

The logo for Howard Partners, featuring the word "Howard" in a large, red, cursive script font.

PARTNERS

Howard Partners Pty Ltd ACN 090 817 369

**Knowledge exchange networks in Australia's
innovation system:
overview and strategic analysis**

**Report of a Study Commissioned by the
Department of Education, Science, and
Training**

Dr John Howard

June 2005

Contents

EXECUTIVE SUMMARY AND OVERVIEW	1
Knowledge network categories	1
Best practice	1
The human interface	2
Economic, industry, and business impact	2
Looking ahead	3
1 INTRODUCTION	4
1.1 The project brief	4
1.2 Scope of knowledge exchange networks	4
1.3 Networks and communication	5
1.4 Communication channels	5
1.5 Network support and promotion	6
1.6 The role of facilitators, brokers and intermediaries	6
1.7 Demand and supply issues in knowledge networks	7
1.8 Categories of networks	7
2 KNOWLEDGE SHARING NETWORKS (KNOWLEDGE COMMUNITIES)	9
2.1 Overview	9
2.2 Communities of practice involving universities and research organisations	10
2.3 Communities of practice involving industry, universities and government	12
2.4 Communities of practice supported by Industry associations	14
2.5 Communities of practice supported by professional associations	17
2.6 Communities of practice formed through government enterprise development programs	19
2.7 Science and technology clusters	19
2.8 Conclusion	22
3 KNOWLEDGE EXCHANGE NETWORKS (MARKETS FOR KNOWLEDGE)	24
3.1 Overview	24
3.2 The role of intermediaries in the market for knowledge	25
3.3 Knowledge exchanges in Australia	26
3.4 International knowledge markets and knowledge exchanges	27
3.5 Conclusion	29
4 KNOWLEDGE MANAGEMENT NETWORKS (KNOWLEDGE ORGANISATIONS)	31
4.1 Overview	31
4.2 Australian Institute for Commercialisation Initiatives	31
4.3 Industry Techlink	33
4.4 Intelligent Manufacturing Systems (IMS)	33
4.5 The Triton Foundation	34
4.6 The Warren Centre for Advanced Engineering	34
4.7 Conclusion	34
5 ELECTRONIC INFORMATION, ADVERTISING AND PROMOTIONAL SERVICES	36
5.1 National Innovation Website	36
5.2 IPAccess	36
5.3 The Australian Technology Showcase	37
5.4 Australian Institute for Commercialisation databases	37
5.5 DITR Research Finder	38
5.6 Sci Tech	38
5.7 Conclusion	38
6 ASSESSING ECONOMIC IMPACT	40
7 CONCLUSIONS	42
8 CONCLUSIONS AND RECOMMENDATIONS	44
REFERENCES	45

Executive summary and overview

For the purposes of this project, knowledge exchange networks (KENS) have been identified as structured intermediary mechanisms for users to locate, exchange and acquire knowledge in a systematic way, with a view to development of new products, processes and services. They may be virtual/electronic or actual/physical communities of interest, public or private, free or subscription based.

Knowledge network categories

The project has assessed knowledge exchange networks in three broad categories:

- Knowledge communities – involving the sharing of knowledge through what have become known as ‘communities of practice’ and ‘knowledge or science and technology ‘clusters.
- Knowledge markets – involving the trading of knowledge between sellers and providers, often through Internet based exchanges, but increasingly involving knowledge brokers.
- Knowledge organisations – entities established to facilitate the application of knowledge by developing skills and capabilities on the part of users through specific programs and initiatives. These organisations manage the relationship between the creators and users of knowledge.

Our research for this project identified a very large number of arrangements that could be described as knowledge networks in each of these categories. These are addressed in detail in the main body of the Report.

Knowledge Exchange Networks are sponsored and maintained across a broad spectrum of institutional arrangements. These include:

- Networks supported by industry and professional associations;
- Networks supported by government programs and initiatives;
- Collaborative business and enterprise networks involving participation from industry, research organisations and business associations;
- Networks formed as an outcome of government enterprise development programs;
- Networks formed through the initiative of researchers in universities and publicly funded research organisations.

Best practice

The Report concludes that the most effective networks, in terms of the transfer of knowledge from the creators of knowledge (research providers) to industry users are those that are sponsored and supported by industry through industry associations. Our research found best practice in networking activities in cluster (technology consortia) initiative being promoted and sponsored by the Australian Electrical and Electronics Manufactures Association (AEEMA) through the Electronics Industry Action Agenda, and the *InnovationXchange* being supported by the Australian Industry Group and the Department of Industry Tourism and Resources.

