many organisations find the language, principles and concepts of partnering compelling but have difficulty in putting the arrangements into effective practice. As argued above, many partnerships and alliances are in fact contractual arrangements with cooperative rhetoric. Moreover, most inter organisational collaborations have involved setting up and managing joint ventures in well-defined areas – designed to contain and share known risks - not to create an expansive future. In addition, few managers are prepared for a situation in which the boundaries between independence and collaboration are unclear and where there are

inevitable (but often known) risks to be managed. This applies particularly in the public sector where issues of probity, accountability and control are high on the agendas of public accounts committees, journalists, public policy academics and other commentators.

Nonetheless alliances are now becoming more pervasive through the corporate landscape. The vertically integrated firm is becoming rare in some industries. That comes at a cost – a potential loss of autonomy and control. It also comes with a risk – where one party may behave opportunistically following the motivation of self interest predicted by the organisation economists. The greater the extent to which parties seek to counter the risk of opportunism by the structuring into a relationship a variety of contractual safeguards, such as guarantees, indemnities and rules, the less the relationship looks like a partnership or strategic alliance.

It has been observed that inter-organisational relationships emerge incrementally and emphasise formal bargaining processes to establish a formal legal contract of commitments which parties execute through role interactions. These formal processes facilitate negotiations where personal bonds have not developed. As transactions are repeated through time, and meet basic needs of equity and efficiency, participants feel increasingly secure in committing more resources to a relationship. As expectations become progressively more embedded personal relationships increasingly supplement formal role relationships and psychological (trust based) contracts substitute for formal legal contracts (Van de Ven 1996). Moreover:

Increases in trust between parties, which are produced through an accumulation of prior interactions that were judged by the parties as being efficient and equitable, increases the likelihood that parties are willing to make more significant and risky investments in future transactions. Greater reliance on trust in the goodwill of other parties also decreases transactions costs and increases managerial flexibility since the parties will receive a lower need to specify and formalise the terms of their agreement in a legal document in order to feel confident that the other party will fulfil its commitments. Thus, establishing a mutual understanding of each other's identity in relation to others is a necessary (not sufficient) condition for negotiating parties to commit and enter into a cooperative inter-organisational relationship (Van de Ven 1996).

Paradoxically, however, the greater the level of trust, the greater the potential for opportunism and individualist motivations. To this end, outwardly trust based relationships require maintenance in the form of effective collaborative leadership (Bennis and Biederman 1996).

There are many issues to address, but there are no clear messages about best practice. It is clear, however, that both contracts and alliances need management, leadership and maintenance. Alliances need “governance” arrangements, clear working arrangements and

methods of communication and interpersonal connections. Formal contracts can only set out the basis of agreement – and, as has been said, some contracts may inhibit innovation. There must be high levels of trust between all parties.

Apart from management capacity and capability there are several other barriers that prevent research centres reaching their full potential. These relate to the provisions and administration of the taxation and corporations law that are built around a concept of a single entity rather than a joint venture, strategic alliance, or partnership. Issues arise in relation to taxation liability including capital gains tax, goods and services tax and access to taxation concessions. Under present arrangements taxation accountants and corporate lawyers are diverting resources that could otherwise be used for research to devising elaborate tax effective schemes and risk minimisation joint ventures structures or their clients.

8.7 Collaborations or contracts

Many organizations find the language, principles and concepts of partnering compelling but have difficulty in putting the arrangements into effective practice. Many partnerships and alliances are in fact contractual arrangements with cooperative rhetoric. Moreover, most inter organisational collaborations have involved setting up and managing joint ventures in well-defined areas – designed to contain and share known risks - not to create an expansive future.

In addition, few managers are prepared for a situation in which the boundaries between independence and collaboration are unclear and where there are inevitable (but often known) risks to be managed. This applies particularly in the public sector where issues of probity, accountability and control are high on the agendas of public accounts committees, journalists, public policy academics and other commentators.

Many business organisations and government agencies seek collaborations, but in reality want contracts. They do not want to end up with no results or other surprises at the conclusion of a relationship. There is a tendency within government in particular to deal with alliances through traditional procurement and contracting approaches. A procurement approach tends to concentrate on purchasing a definable service with a strong input and process focus.

The Australian Government's Management Advisory Board, for example, has produced a very useful document, *Before You Sign the Dotted Line*, which includes the Commonwealth's standard form of contract (Australia. Management Advisory Board 2000). The document has an emphasis on control and enforcement and a reduction of the purchaser risk.

In the area of innovation there are some special problems. The way in which the solution comes out cannot always be known in advance because quite often the product is a learning process. Contracting organisations may not be able to correctly articulate their expectations in advance - particularly when they have never experienced the outcome involved.

There is often a tendency for purchase contracts to prescribe a detailed “statement of work” on an assumption that if this is performed a successful outcome will be ensured. This may not necessarily be the case in all circumstances: following a pre-determined and highly structured set of activities may actually reduce the opportunity for innovation. Innovation, by its nature, is a problem solving and issues driven activity. It is also often inspirational. It involves the application of knowledge – both tacit and explicit – and tends to work best under collaborative arrangements.

Collaboration and partnering based on procurement and service contracts involves a commitment on the part of all parties to establish effective working relationships and understandings, and to accommodate changes in expectations when situations and circumstances change and without unduly or unfairly shifting risk to the service provider. Drawing up an appropriate formal partnering arrangement is therefore quite difficult, and there are quite often mismatches between understanding and expectations between the parties. This comes back to a matter of communication as basis for engagement addressed in Chapter 3. There are clear differences between wanting to acquire a capability as opposed to acquiring a commodity or predefined service. Purchaser-provider agreements and policy-administration splits have suffered from this problem (Howard 2000b).

A common problem in procurement based purchaser provider relationships is that purchasers often have a difficulty in making providers do what is wanted, particularly when the specific requirements are not mandated in formal agreements. This matter gives rise to a need to develop “alliance competencies” which differ from the traditional command and control process found in procurement contracting (Howard 2001b). It is also important to establish agreements that are appropriate to innovation, and to have a mutual understanding that evolution is likely to occur. It is therefore necessary to think about arrangements to put in place for change and how any competency gaps might be filled. There may be a need to convince partners to accept a dilution of rewards in order to bring in new competencies.

In other words, if an alliance partner does not have the necessary skills and capability to address a particular issue they should be given the option of either acquiring it at no extra cost

to the organisation or agreeing to the agency acquiring that capably from other sources and a commensurate reduction in cost.

In any partnership arrangement, it needs to be clear that there must be benefits for all involved. In innovation, this might be collective/collaborative learning, for example. Otherwise, the arrangement would be a simple procurement arrangement. There must be effective collaboration and a recognition that alliances cannot be “controlled” by formal systems. This leads to the requirement for a dense web of interpersonal connections and relationships - getting businesses together to enhance learning.

8.8 Summary

Managed relationships are the essence of engagement in a mode 2 society. Innovation, involving multi disciplinary approaches to the development of new products, processes and services occur at the interface between disciplines, higher education institutions and businesses. These managed relationships are *integrative* in their structure and approach. Not only to they transgress disciplines they also have the capacity to work across the diverse purposes and cultures reflected in the engaging institutions.

The institutional framework for public private industrial research collaboration has undergone a substantial evolution over the last decade – the period in which the CRC Programme has been operation. A feature of the evolution is not only the emergence of a greater level of cooperation and collaboration between research providers and research users but also a focus on the *value* of interactions and a growing *marketisation* of those relationships.

With corporations giving greater attention to market relationships in the management of their research program, and the increasing attention of universities and public research organisations on the marketing of knowledge assets, university-industry interactions are increasingly being conducted in a trading relationship.

Loose, opportunistic alliances are giving way to more strategic, integrative forms of engagement. These are much more robust than the “communicative interaction” described in the mode 2 frameworks. This has, in turn, raised the need for management skills and capabilities that are specifically focussed on effective alliance management.

Chapter 9. Community Engagement – Communicative Interaction and Creative Communities

The purpose of this Chapter is to address the third dimension of engagement – the dimension based around the institution of community and based on communication. It is this third dimension that gives effect to “communicative interaction” – the substance of mode 2 thinking, identified in the work of Gibbons and discussed in Chapter 2.

The concept of community recognises the significance of “place and space” in human settlement. It is an area that has been traditionally the interest of geographers, planners and community development practitioners. It has also been of increasing interest to economists who seek to explain locational advantage as a source of competitiveness.

It is not intended that this Chapter canvass the debates about agglomeration theory, which seem to be inconclusive (Krugman 1996). It is intended to draw attention to the role of knowledge in building communities and providing impetus to economic development.

Communication lies at the basis of thinking about the geographic location, knowledge communities and strategies for knowledge based regional development and thinking about community “clusters”.

It has been observed that once a pattern of communication has become established in a community, it will have an important impact on decision making processes – and particularly problem solving activity. A research and development unit that has frequent contact with a sales team and little contact with people involved in basic research will live in a different environment for new product ideas than if the opposite communication pattern were the case (March and Simon 1958).

9.1 Communities, networks and leadership

Notwithstanding the influence and importance of globalisation, informal interactions continue to cement relationships in a complex structure of implicit contracts and understandings. As John Kay (Kay 1996) observes, there are still things that are best done by people who find themselves in the same room. These include: transfer of certain aspects of knowledge and skills; development of trust through shared experiences and values; and non-verbal communication. It is on success in creating networks that facilitate these exchanges of tacit knowledge that many competitive advantages in the world depend.

Throughout history communities have formed around specific standards, doctrines and traditions. Economic communities have come into existence as the definers of individual property rights necessary to make market economies work and as the enforcement institutions necessary to stop people from inside or outside stealing them (Thurow 1998).

Communities, as social institutions, provide comfort, support, and satisfaction in working towards a common purpose. However, communities generally require that individuals conform, obey, and serve the greater good, rather than honouring the individual as a unique contributor to overall capability (Wheatley and Kellnor-Rogers 1998). In this formulation, inclusion in a community involves loss of individual self expression and identity, loss of diversity, and an acceptance of control. Communities spend a great deal of time creating rules, setting standards and laying down doctrines. The processes may differ (from democracy to autocracy), but the outcomes are the same.

In reality, of course, life requires look after two great needs – not just one. In seeking to be members of a community individuals cannot abandon their need for self expression. Even in the most restrictive communities, the need for freedom moves people to the edge (splinter groups, cliques, schisms) and often outside altogether. People move towards isolation to protect individual freedoms and identities. However, isolation also carries a price. This creates a paradox – a need to belong to a community and a need for freedom to act independently (Wheatley and Kellnor-Rogers 1998).

In human communities the conditions of connectedness and freedom are kept vibrant by continually focussing on what is going on at the heart of a community rather than a fixation on the forms and structure. Wheatley observes that clarity of purpose of a community and the nature of relationships does not ask people to forfeit their freedom as a condition of belonging. Belonging is defined by a shared sense of purpose rather than beliefs about specific behaviours. Purpose, a shared commitment to mission and agreement to what is significant are seen to be fundamental to transforming the tension of belonging and individuality into an energetic and resilient community. When these are clear communities can be powerful in creativity as well as diversity (Wheatley and Kellnor-Rogers 1998).