Industry sponsored and supported research and development networks, which most effectively utilise industry and government supported research and development corporations, have been important to Australian economic and industrial development in the animal and plant production sectors. The mining industry has demonstrated the benefits of knowledge exchange and collaboration through the Australian Minerals Industry Research Association (AMIRA) and the wine industry has demonstrated similar benefits through knowledge a cluster that creates and shares product related knowledge through the Wine Research Institute.

The human interface

The Report indicates that Knowledge Exchange Networks based on the transfer of knowledge through electronic web-based technologies have limited impact without the involvement of people and organisations performing the roles of facilitator and/or broker.

Paradoxically, the greater the opportunity for the transfer of knowledge through the Internet, the greater is the need for skilled facilitators, trusted advisers and what has been termed 'honest brokers', who can bridge the cultures and interests of academic and industrial researchers and who can ensure create a high level of engagement and commitment between parties to an exchange.

Building capacity and capability for engagement in Knowledge Exchange Networks requires continuity and ongoing investment in the development and maintenance of skills. Allocating this responsibility to an established organisation with a strong commitment to innovation, such as an industry association, is the most effective way to ensure that this investment takes place.

Economic, industry, and business impact

There is now an acceptance within business that the main sources of innovation are likely to come from outside the organisation.

Access to new knowledge through networks is recognised as an important way of accessing and acquiring new ideas, insights and technologies for new products and services, for new approaches to business processes (both within and between businesses), and new ways of responding to consumer behaviour and wants.

The overall economic benefits are difficult to gauge, but they will be reflected in:

- Improved business performance for companies which successfully innovate on the basis of knowledge that is sourced through participation in knowledge network arrangements;
- Improved industry competitiveness, at an international level, where there is broad adoption and application of new knowledge generated through knowledge networks arrangements;
- Improved national economic performance, in terms of increased national output (GDP), employment and exports that flow directly from businesses sharing, exchanging and more effectively using knowledge that flows from involvement in network arrangements.

A recent report by the Allen Consulting Group for the Australian Vice Chancellor's Committee and Business Council of Australia (Allen Consulting Group 2004) estimates that the \$83m that was made by Australian universities through licensing revenues in 2000 could have been doubled if 'best practice' had been followed. This 'best practice' includes free flow of information through knowledge networks.

The Allen Consulting Group also estimated that companies formed on the basis of commercialising publicly funded research had sales of between \$2billion and \$3billion through publicly funded research. While this estimate is highly speculative, it does suggest that there is potential for substantial economic benefit if the level of commercialisation can be increased through improved knowledge exchange.

The Australian wine industry, which as developed and grown through networking and collaboration in production technologies, now exports almost a third of total production compared to two percent in the mid 1980s (Marsh and Shaw 2000).

Whilst the contribution of improved knowledge transfer to GDP cannot be assessed with any accuracy due to the limitations of modelling techniques, proxy indicators such as increased sales, employment, investment and exports are widely accepted indicators of economic impact.

Looking ahead

The Report makes a number of recommendations for developing and improving the performance of knowledge exchange networks. These are set out in Section 8.

Innovation research is increasingly recognising the powerful role that networks provide in building a nation's innovation capability. Innovation requires the development of new relationships among and between businesses, government, education and research organisations, workers and society in general. Above all, it requires a culture of collaboration, a symbiotic relationship between research and commercialisation, and life long skill development (United States. Council on Competitiveness 2004).

Much is being written and said about *engagement* as a basis for these new forms of relationships. But long held values and cultures of business, government and higher education are fundamentally different and unlikely to change, at least in the short term. Engagement through networks does not imply convergence of values, cultures and commitment. Building networks will necessarily require giving specific attention to building *institutions of engagement* (Howard 2004).

This Report has provided a basis for thinking about *institutions of engagement* in an organisational, market and community setting by focussing on knowledge exchange networks. Institutions of engagement refer to frameworks of rules, roles and relationships (formal and informal) that must be developed to ensure meaningful and productive interaction in network contexts. Engagement involves structures as well as contracts, and mutually shared understandings and a basis for communication between all parties.

Future work in the area of university-business-government relations should give a priority to building practical, efficient and effective institutions of engagement as a foundation for the networks that are needed to underpin Australia's national innovation system. We need to ensure that the structures for collaboration such as partnership, alliances and joint venture are capable of delivering value for all stakeholders, and at the same time ensuring that core institutional values are preserved.

This may require, for example, developing a strong skill base in industrial research management and ensuring that there are longer term career opportunities for researchers who work at the academy-industry interface.

1 Introduction

1.1 The project brief

The objective of this project is to provide the Business/Industry/Higher Education Collaboration Council (BIHECC) with an overview and recommendations on existing and planned knowledge exchange networks (KENS) linking Australia's higher education system and business/industry.

The project brief required that a 'mapping exercise' be undertaken of known knowledge exchange networks and knowledge exchange network services operating in Australia's innovation system. Information was sought in relation to:

- subject matter (industry sector the network is concerned with, or R&D focus)
- target users (intended providers and clients)
- mode of operation (web based platform, human interface)
- accessibility (criteria for membership or participation, freedom of content)
- coverage (size and breadth of the market included)
- visibility (profile and market saturation)
- quality (credibility, effectiveness and usefulness)

This report provides an assessment and evaluation of the knowledge exchange environment overall, with a particular focus on:

- the nature and use of knowledge exchange networks by different stakeholders in the national innovation system, in particular by individual universities and by different types of businesses.
- gaps in current knowledge exchange mechanisms or services and areas of the market that are not well serviced due to lack of provision or inadequate quality.
- benefits observed, and solutions resulting from, the operations of existing knowledge exchange networks.

The report concludes with observations and recommendations for BIHECC on how knowledge exchange networks linking universities and business/industry can best be supported and promoted across the different types of institutions and businesses.

A presentation of preliminary findings and conclusions was made to BIHECC on 29 April.

1.2 Scope of knowledge exchange networks

For the purposes of this project, knowledge exchange networks (KENS) are structured intermediary mechanisms for users to locate, exchange and acquire knowledge in a systematic way, with a view to development of new products, processes and services. They may be virtual/electronic or actual/physical communities of interest, public or private, free or subscription based.

Knowledge exchange networks operating in Australia's innovation system are seen by policy advisers as vital intermediaries in the innovation cycle, putting the providers of research in touch with existing and potential users. Knowledge exchange networks may provide users with case studies of best practice, links to relevant resources, websites, potential business partners, access to information about current research and development, news, activities and events.

This project is particularly focussed on knowledge networks that facilitate collaboration between:

- Australia's higher education system (especially universities)

- R&D networks (eg Co-operative Research Centres)
- Other publicly funded research agencies (eg. CSIRO)
- Businesses (including metropolitan and regional, large and small/medium sized firms)
- Industry/representative bodies (eg. Australian Vice Chancellor's Committee, Australian Industry Group, Australian Chamber of Commerce and Industry and the Business Council of Australia).

The scope of this project incorporates all aspects of Australia's national innovation system (including stakeholders such as governments, public and private research organisations, business and industry) but with a primary focus on how the Australian higher education system interacts.

A focus on innovation implies a focus on end users – that is bringing discoveries, inventions and technologies into adoption and application in the form of either new or enhanced business processes or marketable products and services, or alternatively, new or improved social, environmental and cultural programs.

From a management and policy perspective, innovation involves investments that yields future benefits. As this entails substantial risks, knowledge exchange networks can assist in managing and mitigating risk.

1.3 Networks and communication

Our starting point is that knowledge exchange networks should be seen as arrangements where creators (suppliers) of knowledge – discoveries, inventions, technologies - communicate through various channels with current and potential users. Users may be other creators or end users (adopters).

From this standpoint, it is important to see knowledge exchange networks from both the perspective of the users as well as the creators of knowledge. This means addressing specifically the way users 'receive' knowledge, as well as the way in which creators provide it. This has a number of implications (Drucker 2001):

- People have to interact in terms of the experience of the recipient;
- There is no possibility of communication unless we first know what the recipient, can comprehend, and why;
- People perceive, see and hear largely what they expect; the unexpected is usually not received at all;
- Communication always makes demands: it demands that the recipient do something, believe something, or act in some way.
- At its most powerful, communication brings about conversion – or, in the case of knowledge networks, adoption and use.

Many knowledge networks have been developed from the creator and provider perspective on an assumption that once information is available (for example in a report or on the Internet) it will be sought after, accessed and effectively received by potential users.