The concept of purpose and commitment to shared mission is associated with the concept of *social capital*. It has been defined in the following terms:

Social capital consists of the stock of active connections among people: the trust, mutual understanding, and shared values and behaviours that bind the members of

human networks and communities and make cooperative action possible (Cohen, Don and Prusak 2001).

The existence of social capital is manifested in high levels of trust, robust personal networks and vibrant communities, shared understandings and a sense of equitable participation in a joint enterprise – all of the things that draw people to a group. This type of connection supports collaboration, commitment, ready access to knowledge and talent and coherent organisational behaviours. Ghoshal and Moran argue that organizations, as social institutions that encourage and support collaboration, represent the embodiment of the nation's social capital, a factor that is being recognised as a key driver of economic growth (Goshal, *et al.* 1999). They argue that:

Successful and innovative companies emphasise the non-market like nature of a company – encouraging people to work collectively toward shared goals and values rather than more restrictively, within their narrow self interests. They can share resources, including knowledge, without having to be certain of how precisely each of them will benefit personally – as long as they believe that the company overall will benefit their collective gain.

Researchers in the area of science and technology policy have argued that without adequate investment in social capital, existing physical capital and human capital can be insufficiently exploited because there is insufficient trust and shared expectations to overcome the inherent risks in knowledge-based interactions.

The concept of social capital is being explored in the United States by researchers and policy-makers because it helps to explain what is seen as the pervasive trend towards greater inter-organisational linkages (partnerships and consortia of various kinds). These linkages are judged to have played a major role in the resurgence of the US economy in recent years. As Fountain observes:

Many firms, industries, and regions that are currently successful have formed productive collaborative relationships with a variety of other firms, laboratories, universities, and governments at both state and federal levels in order to leverage the benefits of co-operation. These benefits include shared resources, shared staff and expertise, group problem solving, multiple sources of learning, collaborative development, and diffusion of innovation (Fountain 1998).

The social capital concept provides policy-makers with a means of explaining why collaborative networks are playing an increasingly important role in university-industry interactions (and in the economy in general). It also highlights the importance of modernising those aspects of government policy that can act as impediments to network-evolution.

Scrutiny of overseas models does however raise a concern that too rigid an approach to network-building is being adopted. Science and innovation networks require *flexibility*: the ability to build and re-configure linkages as learning takes place and events unfold. Rigid network financing (such as in the NCE model) risks ‘freezing’ networks with too limited a capacity to admit new members and re-configure them. This rigidity has to be avoided as it can undermine the core strength of science and innovation networks (Australia. PMSEIC Independent Working Group 2001).

Hargadon in *How Breakthroughs Happen* has argued that the companies that have demonstrated a capacity for sustained innovation have had a strategy for exploiting the networked nature of the innovation process. He notes that these companies do not necessarily produce fundamentally novel advances in any one technology or dominate in any one industry, but they combine existing objects, ideas and people “in ways that, nevertheless, spark technological revolutions” (Hargadon 2003). This observation has been made by Ganguly in *Business Driven Research and Development* (Ganguly 1999) and is the essence of the mode 2 perspective on engaged knowledge production (see Chapter 2 above).

Information and knowledge sharing in a community context involves the *voluntary* act of making it available to others. It is distinguished from reporting – which involves providing information and knowledge on a routine or structured basis. Reporting is the most common form of knowledge exchange in an organisational setting where knowledge tends to follow formal organisation structures and hierarchies.

The way in which knowledge and information is shared is determined in large measure by the attitudes and behaviours that constitute the *information and knowledge culture* – the pattern of values and beliefs that express an orientation towards information. Cultures can be open or closed, factual or rumour oriented, controlling or empowering. The culture impacts in the way in which people acquire information and knowledge as well the way in which they use it, interpret and modify it, share it, and hoard it. Studies have concluded that a supportive culture for acquiring and sharing information is correlated with higher innovation and scientific and engineering productivity (Davenport and Prusak 1997a).

In any networked setting those who control the right information have the most power. Barriers to information flow include functionally based information systems, incompatible information architectures and “political and cultural differences that can be reinforced as early as the university training of future scientists, engineers, marketers and accountants” (Davenport and Prusak 1997a). Increasing the flow of knowledge and information does not

happen by simply mandating it. It requires changing ways in which performance is measured and rewarded, and understanding competing subcultures.

North American and European business practices have not generally advocated information sharing cultures and have sought to restrict sharing to within the corporation. But some firms have found that sharing information with business partners and competitors has advantages. In the ICT sector, for example, where customers use products from multiple vendors, and want to be able to contact a single source for advice and assistance, companies share their knowledge so that customer service can be executed seamlessly (Davenport and Prusak 1997a).

It is also inappropriate, and sometimes illegal, to share information within a community setting. This includes restrictions relating to insider trading, company performance, competitive secrets (including but not restricted to IP) and personnel information. People are often reluctant to share information if it could be advantageous (or detrimental) to their career prospects, particularly if they are suspicious that others will claim the information as their own. The barriers to sharing information are often deeply embedded in the information politics of an organisation, network or community. In order for knowledge and information behaviour to shift, divisive political structures may also have to shift (Davenport, *et al.* 1993).

Davenport concludes, on the basis of a number of studies, that information sharing in companies is “almost an unnatural act”. He argues that in order to manage the communication or sharing of information effectively those in charge need to set up standards for how employees decide what information to share and with whom to share it. Managers are advised to not only model the right behaviours themselves but also remove the organisational barriers to information sharing – be they political, emotional or technological. At the same time, managers surveyed were aware that improving a firm’s use of information can make or break a business (Davenport and Prusak 1997a).

Contemporary management literature has emphasised the criticality of building trust in the institutions of engagement. Markets, organisations and communities work best when there are high levels of trust among the participants (Fukuyama 1995). In the community arena trust is the vital attribute that works towards overcoming the barriers to knowledge and information sharing. Trust is embodied in the concept of social capital referred to above and which has been popularised in the science and technology literature. It is seen to be at the basis of successful research collaborations. It is, however, much easier to assert that trust is important than it is to create it. Creation of trust is a matter of leadership.

There is an extensive management literature on leadership. Much of the literature emphasises a dichotomous relationships between leadership and management. Whereas management is essentially roles based, emphasising organisational performance and relating to control, leadership is values based, emphasising a community culture. Leadership is essential for creating trust and ensuring that collaboration happens. Warren Bennis in *Organising Genius: The Secrets of Creative Collaboration*, a study of successful research and development collaborations found that effective collaboration requires a person who “acts as maestro, organising the genius of the others”. He identifies the leadership skills in the following terms:

Within the group, the leader is often a good steward, keeping the others focussed, eliminating the distractions, keeping the hope alive in the face of setbacks and stress. One of the simple pleasures of Great Groups is that they are almost never bureaucratic. People in them feel liberated from the trivial and the arbitrary. Often everyone deals with the leader, who can make most of the decisions on the spot (Bennis and Biederman 1996).

In these terms *leadership* is the driver of the community based institution of engagement.

9.2 Location, creativity and innovation

Geographers are attaching importance to the concept of community and the way in which it facilitates creativity through interactions between people and groups. Richard Florida has argued that rather than being driven exclusively by companies, economic growth has been occurring in places that are tolerant, diverse and open to creativity – because they were places where people of all types wanted to live (Florida 2002). He argues that:

It is often said that geography is dead in these times of high technology and communication. This could not be further from the truth. Place has become a central organising unit of our time, taking in many of the functions performed by firms and organisations. Corporations used to attract people and provide long-term employment. Today, corporations are far less committed to their employees and people change jobs frequently, making the employment contract more contingent. It is geographic place rather than the corporation that provides the organisational matrix for matching people and jobs. Access to talented and creative people is to modern business what access to coal and iron ore was to steel making.

Creativity has been identified as a driver of innovation in a number of studies, research projects and publications on innovation and business development. It is also reflected in the work of the Australian Chief Scientist in the *Chance to Change* and in the Report of the Innovation Summit Working Group. The dimensions of creativity are identified by Florida in the following terms:

- Creativity is not the same as intelligence
- It involves the ability to synthesize – sifting through data, perceptions and materials to come up with combinations that are new and useful – to produce a practical device, a theory, insight that can be applied to solve a problem, or work of art that can be appreciated
- It can be subversive in that it disrupts existing patterns of thought and life – destroying something to get a better one
- Technological creativity (invention), economic creativity (entrepreneurship) and artistic and cultural creativity are deeply interrelated
- People are the main source of creativity – for ideas.

Instead of communities being defined as close associations with deep commitments to family, friends and organisations, creativity occurs where people can make friends and acquaintances easily and live quasi-autonomous lives. These weak ties replace stronger bonds that are more typical of communities built around strong values and norms (social capital). In this regard creative capital is not the same as social capital. It has been argued that social capital can actually stifle innovation (Florida, *et al.* 2002).

The rise of creativity as an economic force is considered to have brought new economic and social forms into existence. Everything from the rise of the entrepreneurial start-up to the formal venture capital system to the loosening of cultural norms regarding work and life is seen to reflect attempts to elude the structures of organisational conformity where products are created through the action of knowledge on knowledge. Large organisations are still needed, however, to manufacture, market, and distribute the devices in which that knowledge is embedded (Florida 2002).

The value of creative capital, built around the institution of place and space has prompted governments to initiate programs to encourage the formation of knowledge clusters. Policies and programs also support strategies of civic entrepreneurship (Henton, *et al.* 1997), which pre-suppose an organisational and leadership function. There is, however, a difference between creative communities that emerge on the basis of the loose ties generated by the amenity of place and space and the engagement organisations that are created and managed as alliances, partnerships and joint ventures.

The most celebrated knowledge cluster is Silicon Valley. It reflects the synergistic development of high technology firms through linkages between the finance sector, a strong entrepreneurial culture, corporate research laboratories and higher education institutions. Silicon Valley and the Boston area of the United States have been observed as creating an

internal dynamic that supports and mutually reinforces interaction between universities, entrepreneurial and innovative businesses and the venture capital sector and business (Saxenian 1996).