Experience shows, however, that the *channel* and the *management* of communication is critical to its reception.

1.4 Communication channels

Communication channels relevant to knowledge exchange networks can be represented as a continuum ranging from *rich channels* which allow a communicator to focus the message in a personal manner to *lean channels* which lack the personalisation but are more economical and provide broader reach.

<i>The Communication Channel Continuum</i>	
Rich Channels	<ul style="list-style-type: none"> ▪ One-to-One/Face-to-Face Communication ▪ Hallway/Coffeepot Communications ▪ Small Group Meetings ▪ Telephone Conversations ▪ E-Mail ▪ Large Group Meetings (Conferences) ▪ Hand Written Personal Notes ▪ Faxes ▪ Formal Speeches and Lectures ▪ Newsletters ▪ Reports ▪ The Internet
Lean Channels	<ul style="list-style-type: none"> ▪ Public Broadcasting

Rich channels allow the sender to respond to questions and feedback. They are highly effective in getting a message across, but expensive and limited in their reach. Conversely, lean channels have limited effectiveness, but are inexpensive to operate. For example, 'putting something on the "net"' does not amount to communication: there can be no presumption that the information provided will be read, let alone acted upon.

Since the rapid evolution of the Internet, we have seen the emergence of knowledge brokers and information intermediaries to interpret and recast information into a form that can be received and acted upon by users. Inevitably, knowledge exchange networks need these information brokers and intermediaries. Network initiatives that do not make this investment, on a committed and continuing basis, rarely achieve anything substantial from a communication perspective.

1.5 Network support and promotion

It is possible to identify a number of categories of networks in terms of the support provided and the arrangements for ongoing management and promotion. These categories, which form the basis for the structure of this report, are as follows:

- Networks supported by industry associations
- Networks supported by professional associations
- Networks supported by government programs
- Collaborative business and enterprise networks involving participation from industry, research organisations and business association
- Networks formed as an outcome of government enterprise development programs.
- Academic initiatives – networks formed through the initiative of researchers in university and publicly funded research organisations

These networks variously exhibit characteristics of community, market and organisational frameworks. The way they interact and complement each other is an important issue in addressing the overall performance of networks.

1.6 The role of facilitators, brokers and intermediaries

In this Study of knowledge exchange networks, the focus of attention will be the knowledge brokerage rather than the medium, such as the Internet. The need for information brokers has arisen from a realisation that the publication of research results in print and/or on the Internet are not, on their own, effective communication or marketing channels.

From a communication perspective, the Internet *must* be supported by other channels in order to ensure effective communication, including personal interactions of researchers or people acting on their behalf. The Internet is limited in its ability to make real time linkages and portray complex relationships and subsequent knowledge based analysis and

interpretation. Research indicates that promotion and marketing through the Internet has actually made inter-personal communication *more* important (Howard and Johnston 2001; Howard 2004).

A number of research organisations, including Cooperative Research Centres (CRCs), have appointed *knowledge brokers* with a brief to create linkages between knowledge creators and users.

From previous research undertaken by Howard Partners, a number of preliminary observations can be made about knowledge networks (Howard, Johnston, and Fowler 2001, 2001; Howard and Matthews 2001; Howard 2004). These are outlined below.

1.7 Demand and supply issues in knowledge networks

Prior research indicates that investors and businesses have genuine interest in accessing information generated through publicly funded research. Their motives are primarily driven by need for knowledge, networking, and assessment of expertise. The following findings from our research are relevant in this context:

- Business would like a 'single entry' point into the higher education research system to identify capacity and capability in industry applications of science and technology.
- Investors, be they corporate technology investors or private equity deal makers want information in a form and format that is useful to their business planning, investment or acquisition strategies.
- Equity investors, business and industry association show little inclination to 'purchase' information arising from publicly funded research, so the imposition of a fee would likely have a negative impact.

Universities and publicly funded research organisations are aware of the need to encourage the effective exploitation of R&D that has potential commercial application. In this regard, the following observations have arisen from our research:

- There acceptance by a large majority of universities that selected information should be more publicly available to investors and businesses to facilitate networking and linkages and augment existing channels of knowledge/technology transfer between universities and business.
- There is a very substantial amount of research that can be commercialised through the traditional vehicle of technology licensing by universities. Some of the more advanced websites hosted by universities and their technology transfer offices/companies display such opportunities.