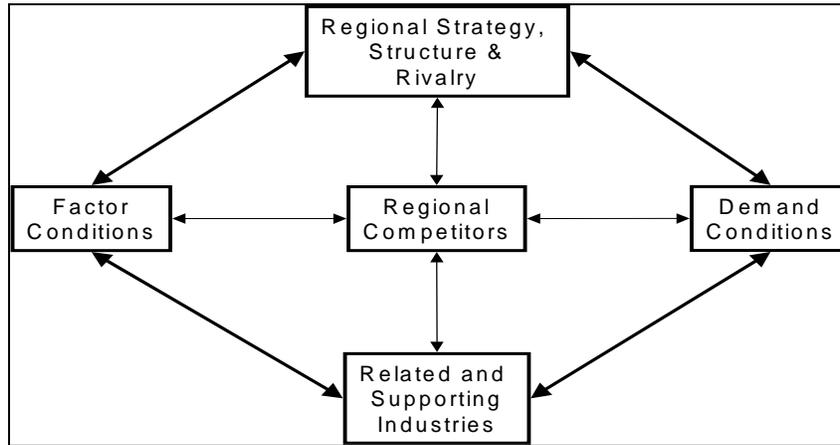
Cluster analysts argue that information and knowledge become embedded within a region when regional resources become difficult to replicate and imitate in other areas. This depends on historical conditions, the existence of tacit, complex and specific knowledge that is unique to the region, the social interaction of the participants and the openness of communication. Silicon Valley is probably the exemplar of this situation – and is in many respects a special and unique case (Saxenian 1996). It is also difficult to replicate.

Potentially, clusters allow participants to benefit *as if* they had greater scale or *as if* they had joined with others formally – without being required to sacrifice flexibility. They impact on competition through increasing the productivity of companies based in the area through factors such as access to suppliers, complementarities, access to institutions and public goods and motivation and measurement. Clusters are also seen to stimulate the direction and pace of innovation and the formation of new businesses, which expands and strengthens the cluster itself.

The definition of a cluster raises some important conceptual issues. While it is possible to identify similar types of institutions and firms set up in specific geographical areas, or in precincts within cities and regions, this does not imply economic integration or substantial collaboration. In this respect, it is important to distinguish between “clusters” and “co-location”. Co-location is often impacted by statutory land use planning, availability of land and property development considerations. *Co-location does not equate with collaboration.*

In addition to geographers, economists have also made contributions to regional development. Their interest tends to be in the way in which competitive advantage is developed and created. Economic development frameworks have been used to explain the circumstances in which investment should take place and the economic impact in terms of income and employment. The Porter “five forces” model is probably the most enduring in the economic development literature. This is shown in Figure 10.

Figure 10: The Porter Five Forces Model



Source: Adapted from Porter, M., *Competitive Advantage* and other publications.

While the economic development literature identifies the *pre-conditions* for investment to take place, it does not necessarily explain the *necessary conditions* that will encourage an investor to take a decision to allocate funds to build a business. Economists cannot explain, for example, why two regions with nearly identical factor and demand conditions, equally articulate strategic plans, and available supporting industries, do not develop in the same pattern (Krugman 1996). To answer the question why some regions do better than others in relation to the creation of wealth it is necessary to move from economics to the disciplines of management strategy and the way in which assets are turned into competitive advantage.

A region's strategic assets will be converted into competitive advantage through the development and exploitation of its *distinctive capabilities*. Distinctive capabilities are the characteristics that set a region apart from other regions and provide the foundation for establishing competitive advantage. The identification, development and marketing of a region's distinctive capabilities is critical for the realisation of strategic objectives and plans.

There are four broad areas of distinctive capability:

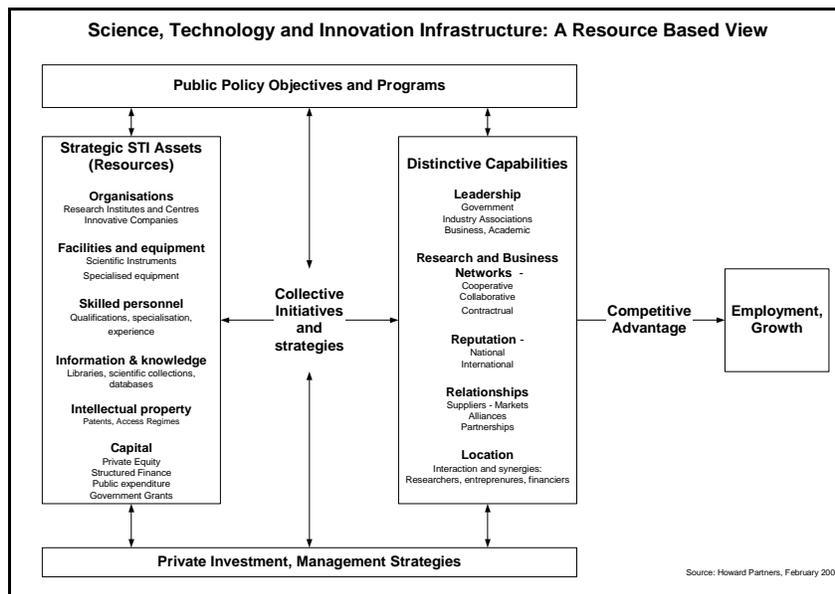
- A capacity to stimulate and implement innovation – a strategy that emphasises developing what a region does well, not what others do well. Innovation is generally based on an entrepreneurial culture and willingness to develop and commit to new business opportunities.
- A reputation within business and the community for stability and fair dealing.
- Community and regional leadership in planning, organising and implementing development strategies.

- A flexible and responsive system of government-business relationships – reflecting a co-operative ethic and willingness to work in partnership with business; there is a balance here between “doing business” and “conflict of interest”, a matter which has received some attention by Auditors General and anti corruption bodies.

Distinctive capabilities are, of course, hard to create. If they were easy to establish, they could be easily replicated and would not be distinctive in the longer term. Nonetheless, the existence of distinctive capabilities is a major factor in the investment decision making process. Distinctive capabilities and competitive advantage must be sustainable over time and capable of realising a net benefit to the community. Regional success is achieved when people and organisations responsible for purchasing, investment and location decisions are consistently willing to make those decisions on terms and conditions that they would not undertake in other cities or regions.

The relationships between strategic assets, distinctive capabilities, and competitive advantage are illustrated in Figure 11.

Figure 11: From strategic assets to distinctive capabilities



Source: Adapted from Kay, John, *Why Firms Succeed*.

This framework was developed by the author and applied in the audit and review of Victoria’s science and technology infrastructure. It provided an important way of thinking about the relationships between strategic assets and competitive advantage through the prism of distinctive capabilities. The main focus of the audit and review was on identification of strategic assets – as distinct from counting machines and buildings. The framework also

provides a conceptual link between industry, higher education institutions, research institutions and government (Howard and Johnston 2000). The findings of the audit and review have not been published.

A focus on strategic assets and distinctive capabilities provides a more robust approach to thinking about knowledge clusters and the interactions between business networks, reputation, relationships and leadership. Research and reports indicate that leadership is an essential ingredient for success in knowledge based regional economic and industry development (Walshok 1995; Walshok, *et al.* 2002).

9.3 The role of higher education in regional development

Porter argues that clusters reveal the mutual dependence and collective responsibility of business, research organisations and government for creating the conditions of productive competition. He suggests that the development task requires fresh thinking on the part of leaders and the willingness to abandon the traditional premises that drive thinking about who does what in the economy (Porter 1998a). In particular, there is a blurring of the lines between public and private investment:

- Companies, no less than universities, have a stake in education
- Universities have a stake in the competitiveness of local businesses
- Governments can achieve a great deal through information dissemination rather than through public expenditure.

Higher education institutions are often involved in sponsoring and supporting science and technology parks as a way of providing support for businesses. There are several other features to have in place before a technology park can be considered to be cluster in the sense that it is being used here. A science and technology cluster is where separate institutions, in combination and collaboration, build a critical mass of utilisable knowledge that is shared between institutions and organisations. This is important in medical research and biotechnology related drug discovery where there is a requirement for scientists to work together in a multi-disciplinary approach. Innovation is likely to come from discoveries in genetics and identification of new targets for drug design. These opportunities will be achieved through close working relationships between geneticists, molecular biologists, chemists, pharmacologists, toxicologists and clinicians.

In North America, Europe and Australia, state and local governments and universities have been actively involved in promoting the development of knowledge based industry clusters.

While businesses and research facilities cannot be forced to locate in a specific area, a combination of infrastructure support, statutory planning instruments and an institutional climate that encourages university-industry collaboration are important for businesses, both national and global, to make the decision to invest.

The economic benefits associated with clustering flow from an integration of technology development activity with commercialisation of research outcomes. Invariably, this involves the presence and commitment of a large company with its own research commitment together with product development and marketing (including market access) capability. With Australia's small population base, global market access is a critical success factor for Australian science, technology and innovation effort.

Recent research has suggested that clustered firms do not get a free ride on knowledge spill overs – the pervasive pool of knowledge in the cluster. Rather, the opposite is the case: agglomerated firms provide less breakthrough innovations. The benefit arises from obtaining an edge in finding new markets and customers and tailoring products and services for them. In contrast to technological information which is not geographically bound, market information, covering industry trends, market niches and customer needs is considered to be easier to acquire when a firm is in a cluster. Non-agglomerated firms may be able to provide more breakthrough innovations, but they are more likely to miss out on market entry opportunities or be unaware of markets that are emerging (Yu 2002).

The geographic positioning of a large organisation, that has many suppliers and a broad base of clients and customers, as well as access to common infrastructure will generally flow through to decisions of smaller organisations to locate within close proximity. Close physical proximity reduces transaction costs and increases returns. It may increase local employment – but not necessarily impact on innovation.⁴⁵ Town planning schemes and zoning regulations may also influence co-location decisions.

Australian regional economic development strategies have had little involvement of higher education institutions. Beyond support for technology parks and revenue earning infrastructure, higher education has rarely been involved as a leader in economic development through attracting and appointing top faculty and students as a way of building engagement with industry and government. A disappointing aspect of the recently released *Plan of Action*

⁴⁵ Large manufacturing assembly plants are a good example. They create many jobs and opportunities for component suppliers.

for *Regional Business* is that it made no mention of the role of higher education leadership (Australia. Regional Business Development Analysis Advisory Panel 2003).

In a study undertaken in 2000 it was concluded that universities and regions need to focus more on graduate regional labour market outcomes. In relation to achievement of agreed regional economic development outcomes it was concluded that there are no easy solutions to engagement and that each region and campus should not expect that outcomes would automatically occur as a result of a policy change or a program delivered by government. Consistent with overseas practice, it was observed that effective engagement requires particular effort by all parties at the local level. The study also notes that social capital is a significant 'untraded' but highly undervalued determinant of regional economic development outcomes (Garlick 2000).

9.4 Knowledge communities and leadership

The defining characteristic of successful community engagement is leadership. Leadership emanates from a variety of sources, such as local government, service organisations, higher education institutions, managers of devolved government programs - or simply highly motivated individuals. For knowledge based regional development, higher education institutions have a critical role in providing leadership (Walshok, *et al.* 2002).

The key role of higher education institutions in regional economic development relates to their potential to incubate innovations and transfer commercial technology and, perhaps more significantly, to attract *talent* – the people who are likely to form entrepreneurial companies and work in technology based manufacturing businesses. These knowledge workers also become the “receptors” for university generated discovery and invention. Richard Florida has pointed out:

The labour market for knowledge workers is different from the general labour market. Highly skilled people are also highly mobile. They do not necessarily respond to monetary incentives alone; they want to be around other smart people. The university plays a magnetic role in the attraction of talent, supporting a classic increasing returns phenomenon. Good people attract other good people, and places with lots of good people attract firms who want access to that talent, creating a self-reinforcing cycle of growth (Florida 1999).

Florida argues that a key, and all too frequently neglected, role of the university in the knowledge economy is as collector of talent which supports the location and growth of technology companies. But the university is only part of the system. It is up to companies, business networks and economic development agencies to put in place the opportunities to

make the region attractive to that talent in the longer term. These opportunities are generated from a position of strength in the institutions of engagement – particularly local councils.

Technology regions such as Silicon Valley, Boston, Austin, San Diego, and Cambridge all developed with regional leaders in collaboration with university administrators taking aggressive measures to build facilities, encourage venture capital, provide amenities and the environmental quality demanded by knowledge workers. Success has been associated with a substantial element of strategy and coordination in implementation (National Governors Association 2002a, 2002b; Walshok, *et al.* 2002). Leaders in Australian regional universities, such as the University of New England, are beginning to take on this role (Howard 2003b).

Most Australian governments have had in place regional policies and strategies designed to achieve economic and industry outcomes for many years. A significant element of regional policy has been linked to sustainability in agriculture and rural based manufacturing industries. The Commonwealth and the state governments have at various times initiated growth centres and decentralisation policies and programs and provided specific assistance to businesses prepared to locate (or stay) in regional areas.

During an evaluation of the Local Government Development Program (Howard 1998b) it was apparent that there was a general acceptance that the Commonwealth Government had a role to play in supporting institutional strengthening and capacity building as a basis for ensuring that the funds provided under specific support programs, such as Financial Assistance Grants, are spent efficiently and effectively, and facilitate the implementation of national policies and programs in other areas – such as industry development, telecommunications, the environment and sustainable resource management.

Commonwealth government interest at the regional delivery level has been centred on industry development, telecommunications, and more recently environmental sustainability and preservation and restoration of natural capital through initiatives such as the Natural Heritage Trust. Only a small number of Councils in Australia have demonstrated a commitment to knowledge based regional and economic development. There is, however, a substantial commitment on the part of state governments to attract public funding for research and development into their states and regions.

9.5 Summary

Location is an institution of engagement that complements engagement built around markets and management. But just as these engagement market and management based institutions require investment in institutional capacity building, so too does community based engagement. Those institutions must reflect leadership and build a culture for effective communicative interaction.

Communicative interaction is at the core of the concept of a mode 2 society. However it is possibly the most difficult mode of engagement to create and sustain in that it relies heavily on building common and shared perceptions and expectations between participants. These are essentially non-market and non-organisational behaviours.

State based science and innovation strategies have given a great deal of focus to investment in infrastructure and encouraging the re-location of research facilities and centres. They have not focussed as much on the development of leadership capacity and capability. Very few local councils in Australia have an economic development strategy based on knowledge, although this is changing.

Higher education institutions are in a position to commence building engagement institutions in partnership with state and local government and businesses. It means, however, that higher education institutions must begin to engage with their communities and see this as critical for their viability. It means, first and foremost, attracting top talent into their faculties and consolidating this with institutional strengthening at the interface with local government and business.

Chapter 10. From Industry Policy to Science and Innovation Policy - Issues and Implications

The purpose of this Chapter is to examine the role of public policy in supporting engagement. To set the context a brief history of public policy in science and technology is provided followed by trends and developments during the 1990s in the context of policies and strategies designed to capture the employment and wealth outcomes of the knowledge economy.

This is followed by a discussion of the implications of the move from a focus on industry policy to one centred on science and innovation policy that is built around the commercialisation of publicly funded research. It is suggested that, in the context of engagement discussed in the earlier chapters, such a policy could be misplaced and misdirected. A more appropriate policy would be directed towards institutional strengthening and building capability to ensure the effective working of knowledge markets, industrial research partnerships and knowledge communities.

10.1 The evolution of science and technology policy

During the 1970s the Australian government became concerned about the competitiveness of the manufacturing sector and the need for policy responses (Australia. Committee to Advise on Policies for the Australian Manufacturing Industry 1975). There was also concern about the impact of technological change (Australia. Committee of Inquiry Into Technological Change in Australia 1980). But the impact of the resources and agriculture sectors overshadowed these concerns and there was little in the way of policy initiative. At the end of the 1970s Australia was in the midst of a resources boom. Policy was directed at the time towards ensuring that Australia *imported* enough to balance the trade surpluses generated by commodity exports. Very little attention was given to value added processing, particularly in food.

The election of the Labour Government in 1983 involved a new approach to economic and industry policy (Sheehan, *et al.* 1994). There were several strands: the Prices and Incomes Accord, aimed at stabilising wages and prices, deregulation of financial and foreign exchange

markets, tariff reductions, specific (manufacturing) industry sector support programs⁴⁶ and a program of “microeconomic reform”. Apart from sectoral policies, microeconomic reform continued to be the basis of Australia’s industry policy well into the 1990s.

Writing in 1992, political scientist and policy analyst Jenny Stewart observed that Australia’s science and technology policy framework has been characterized as resources first, science second, technology third. This was seen to capture both the “undeniable *raison d’etre* of the Australian economy as well as the relatively low place accorded technological development in official Australian thinking on industry needs”. Stewart argued Australia had no technology policy as such – that is, no definitive statement of the means to be employed to enhance the generation and use of new, industrially relevant knowledge. Australia was seen to have an industry policy with some technological elements to it and a science (or more accurately a research) policy, but the bind between the two – technology broadly defined – escaped detailed consideration (Stewart 1992).

Up until the mid 1990s science and technology policy had a varied track record. To a significant extent policy had been driven by the CSIRO and the research funding agencies with an objective of keeping science out of politics. The policy focus was therefore largely mission orientated, involving the launch of strategic sectors (such as medical research) with an emphasis on the generation of technological innovations and support of national champions.

During the early 1990s Australian and state governments grappled with debates over industry policy. Industry policy was generally associated with protectionist manufacturing industry policies of the post war era. The Commonwealth government, elected in 1996 with strong economic management credentials, had been reluctant to have an interventionist industry policy. The National Commission of Audit, reporting in 1996, captured the prevailing view in public policy with its comment that:

Governments have a responsibility to ensure that taxpayer funds are used where they will deliver the greatest benefit to the community. Governments also have to balance calls for new or increased government expenditure with the broader community’s willingness to fund government services through increased taxation or reductions in other areas of government expenditure (Australia. National Commission of Audit 1996).

⁴⁶ Sector specific polices were developed for: pharmaceuticals; information technology industries; telecommunications; motor vehicles; shipbuilding, and clothing.

There was also a strong view sourced from economists and management consultants that government needed to be “reinvented”. The main thrust of the reinvention argument was that while government should take responsibility for deciding what services should be provided it did not necessarily have to produce them (Osborne and Gaebler 1992). Outsourcing, contracting and purchaser-provider relationships were seen to be capable of delivering efficiencies and savings in public expenditure. Outsourcing and contracting were seen to provide opportunities for private sector industry development. These considerations reflect the strong influence of economics in public policy. To that extent, industry policy had been, and continued to be built around the strategy of microeconomic reform, where the market mechanism was seen to be the best way of allocating resources.

The justification for economic influence in policy was offered by Bob Gregory, an ANU economist in a paper in 1992:

The proposition that the demand for microeconomic reform is the result of more economists in positions of power must be taken seriously because there is a simple correlation between the number of public sector economists and the bureaucracy’s endorsement of microeconomic reform and political advocacy of the program. Although it must be true that these economists are exerting some influence I do not believe that they are the fundamental source of demand. They have provided a coherent rationale for microeconomic reform and have facilitated the selling of the idea. They are, however, more a messenger than a demand source (Gregory 1992).

The strong influence of economists in public policy was referred to as economic rationalism and was the subject of a great deal of criticism. The works of sociologists (Pusey 1991) and political economists (Quiggin 1996) did not make a substantial impact in altering policy direction. There were strong academic defenders (Forsyth 1992; James 1993). There was a political science and public policy critique but this had been largely in the form of description and commentary reflecting the mode 1 orientation of public policy research (Kelly 2000; Singleton 1997, 2000; Weller and Davis 1996; Weller, *et al.* 1993). Unlike economics, academic public policy did not offer prescriptions or workable alternatives. The publication of a critique by respected economist Russell Mathews in 1997 possibly marked a turning point (Mathews and Grewal 1997).

Industry policy based on industry economics and a microeconomic reform is useful for rationalising and explaining firm behaviour at the industry level, but it has little influence or impact on addressing how business people make decisions. There is little recognition in this area of policy that different *businesses* constitute industries and that it is *business decisions* that collectively, have economic impact. Business people make decisions on the basis of

business strategy, not economics. The economic input into business decisions is minimal (Kay 1996).

Economists tend to base their analyses on the “representative” firm and their models and theories are not particularly useful to business people. *Management strategy* is of interest to business people. Few companies have an economic adviser, except in the form of a chief economist. These companies are mainly found in the finance sector. Notwithstanding the importance of business to the economy in a microeconomic reform environment of deregulation and privatisation, economics continues to dominate public policy. Few economists working in government have had business experience.

Microeconomics sheds very little light on how firms behave and make decisions. Michael Porter has taken economics to business leaders, but Porter’s approach to competitive advantage is much less successful when applied to the firm as distinct from the industry and the economy (Kay 1994). It follows that reconciling economic and business approaches to public policy has been an important issue in industry policy and later in science, technology and innovation policy.

From 1997 a frustration among policy makers began to emerge in that the microeconomic reform agenda was not delivering in terms of economic growth and employment. There was, however, no desire to return to tariffs and industry protection. Governments started looking around for ways to get the economy going. The emergence of new growth theory and the arrival of the concept of the new economy provided a springboard for a debate about new policy directions. This debate involved government and industry associations which were broadening their interests from the traditional concerns with industrial relations.

From the beginning of the 1990s the OECD had been doing a large amount of work on the knowledge economy, venture capital and advocating investment in research and development (OECD 1992, 1996a, 1996b, 1996c, 1997). A major focus of the debate in Australia was the weak performance in industrial R&D and what the government should do about it. This is reflected in the Australian Business Foundation sponsored *The High Road or the Low Road* (Marceau, *et al.* 1997) and the Australian Industry Group sponsored *Make or Break* (Economist Intelligence Unit 1997). This work drew heavily on the work of the OECD and highlighted the link between academic science, investment in industrial research and development and economic prosperity. It also drew attention to linkages between university research, technology based start-up companies and the venture capital asset class as a new form of investment in knowledge capital.

The research undertaken was very much in the mode 1 style of knowledge creation. It was based on the analysis of data through the methodology of observation, analysis, description and explanation. An integrating disciplinary framework was provided by new growth theory, which highlighted the contribution of technological change to economic development, and causality was related to investment in science. High levels of patenting were associated with high levels of sectoral growth across industries. At the same time, higher education institutions were seen as becoming more entrepreneurial and there was widespread support for the notion of convergence between universities and business (Etzkowitz, *et al.* 1998).

The research was attractive in a policy sense in that it provided a model and a basis for government initiative: more investment in public research would lead to industrial growth and economic development through the creation of new businesses exploiting discoveries and inventions made in higher education institutions. The excitement attached to the potential of biotechnology in resolving problems in human health and the possibilities in the application of information and communications technologies fuelled the policy agenda. The initiative in industry policy shifted from industry Ministers to science and technology Ministers.

In undertaking this policy related research there was very little engagement with industry. In fact the research agenda suggested that there was no real need as future prosperity was seen as coming from newly created businesses based on the commercialisation of science and technology rather than from investments by existing ones. Concepts of creative destruction, drawn from the insights of Joseph Schumpeter (Schumpeter 1954, 1989) were also called upon and given credibility. However, research and case studies conducted in North America had been questioning the role of universities as drivers of industrial innovation based on case study analysis and extensive consultation with businesses (Rosenberg and Nelson 1996a, 1996b).

The microeconomic approach to industry policy persisted in a number of reviews and inquiries undertaken in 1996 and 1997. The review of business programs, completed in 1997, advocated a winding back of industry support programs (Australia. Review of Business Programs 1997). The Government's approach to industry policy was set out in a statement by the Prime Minister in 1997, *Investing For Growth* (Australia. Prime Minister 1997). This paper sought to enhance the prospects for growth and strengthen the capacity of Australian industries by increasing support for business research and development and the commercialisation of that research, making investment in Australia more attractive, building Australia's strength as a trading nation, improving the attractiveness of Australia as a

financial centre, and helping ensure that all tiers of government, business and the community at large maximise the opportunities (Australia. Prime Minister 1997).

Investing for Growth contained the beginnings of a science and technology policy focus through its commitment to increasing expenditure on research and development. A science and technology policy focus provided the basis for moving away from the microeconomic reform and industry economics basis for promoting industry development. Science and technology policy places scientists in the position of promoting the agenda of employment and income generation, particularly through the creation of new businesses based on the commercialisation of technologies. There was a view that science must do the task that business is not doing. Science and science policy academics and advisers had advocated a policy and set of programs built around a lead government role in the increased government support for public research and development and commercialisation of scientific discovery.

As the causality in the relationship between investment in research and development and commercial outcomes was not clear, the policy attracted the interest of a range of advisers and consultants eager to offer advice on how the processes work and to plug gaps in what was seen as an “innovation progression” path or to remove blockages in a perceived “innovation pipeline”.

From 1997 there was also a growing interest in the venture capital asset class and its role in stimulating business growth and employment and its association with the commercialisation of research and development. The publication of the Coopers & Lybrand survey, *The Economic Impact of Venture Capital* in 1997 created a great deal of interest in the policy arena (Coopers & Lybrand 1997). Initially dismissed by public service economists as not being statistically robust, Ministers became interested in the issues of venture capital investment and the finance of new technology based firms. The support from the Industry Research and Development Board led to the introduction of the Innovation Investment Fund (IIF) Program in 1998. The program had as its main focus the commercialisation of research. As it has turned out, and with the exception of biotechnology, the IIF has done little in this regard. More targeted programs such as the Renewable Energy Equity Fund (REEF) have done more to pull through promising technologies.

Recognition of the importance of the new economy and emerging industries and technologies began to take hold in public policy in 1999. The overwhelming interest in science policy was the commercialisation of university research. This interest is reflected in a very high level of

review work that entered into the public arena. In 1999 the following reports and papers were released:

- A Report from the National Health and Medical Research Council, *The Virtuous Cycle: Working Together for Health and Medical Research (Australia. Health and Medical Strategic Review 1999)*
- *New Knowledge, New Opportunities*, a policy paper from the Minister for Education, Training and Youth Affairs (Australia. Minister for Education Training and Youth Affairs (Hon. David Kemp MP) 1999)
- A Discussion Paper from the Biotechnology Task Force, *Developing Australia's Biotechnology Future (Australia. Biotechnology Task Force 1999)*
- A Report from the House of Representatives Standing Committee on Industry, Science and Resources, "The Effect of Certain Public Policy Changes on Australia's R&D" (Australia. House of Representatives Standing Committee on Industry Science and Resources 1999)

In 2000 more reports were issued:

- A Discussion Paper and Report by the Chief Scientist, *The Chance to Change (Australia. Chief Scientist (Dr Robin Batterham) 2000a, 2000c)*
- A Report from the Australian Research Council, "Research in the National Interest: Commercialising University Research in Australia" (Australia. Australian Research Council 2000)
- The Report of the Innovation Summit Implementation Group *Unlocking the Future (Australia. Innovation Summit Implementation Group 2000)*

In 2001, the following papers were released

- A Report from a PMSEIC Working Group, "Commercialisation of Public Sector Research" (Australia. PMSEIC Independent Working Group 2001)
- A Report from the Department of Agriculture, Fisheries and Forestry on, "Innovating Rural Australia: Research and Development Corporation Outcomes" (Australia. Department of Agriculture 2001)

This level of inquiry and reporting was also evident in Canada (Canada. Expert Panel on the Commercialization of University Research 1999; Canada. Prime Minister 2001a, 2001b; Canadian Institute for Advanced Research 1995), Great Britain (Great Britain. Cabinet Office 1998; Great Britain. Department of Trade and Industry 1988, 2000; Great Britain. Parliament 1998) and the United States (United States. Committee on Civilian Industrial Technology 1996; United States. Council on Competitiveness 1998; United States. Department of Commerce 1995, 1997; United States. General Accounting Office 1998).

The general thrust of the arguments was captured by the Chief Scientist in *The Chance to Change* that it is "vital that appropriate mechanisms and incentives are in place" to ensure that ideas and technologies generated by the science, engineering and technology (SET) base are

converted into wealth and jobs so that the community can get the best possible return on its investment”. The discussion paper states:

This involves strengthening the links in Australia’s innovation network by bringing universities and businesses closer together, and by providing researchers with the skills and incentives to take their ideas to the market – that is, encouraging commercialisation and connectivity in Australia’s SET base (Australia. Chief Scientist (Dr Robin Batterham) 2000b).

Similarly, the Innovation Summit Implementation Group (ISIG) argued that:

Maximising the outcomes of investment in public sector research will create new business opportunities, jobs and exports. However, there is a perception that public sector research in Australia is somewhat less than commercially orientated and that this needs to be addressed. Where there is a commercial orientation, there is often a lack of expertise in valuing and managing Intellectual Property, business planning and business management. If we do not have the skills to manage commercialisation well, we cannot expect healthy returns from our investment and efforts.

The Virtuous Cycle pointed out that collaboration between top researchers and new business enterprises has a positive effect on the enterprise’s products in market, products in development and employment growth. The report also noted a comparatively low level of involvement by Australian researchers in new business enterprises (Australia. Health and Medical Strategic Review 1999).

The process ended with another policy statement by the Prime Minister in 2001. *Backing Australia’s Ability: Real Results, Real Jobs* (Australia. Prime Minister 2001). The statement reflected a recognition that the role of government in a modern economy is incompatible with conducting activities too close to the market: what is left for government is -

- Building up infrastructure – including human resources
- Support for networking activities – such as human mobility
- Financing research programs in basic pervasive technologies – promoting the notion of generic technologies
- Provision of science and technology services, education and training at the national level – leading to better public understanding of S&T.

Backing Australia’s Ability has a focus on investment in basic research and an orientation towards encouraging growth in the life sciences (specifically biotechnology) and information technology and communications industry sectors through encouragement and support for “centres of excellence” and major research facilities. Its focus is on pre-competitive research and generic commercialisation strategies, thus avoiding the criticism of “picking winners”.

In all of this work a great deal of faith was placed in the capacity of scientific research and development to deliver wealth. It amounted to a very strong science and technology push in industry policy. Inevitable there has been a reaction from business.

10.2 Reactions to the science and technology push

Science had successfully advocated a policy and set of programs built around a lead government role in the commercialisation of scientific discovery and research and development. This reflects the trend towards science-based innovation. However, it does not address, or even relate to other forms of innovation, and the domain gets confused. These programs are largely based on a strategy of diffusion and communicative interaction but do not address the way in which science *engages* with business.

Whilst policy has concentrated on stimulating research and development as the basis for business ventures, even to the extent of providing finance for venture creation, it has done less to support the development of management capacity and capability required to create the customers and the markets where financial returns from the products and services associated with scientific discoveries and inventions can be realised. But this is, fundamentally, a task for business operating on a platform of competition and commercial drivers. Public policy should focus on the institutions of engagement – not the institution of business itself.

In a number of respects public policy interventions might be of greater significance in identifying and supporting institutional developments along the value chain, such as technology markets and effective business relationships between research institutions and businesses that will adapt and apply scientific discoveries and inventions created in a research environment. This includes strategies such as a supportive business environment and foreign direct investment.

The start-up business model is largely confined to the sciences and information and communications technology sectors. Notwithstanding the level of support for start-up initiatives, policies that encourage the growth and location in Australia of businesses that will acquire the output of those start-ups (and even the start-ups themselves) in a supply chain context through foreign direct investment policies, is largely absent. Thus, the potential for the commercialisation of research in biotechnology through new business start-ups will be limited by the absence of pharmaceutical companies to acquire the research output. Major pharmaceutical companies are actually scaling back their operations in Australia.

The focus on start-ups and new business creation as a basis for industrial development has been an interesting development in Australia. It is in many ways an expression of disappointment and a lack of confidence by policy makers in the capacity of existing businesses to be innovative. However, there are in all western countries too many clever ideas that could be exploited but not enough industry to exploit them – and the development costs of bringing an idea to market are immensely greater than the cost of the invention. The Sarich engine is cited as an example. Moreover, in Australia, industries are not strong in the areas where scientists are likely to make discoveries. It was ten years ago that the Chair of the Australian Research Council, Professor Don Aitken, suggested that:

The exploitation of scientific discoveries requires much more money and quite different skills to the original getting of discoveries. A simplistic model of science inevitably reduces to the “science push” or “linear model” account of economic growth in which scientists make discoveries that are then developed in industry. This rarely happens. If the model worked it would be possible to point to numerous successes - rather than the four or five that are regularly profiled at conferences and workshops (Aitkin 1992).

Business organisations are now pointing out that innovation is something that *businesses* do in response to market opportunities and customer needs. Business is now questioning the amount of research funding that is being allocated to higher education institutions for potentially commercialisable research (Australian Industry Group 2003). There is a growing unease about the capacity of publicly funded research institutions to undertake research that will result in bringing products, processes and services into adoption, application and use.

As pointed out in Chapter 5 businesses are looking to higher education institutions to provide industry with a stream of educated and qualified graduates who are knowledgeable not only into the traditional science and technology based industries but also into service industries – including finance, business services, health and public administration.

10.3 Public policy and public programs

There had been a perception in public policy that Australia’s industrial future did not lie in playing catch up with large global capital-intensive industries. Policy became focussed on creating and supporting knowledge intensive industries, based on the commercialisation of scientific research in the form of new business generation. This created a few challenges for public program design.

Recent research and commentary has identified four areas where program design should focus (Lerner 2000):

- Building relationships with, and understanding of, the venture capital industry in the area of science-based innovation. Venture capitalists in this area have developed mechanisms to finance small firms and it is important that these be understood.
- Public venture capital investments should be made with an eye to a narrow technological focus and uneven levels of venture capital investment. The focus should be on technologies that are not currently popular among venture capitalists and providing follow on capital to firms during periods when venture capital interest is falling.
- There is a need for flexibility – allowing for changes in conditions and adaptation to uncertainties.
- The track record of firms seeking public funding should be assessed to avoid supporting under-performing businesses.

Technology based start-up businesses were eager for funds to support what became termed pre-commercial research. Public programs had been designed to provide seed and pre-seed funds for these newly created businesses. However, Lerner argues that there is a need to think carefully about the validity of the concept of “pre-commercial research” in an entrepreneurial setting. Very few entrepreneurs commercialise what they initially set out to develop in their original time frame. Successful entrepreneurs gather signals from the market in response to initial efforts and adjust their plans. Once an opportunity is identified, they move very rapidly to take advantage of it before the major corporations respond. The problem is that public program managers, wary of “picking winners” push entrepreneurs to pre-commercial research. This can mean ignoring important information – feedback from customers (Lerner 2000).

The transition from a “promising start-up” to long term growth requires comprehensive change in many attributes of a business organisation. It requires a transition to ambitious, strategy minded risk takers. They have to find new employees, customers and sources of capital.

The rationale for public support for entrepreneurial and technology based growth firms rests on two main arguments: certifying firms to outside investors; and encouraging technological spillovers.

There is an argument that new technology intensive firms receive insufficient capital to fund all positive net present value projects due to information asymmetries. To the extent that public support could certify that firms are of high quality, these information problems could be ameliorated. This has been the focus of “investment readiness” programs and public support for venture capital.

In addition, the structure of the venture investment market is inappropriate for many small firms. While venture capital investors make substantial investments, even in young firms, they are, however, generally unwilling to invest in new firms that require only small capital injections. Public venture capital support has focussed on providing assistance at the seed and start-up stages of company growth. Public venture capital support is channelled through specialist seed and pre-seed funds.

Spillovers represent a form of market failure – where the market fails to deliver what is considered to be socially and economically optimal. Spillovers are economic rents associated with the returns from inventions accruing to competitors who rapidly introduce imitations or complementary products. Accordingly a firm might invest below what is socially optimal. The gap between the private and social rate of return in research and development is considered to be substantial. Capturing spillover benefits provides the logic for many public research and development programs.

In addition to the economic rationale for government programs based on market failure, there is also a rationale based on institutional failure. There are, for example, social pressures against risk taking and without an environment supporting entrepreneurship, critically needed resources – money, people, technology, suppliers and customers may be diverted away from risk taking entrepreneurial growth companies. In Australia, a career in a large corporation, a professional services firm, or government, is still more valued than starting a business (Hindle and Rushworth 2002).

Institutional failures occur in the context of the institutions of engagement identified in this thesis: that is, in knowledge markets, knowledge organisations and knowledge communities. In knowledge markets there is a failure on the capabilities and competencies of technology transfer managers and venture capital investors; in knowledge organisations in the skill, capabilities and experience of industrial research managers; and in knowledge communities in terms of the culture, attitude and beliefs relating to entrepreneurship.

Public programs have tended to focus on increasing funding to finance commercialisation. There are a few that endeavour to build commercial and management skills for inventors. There are, however, few public initiatives that focus on building skills *within* the institutions for engagement. These includes marketing capabilities in technology transfer offices, business assessment skills for venture investors, management skills for research centre managers and skills in community leadership. Building capabilities in these areas requires a commitment to *practice based* learning in the framework of mode 2 knowledge creation.

10.4 Summary

Public policy to stimulate employment and economic growth has shifted from the traditional concerns of industry policy to science and innovation policy. This follows from a perception that public investments in research and development can deliver economic outcomes through the creation of new technology based businesses. These perceptions have been supported by theoretical references to concepts of creative destruction and views that established businesses are unable or unwilling to invest in innovation.

The language and direction of policy has shifted from support for research and development to support for innovation. There is a view, promoted mainly by the science community, that academic science can lay the foundations for business development through the application of discoveries and inventions. There is a call from these quarters for more funding to undertake development research and assist in bringing products conceived in an academic environment to market. To date, the record of success in public programs that support these strategies has been unremarkable.

Enhancing the scope for commercialisation requires more integrated policies and strategies, including leverage of talent in universities and effective relationships with business and regional leaders. It also requires a much greater understanding of the nature of business innovation. Innovation is, quite fundamentally, a *business* concept. Above all, it requires building institutional capacity and capability.

In these respects there is a case for a move back to an industry focus in science and innovation policy and to ensure that public support for economic and industry development is both effective and appropriate. There is a need to review and evaluate public policies and programs that underwrite a “science push” approach to industrial and economic development.

This would involve a commitment to policy based mode 2 research – research that engaged industry in the research process and identified the generative mechanisms between policy interventions and industrial and economic outcomes. It would recognise that innovation is a *business* activity and that investment in innovation is determined by appraisal of market opportunities and customer wants. Policy would, perhaps, support the discipline of innovation that has been a fundamental driver of innovation for 30 years and provides the basis for industrial and economic growth.

Industry is a strong supporter of collaborative research undertaken through the institutions of engagement of public-private industrial research partnerships – but it takes the position that research agendas should be defined by business – not academics.

Chapter 11. Conclusion - Building Institutional Capacity

Innovation is seen by scientists, business people and economists as vital for industrial and economic development. But each group sees the processes and drivers of innovation somewhat differently. Scientists and science policy analysts have focussed on the community of science as a major source of knowledge that is associated with technological advance and point to scientific discoveries and technological inventions that can be commercialised through licensing and start-up companies (Mowery and Rosenberg 1999; Nelson 1998) – an emphasis on the supply side. Managers of innovative corporations and their technology and business advisers have focussed on a discipline of innovation that occurs in an organisational context and responds to change, opportunities and discontinuities (Drucker 1985) – an emphasis on the demand side. Economists, particularly neo classical economists, focus on the market and exchange, arguing that trade and exchange is a major focus of innovation (Baumol 2002) – an emphasis on responding to changing demand conditions and the dynamics of competition.

It is not the argument of this thesis that one group of explanations is more powerful than the other. The argument is that different institutional perspectives have been important at different times in history, but in the current economic, social and cultural environment there is a need for all forces to be working in the same direction, to be mutually supportive and where possible contradictions avoided. Explanations, analysis and policy interventions need to take into account the impact and influences of all perspectives. Underlying all of the approaches is a recognition of the importance of new knowledge and the adoption of ideas. Higher education institutions are seen to be an important source of those ideas in the form of scientific discoveries and technological inventions.

This thesis has explored the nature of interactions and relationships between higher education institutions and industry. It has done so in the context of developments and evolutionary change within those institutions. It has rejected a notion of institutional convergence between higher education institutions and business organisations on the basis of fundamental differences in purpose and ways in which performance is assessed. It has also rejected the notion that academic science can be an engine or dynamo for economic and industrial development. However, this view has been, and to a large extent remains, popular among universities and scientists and has been used as an argument for continued government funding of higher education research (Australian Vice-Chancellor's Committee 2003).

The thesis has approached the nature of interactions from the perspective of the emergence of mode 2 knowledge creation – that is, knowledge created in the context of its application. Whereas mode 1 knowledge creation is built around disciplinary science, which has an emphasis on the description of phenomena, mode 2 knowledge creation is built around prescription (problem solving) and tends to have a trans- or inter-disciplinary focus. More particularly, mode 2 knowledge creation involves a high level of engagement between the creators and the users of knowledge. But the move towards a mode 2 framework is not universal: at this stage it is concentrated in only a few areas of academic activity where there are already established links to industry on the basis of research that has a prescriptive orientation – such as computer science and engineering, molecular biology and clinical medicine (Kodama and Branscomb 1999).

In the humanities, the main area of interaction is in the field of management. There is, however, little interaction *within* management studies between the mode 1 academic pursuits in areas such as the management of science and technology and studies of industrial firms in the area of business innovation. This reflects in large part the commercial orientation of a significant portion of management research.

Increasingly, however, knowledge in all areas is becoming categorised as a product that can be traded through mechanisms such as Intellectual Property licenses, expert advisory services, and full fee paying courses and programs. These activities and services cover all areas of academic endeavour. Higher education institutions are becoming identified as knowledge producing organisations, but, it has been argued in Chapter 4, this does not make them businesses: it only makes them *business like*. At the same time, businesses are looking outside their boundaries for sources of innovation and are placing greater reliance on them for professional education and training.

The thesis has recognised that higher education institutions are committed to their purpose of research and teaching and businesses are committed to meeting the needs and expectations of customers. Both sets of institutions are under pressure to perform, with universities being required to operate in an emerging industrial framework and a highly competitive market for faculty and students with reduced levels of public funding. Businesses are being required to meet growing demands for delivery of shareholder value which requires higher levels of profitability and, at the same time, commitment to the development of new products through innovation and new market development.

Within this changing environment, the relationship between institutions is becoming more fluid. There is a two-way flow emerging as institutions interact in increasingly complex ways. But with higher education institutions and businesses maintaining their institutional characteristics, and recognising the evolution of mode 2 approaches to knowledge creation, the thesis has proposed a model of engagement based on the institutional characteristics of markets, organisations and communities. The thesis has identified the major characteristics of markets for knowledge, knowledge organisations and knowledge communities. The activities and performance of each of these forms of engagement have been described and assessed.

The key message of the thesis is that rather than thinking about institutional convergence and expecting higher education institutions to become committed to research commercialisation, and businesses to commit resources to research projects with uncertain agendas and outcomes, a better strategy would involve building and strengthening capacity and capability in the institutions of engagement.

Whilst innovation has been something that successful businesses do in the normal course of their strategies, there has been a view put forward by some elements of the scientific community that academic science and higher education can become the major source of industrial innovation. The creation of new business ventures (start-up companies) based on the exploitation of knowledge assets suggested that science and higher education could take on the role of business in industrial development. To many this was seen as essential as business was regarded as failing in its own mission for innovation and wealth creation.

Policy makers and economists have criticised businesses for not investing enough in research and development. The emergence of the economic and financial view of the firm fuelled this perception as did populist conceptions of the emergence of a new economy based on the exploitation of knowledge assets, or knowledge capital. The venture capital community, demonstrating its willingness to invest large amounts of money in start-up companies without plausible business models, added credibility to many of these arguments.

To many in government, science, and the academic press, industrial and economic development would be secured by increased funding of public research organisations (particularly higher education institutions) which would create science and technology based start-up companies supported by venture capital. Consultant produced studies that demonstrated this potential. Popular rhetoric during the late 1990s was that venture backed companies created more jobs, more sales and more exports than more traditional companies (Coopers & Lybrand 1997). The methodology and statistical validity of these studies was

heavily flawed but it did not dampen the enthusiasm of those who saw an industrial and economic future built around venture capital investment.

More recent and sanguine accounts point to the very limited impact of venture backed companies in the overall pattern of new business development (Howard 2002b). The basis of this change in emphasis and orientation has now been called into question as technology start-ups have failed to live up to expectations and biotechnology companies have failed to deliver values anticipated. Higher education institutions are finding it necessary to re-state their commitment to excellence in teaching and research following ethical dilemmas associated with the pursuit of profit in the biotechnology boom.

Attention is now turning to a more serious examination of how business and higher education interact and relate, and the way in which value is created from those interactions. In Britain it has been observed that the recent surge in the number of publications and patents has failed to enhance international competitiveness. Publication and patenting must go a step further to ensure that there is engagement between institutions to ensure that discoveries and inventions can be incorporated into new products that relate to customer demand. Nonetheless, the brief hiatus created by the science push rhetoric glossed over some more fundamental changes and developments occurring within higher education and business.

The expansion in the scope and scale of engagement of universities with business and the community creates challenges for the way in which relationships are managed. Increasingly, market relationships involve the intermediation of brokers, intermediaries and advisers in areas such as finance, Intellectual Property, corporate structure, and marketing. The challenge, and the imperative, is to build trust based relationships in these areas to ensure that credible, expert and independent advice is available and that universities are not exposed to unnecessary risks.

Similarly, cooperative and collaborative arrangements and ventures between universities, business and public organisations require increasingly sophisticated management processes and systems. The practice of management in a collaborative environment is complex - requiring not only skills necessary for the motivation of scientists and technologists, but also capabilities for ensuring that milestones and results are achieved, stakeholder interests and views are accommodated, budgets and plans are created and monitored and accountability is assured. Experience with cooperative arrangements between universities and businesses suggest that management is one of the greatest challenges.

Finally, the community of science is undergoing fundamental change as many scientists earn less in the way of peer “credit” for their work and more from the capitalisation of their discoveries and inventions in the form of Intellectual Property assets. Although many fear that the “enclosure of the knowledge commons” will result in impediments to the creation of knowledge, it may well be that the creation of knowledge assets, and attaching value to those assets, will result in their *more* productive and effective utilisation. Moreover, there can be no suggestion that all forms of knowledge creation will be, can be, or should be, capitalised.

With increasing expectations about the contribution of academic research to industrial performance there is a need to ensure that Australia has a globally recognised higher education sector and a globally competitive business sector. With these objectives the last thing that is required is convergence between these sets of institutions. Higher education institutions should not be expected to direct their activities to research commercialisation and businesses should be expected to invest in their own right in research and development that is directed towards innovation and international competitiveness. The logic of mode 2 knowledge production should be encouraged to flourish in this environment.

What is required, however, are strong and effective institutions of engagement. Specifically, institutional capacity building is required in the following areas

- Knowledge markets – capacities and capabilities in technology licensing, technology marketing and early stage venture capital management
- Knowledge organisations – developing capacities and capabilities of industrial research managers
- Knowledge communities – developing leadership capacities and capabilities for knowledge based regional development.

These institutions require nurturing and development through capacity building. Resources currently allocated to public programs that focus on commercialisation of university research would be more appropriately allocated to building institutional capacity and capability in these institutions. This does not mean necessarily creating new organisations and entities: research commercialisation in universities can be approached by supporting capacity building in technology existing Technology Transfer Offices rather than impose new commercially driven organisations.

Similarly, capacity building in industrial research partnerships involves investing in capacity building for industrial research managers. It also requires developing appropriate entities for

the conduct of collaborative research to overcome constraints imposed by the current taxation and corporations law.

As argued throughout this thesis, innovation occurs at the interface between disciplines *and* institutions. It is reflected in multi-disciplinary research conducted in research centres and involving reduction to practice projects and programs with higher education institutions and technology intensive companies and early stage venture capital investors. Working in this environment requires appropriately skilled people and entities in which activity is conducted.

Knowledge based industrial development in this environment should occur with *strong institutions* in higher education, industry, and at the interface between them. Institutional engagement and capacity building has received little attention to date, but the potential of the knowledge economy and knowledge based industrial development requires strong, robust and effective institutions operating in this arena.

Expectations for industrial development cannot be assigned to universities and research institutions to come up with discoveries that create global companies and wealth for Australian is the task of business. There is a need to provide an institutional environment for business, universities, and government to adapt. This requires strong engagement between institutions: it does not mean institutional convergence.

In a contemporary context the thesis provides support for the attention that is being given within industry for the development of capacities and capabilities for the *management* of innovation in terms of taking ideas that come from research as well as from market signals into commercial application. There is no shortage of ideas for innovation: what is in short supply are managers who are competent and capable of managing an innovation process through to adoption and application in the market.

Similarly, in the market for knowledge, there is a shortage of investment managers with the skills and capabilities required to *pull through* ideas into a commercial. This goes further than obtaining intellectual property protection and attempting to push technologies onto customers and potential industrial users: it extends to developing marketing and sales capabilities and understanding customer wants. Recent research in the software industry, for example, indicates successful companies obtain early feedback from customers, including downstream supply chain partners, in beta testing and only invest in features that customers need (Smagalla 2004).

Conclusion

Whilst American and European companies, on account of their large scale, have the capacity to develop innovation management capacities in-house, Australian firms are smaller and have limited resources to invest in management capacity building. Higher education institutions tend to approach management from a research and descriptive perspective rather than a practice based prescriptive orientation. This institutional failure has not been recognised in public policy but it is a matter that needs to be addressed if Australian businesses are to lift their rates of innovation and international competitiveness.

Australian venture capital firms have tended to recruit investment managers from the finance sector rather than from the business sector. Investment decisions are made, quite correctly, on the basis of analysis of financial data. However, successful early stage venture capital investing carries with it a track record in managing early stage companies and deep understanding of business and commercial issues. Again, the small size of Australian venture funds represents an institutional failure in terms of being unable to recruit, train and retain investment managers with necessary business skills (particularly market and supply chain knowledge) and domestic and international contacts, to pull through ideas into successful start-ups. The nascent Australian venture capital industry could also address this issue on a collective basis.

The conclusions outlined above point to an opportunity to implement an approach to teaching and research in the management and finance of emerging businesses that focuses specifically on the Australian industrial, commercial and financial context. Australian management and financial concepts borrow heavily from North American and European contexts where businesses are large and have led industrial research and development. Australian businesses tend to be smaller, the finance sector more concentrated and there has been a higher proportion of industrial research carried out in public sector organisations. In the framework of the institutions of engagement outlined in this thesis, there is a need for further research relating specifically to the Australian context that can provide the skills and capabilities that will assist in building national productivity, industry competitiveness and business success.

The issues raised in the thesis have focussed on relationships between higher education institutions and business. The issues also apply to relationships between the institution of the state, business and non-government organisations in the area of sustainability and natural resource management. The responsibilities being placed on non-government organisations for the delivery of sustainability and natural resource outcomes are increasing, but the mechanisms for support and assistance are still reliant on grants based, subsidy and

philanthropic models. The institutions for engagement between the state, business and non government organisations are only emerging. They provide an important area for further research and analysis in relation to institution building. It was Peter Drucker who identified this area as “where management is today most needed and where systematic, principled, theory based management can yield the greatest results the fastest” (Drucker 1999).

The concept of *institutions of engagement* explored in this thesis, drawing on the idea of engagement in a mode 2 society, has provided a theoretical framework for further analysis of engagement institutions in an organisational, market and community setting. It provides a basis for addressing institutional development *within* institutions and ensuring that the knowledge society and the knowledge economy evolves on the basis of institutional strength rather than institutional confusion. Economic and social development requires strong institutions with clarity about their purpose, role and contribution. Institutions evolve, and this contributes to their strength – as is occurring in the industrialisation of higher education and its segmentation directed towards matching capabilities with mission relating to research, teaching, and training. Similarly, business needs to be globally competitive which will occur through a discipline of innovation determined by business having regard to market and customer considerations.

Appendix: Evidence to Support a Movement from “Mode 1” to “Mode 2” Knowledge Creation

The purpose of this Appendix is to present and analyse some broad statistical data that might shed light on the extent to which there has been a movement from mode 1 to mode 2 forms of knowledge creation. This would be reflected in a movement from research concentrated in the creation of disciplinary knowledge towards research that has a greater emphasis on the creation of knowledge that is trans-disciplinary and has a greater focus on the creation of applicable knowledge.

Data is published by the Department of Education, Science and Training in relation to research undertaken in the higher education sector that classifies research according to four research categories:

- Pure basic research - Experimental and theoretical work undertaken to acquire knowledge without looking for long term benefits other than the advancement of knowledge
- Strategic basic research - Experimental and theoretical work undertaken to acquire knowledge directed towards specified broad areas in the expectation of useful discoveries. Base of knowledge for solving recognised problems
- Applied research - Original work undertaken to acquire new knowledge with a specific application in view. To determine possible uses of findings from basic research or ways of achieving objectives
- Experimental research - Systematic work using existing knowledge gained from research or practice to produce new materials, products or devices, new processes, systems or services – or making substantial improvement (OECD 1992).

Comparable data are available for the years 1977-98 and 1999-2000. While the data only cover a limited time frame, it is sufficient to point to directions of change. It was during the period covered by the data that substantial changes were being seen to operate in university business relationships and when there was a substantial amount of public comment and commentary. The changes in expenditure categories according to research fields are set out in Table 21. The source data are provided in Appendix 1.

Between 1998 and 2000 the level of research expenditure in Australian universities increased by a relatively modest 8.6 percent. Within that total, expenditure on pure basic research decreased by a small amount (-1.1 percent) and expenditure on strategic basic research increased by a small amount (2.4 percent). However, the level of expenditure on applied research increased by 17.4 percent and by 36.9 percent in the area of experimental research.

Table 21: Australian universities: Expenditure on Research and Experimental Development by Research Fields, Course and Disciplines Classification - Change 1998 - 2000 (percent)

	Pure Basic Research	Strategic Basic Research	Applied Research	Experimental Research	TOTAL
	%	%	%	%	%
Natural Sciences, Technologies and Engineering					
Mathematical sciences	-0.7	-5.3	1.7	-38.4	-3.9
Physical sciences	3.4	-2.6	2.9	61.1	6.0
Chemical sciences	2.9	-3.0	13.9	35.9	6.0
Earth sciences	-5.1	-7.8	-25.8	-28.9	-14.0
Biological sciences	-8.6	8.7	18.3	31.7	4.7
Information, computing and communication sciences	-30.0	-18.1	-7.6	-8.4	-15.7
Engineering, technology & applied sciences	25.9	-12.7	38.1	40.2	21.6

Attachment

	Pure Basic Research	Strategic Basic Research	Applied Research	Experimental Research	TOTAL
	%	%	%	%	%
Agricultural, veterinary and environmental sciences	-2.8	5.7	36.6	17.3	20.4
Medical and health sciences	-14.2	17.1	20.7	71.5	13.2
	-5.7	3.7	19.7	34.4	8.6
Social Sciences and Humanities					
Education	-1.5	-18.2	-6.8	-28.5	-9.4
Economics	16.9	7.0	-2.6	85.4	4.6
Commerce, management, tourism and services	96.0	324.2	297.3	800.0	248.8
Policy and political science	9.1	0.0	50.1	147.0	21.1
Other	5.0	-20.8	-17.1	56.7	-4.8
	8.3	-2.6	11.3	51.7	8.6
TOTAL	-1.1	2.4	17.4	36.9	8.6

Source: Analysis of DEST data

Quite clearly, the changes in the emphasis of research activity were not evenly distributed across research fields.

- In the biological sciences there was a decrease of 8.6 percent in pure basic research but an increase strategic research of 8.7 percent. There was also a large increase of 18.3 percent in applied research and 31.7 percent in experiential research. This does not suggest a movement from mode 1 to mode 2 knowledge production – it suggests an increase in the production of applicable knowledge that is directly related to the increasing emphasis on science-based drug discovery using the tools of biotechnology in the pharmaceutical industry.
- Similarly, in the *physical and chemical sciences* there has been a modest increase in research and development expenditure and a switching between pure and strategic research and very large increases in applied and experimental research. Again, this does not of itself suggest a *movement* from mode 1 to mode 2 but more of an *increase* in science-based innovation in industries associated with these disciplines.
- The change in research orientation may also reflect an increase in the amount of contract research undertaken, as part of the universities commercial strategies, as well as a movement of research from a business to academic environment, as part the cooperative and collaborative research framework that is emerging in some industries. This issue will be explored further below.
- There has been an overall decline in research in the earth sciences, particularly in the applied and experimental areas. This may reflect trends in the mining and minerals sector where companies have traditionally have strong relationships with universities for research activity.
- In the information, computing and communication sciences there has been a decline in all research areas. This would be associated with the ending of the technology boom in April 2000.
- In the engineering, technology & applied sciences the data indicate a substantial increase in pure basic research, although a decline in strategic basic research. There have also been substantial increases in the applied and experimental categories. Again, this may reflect the growth in contract and collaborative research – but it does not infer a *movement* from mode 1 to mode 2 as suggested in the “new production of knowledge” thesis.
- The increase in university based applied research and experimental development reflects the availability of new technologies that emerge from materials sciences in and their application in manufacturing processes.

- A similar pattern is evident in the agricultural, veterinary and environmental sciences where there has been a small net increase in basic research but substantial increase in applied and experimental research.
- In the medical and health sciences there has also been a change in orientation from pure basic to strategic research and a substantial increase in applied and experimental research. The focus of research effort in the area of medical devices would be consistent with this trend.
- The increase in all research areas in commerce, management, tourism and services, albeit off a small base is of particular note. It is reflective of the creation of new knowledge in the finance and management disciplines and the involvement of the academic community in its production, but also in its marketing and application. The production of financial and management knowledge has parallels with the production of knowledge in the natural sciences.
- The production of knowledge in the area of finance and management also provides some evidence that universities are moving outside the relatively narrow functional area of science and technology relationships and becoming involved in other business functions such as corporate finance, marketing and logistics which involve the application of both disciplinary and practical knowledge.

Thus, the data provides some indications that would support the “new production of knowledge” thesis. While the data reinforce observations that have been made about closer relationships between universities and businesses in the production of knowledge related to applied research and experimental development, they do not necessarily support the contention of a *movement* of resources and effort away from disciplinary research to the generation of knowledge in application. In many disciplines, the commitment to basic research has increased.

Another perspective on the movement from disciplinary research to applicable research can be obtained by looking at research and development expenditure on the main research performing sectors – business (industry), government, higher education and private non profit. Changes in the main expenditure categories of the period 1998-99 to 2000-2001 are set out in Table 22.

Between 1998-99 and 2000-01 expenditure on research and development had increased by a total of 14.7 percent. However, this increase has not been evenly distributed across sectors, with business expenditure increasing by 17.9 percent and higher education spending increasing by 8.6 percent.

Table 22: Expenditure on research and development by sector and activity - Change 1998-99 to 2000-01 (%)

	Pure Basic Research	Strategic Basic Research	Applied Research	Experimental Development	Total
	%	%	%	%	%
Business	83.3	127.6	49.4	5.5	17.9
Government	13.6	6.1	22.8	-1.9	14.4
Higher Education	-1.1	2.4	17.4	36.9	8.6
Private Non Profit	58.3	29.0	7.0	23.4	28.6
Total	4.7	16.4	28.1	6.3	14.7

Source: Calculated from, Australian Bureau of Statistics, *Research and Experimental Development, 2000-2001*. Cat 8112.0

Table 22 also indicates that higher education expenditure on basic research declined by 1.1 percent over the period but increased in other areas. The increase in experimental development was 36.9 percent and 17.4 percent in applied research. Almost by contrast, business expenditure on basic research increased by 83.3 percent and by 127.6 percent in

strategic basic research. Expenditure by government organisations increased by 22.8 percent in applied research and 13.6 in basic research.

The data provides some evidence that business is increasing its commitment to basic research, which is consistent with observed trends towards science-based innovation in industry. The increase in university commitment to applied research and experimental development is also consistent with observed trends towards increasing levels of research services for and partnerships with businesses.

As with overall research levels of research activity, there have been some significant changes in the relative emphasis of research fields over the last three years. This is indicated in Table 23.

Table 23: Expenditure on Research and Experimental Development by Research Fields, Course and Disciplines Classification - change 1998-99 - 2000-01 (%)

RFCD	Higher Education %	Business %	Government %	Private Non Profit %	TOTAL %
Natural Sciences, Technologies and Engineering					
Mathematical sciences	-3.9	214.9	23.9		25.3
Physical sciences	6.0	66.8	5.6	-39.2	13.3
Chemical sciences	6.0	69.8	9.1	116.5	27.9
Earth sciences	-14.0	-64.9	3.7		-22.4
Biological sciences	4.7	40.5	1.8	87.4	12.7
Information, computing and communication sciences	-15.7	-8.9	85.2	468.7	-2.8
Engineering, technology & applied sciences	21.6	38.9	4.4		31.6
Agricultural, veterinary and environmental sciences	20.4	40.4	16.5		19.8
Medical and health sciences	13.2	41.8	-3.3	43.6	19.0
	8.6	20.3	12.5	55.4	16.0
Social Sciences and Humanities	8.6	418.2	64.6	24.9	16.9
TOTAL	8.6	20.9	14.3	54.0	15.8

Source: Calculated from, Australian Bureau of Statistics, *Research and Experimental Development*, 2000-2001. Cat 8112.0 and DEST publications

Table 23 points to a number of significant trends:

- A decline in research and development expenditure in earth sciences (mainly associated with the mining industry) within both the business and higher education sectors
- A decline in research and development relating to information technology and communications in both the higher education and business sectors, but a substantial increase in the government sector
- A substantial increase in expenditure by businesses in the biological and medical and health sciences
- A sizable increase in expenditure in the non-profit sector on medical and health sciences (reflecting the activities of the medical research institutes)
- A very substantial increase in higher education research relating to commerce, management and services.

These trends carry over into a number of specific areas of economic and industrial activity.

Expenditure data relating to research and development is also collected in accordance with "socio-economic objective". This is essentially a purpose, or functional, classification of data using internationally consistent classification standards and definitions. There is no presumption of a strategic direction underlying the classification, although the strategies of research funding agencies concerning priority will have an impact in due course. In an overall sense, however, the data represents an *ex post* indication of research effort.

Over the years 1998-99 to 2000-01 expenditure by business on health related purposes has increased by over 100 percent. This is indicated in Table 24, which provides details of changes in relative emphasis between higher education and business over the last three years. Table 24 also indicates some very large increases in a number of areas of research focus, particularly in the higher education sector (for example, energy resources, information and communication, social development and community services and environmental management. Many of these increases come off a low base. There has, however, been a large decline in non-oriented research.

Table 24: Expenditure on Research and Experimental Development by Socio-Economic Objective and Sector increase 1998-99 to 2000-2001 (%)

Socio-Economic Objective	Higher Education %	Business %	Government %	Private Non Profit %	TOTAL %
Defence	-24.9	-12.0	16.4		4.6
Economic Development					
Plant Production and Plant Primary Products	15.6	7.0	11.2		
Animal Production and Animal Primary Products	-0.2	64.0	25.4		
Mineral Resources (excluding energy)	25.5	-15.5	37.8		-5.8
Energy Resources	101.0	-32.5	10.1		-12.1
Energy Supply	49.5	44.1	77.1	-100.0	47.9
Manufacturing	21.6	9.1	-1.7	80.8	8.6
Construction	48.4	21.7	-13.5	1,700.0	15.8
Transport	51.4	-5.6	9.2		3.9
Information and Communication Services	107.2	67.1	-23.3		62.6
Commercial Services and Tourism	50.2	137.2	-12.8		102.5
Economic Framework	22.8	299.9	311.5	-19.1	98.6
	34.5	22.7	20.7	45.3	23.3
Society					
Health	47.5	105.5	8.0	65.1	49.9
Education and Training	8.2	142.0	77.2	46.0	13.3
Social Development and Community Services	185.3	20.9	91.9	-23.9	138.0
	60.3	95.4	21.8	61.5	56.4
Environment					
Environmental Policy Frameworks and other	-78.5	-34.7	-82.8	2.1	-79.5
Environmental Management	315.5	28.4	589.1	126.0	310.3
	-12.5	-32.7	0.6	1.6	-8.3
Non-Oriented Research	-35.6	-91.0	-44.3	-93.8	-40.7
TOTAL	8.6	20.9	14.3	54.0	15.8

Source: Calculated from, Australian Bureau of Statistics, *Research and Experimental Development, 2000-2001*. Cat 8112.0 and DEST publications

Table 24 indicates that increases in government research effort have been concentrated in the areas of economic framework and environmental management. This is consistent with the strong public sector research commitment in these areas through CSIRO and State agriculture research institutes.

In summary, the cross sector data also provides indications of moderate support for increasing emphasis on mode 2 knowledge creation with universities being more involved in applied research and experimental development, particularly in industries closely linked to science based research and development. However, this data cannot be taken as a conclusive indication of a change or trend.

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