University technology transfer offices/companies are aware, however, that active marketing of technology to potential users through face to face interactions is essential for effective transfer.

1.8 Categories of networks

Communication managers in knowledge networks take on various roles – they may be facilitators, mediators, or entrepreneurs. These roles depend on the nature of the network. Networks may be:

- Community based - sharing and wide disseminating knowledge in the broader context of the "community of science", or a "community of practice" popularised by Etienne Wenger (Wenger, McDermott, and Snyder 2002; Wenger and Snyder 2000). Facilitators quite often act in a pro-bono capacity, or receive support from government programs – such as the ARC networks program. [Cos.com](#) is a global

community of researchers. There are also many knowledge communities and clusters supported by government programs. Their success is contingent on the willingness to 'give' knowledge rather than 'sell' it in a market based environment.

- Market based - buying and selling 'intellectual products' such as inventions and patent licenses. Entrepreneurs frequently act for the acquirers of knowledge (as they have the greater capacity to pay). The global knowledge exchanges, or brokerages, such as UTEK and yet2.com could be seen as falling into this category. Australia's relatively small technology output limits the scope for creating a market based network which would operate only in Australia.
- Organisationally based - involving mediation between providers and users through 'honest brokers' leading to alliances, partnerships and joint ventures. The *InnovationXchange* and *Techfast* fall into this category. These models have relied on public funding to address perceived market and institutional failures. They are working towards a framework of self sufficiency.

Features of each category of network are discussed in the remainder of this Report.

2 Knowledge sharing networks (knowledge communities)

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.

2.1 Overview

Knowledge communities, such as the science community, are structured around the rules of gift relationships. Scientists give, or present, papers to their peer community via conferences and publication in journals. 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).

The community dimension stresses the importance of social capital, that is, the stock of trust, mutual understanding, and shared values and behaviours that bind members of communities and make cooperative action possible.

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.

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 1997).

Knowledge communities are characterised by high levels of trust, robust personal networks, vibrant societies, 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.

It is possible to identify two broad categories of knowledge community:

- Communities of practice
- Knowledge clusters

The concept of *communities of practice* has emerged from considerations of social capital. More recently attention has turned to the concept of relational capital (Florida 2002; Wenger, McDermott, and Snyder 2002). These communities grow out of practical need, are drawn together by common activities and cannot be managed into existence.

The Australian Research Council provides financial support for knowledge sharing networks. The networks that have been supported are essentially research communities with very little end-user involvement. There are currently 24 networks functioning with ARC support.

Similarly, industry, professional organisations and regions support networks for the exchange of knowledge where there is a *collective* benefit. The Department of Industry,

Tourism and Resources Innovation Access Program has funded 10 network initiatives (including the *InnovationXchange* – see below).

Knowledge clusters are a special case of knowledge sharing networks. Their success is contingent on the willingness to share, or 'give', knowledge as well as 'sell' in an external market based trading environment. There has been strong public policy interest in cluster initiatives by the Department of Transport and Regional Services and State Governments.

The research for this study has not identified many knowledge sharing networks that cross the divide between industry, government and the academy. The wine industry is often cited as a rare example of a working cluster (Marsh and Shaw 2000).

2.2 Communities of practice involving universities and research organisations

Profiles of a number of communities of practice are provided below.

2.2.1 *The Community of Science*

www.cos.com

The Community of Science (COS) is both a generic term as well as a global resource for hard-to-find information critical to scientific research and other projects across all disciplines. It aggregates valuable information so researchers spend less time and money searching for required information. Services include:

- Finding funding with COS Funding Opportunities – one of the world's most comprehensive funding resource, with more than 23,000 records representing nearly 400,000 opportunities, worth over \$33 billion.
- Identifying experts and collaborators with COS Expertise: search among 500,000 profiles of researchers from 1,600 institutions throughout the world. It is possible to find out who is undertaking research across the fields of research, the funding received, publications, patents and new positions.
- The promotion of individual research with a COS Profile: individual research and expertise of researchers and scholars from universities, corporations and nonprofits in more than 170 countries are profiled.
- Convenient tools to keep CVs updated and accessible.

Cos.com is directed primarily at research providers and, as the name suggests, is formed around the values of community.

Market based exchanges tend to focus more on the requirements of users. These include yet2.com. and utek.com which are discussed below.

2.2.2 *Academic networks and communities of practice*

Over the last several years a great deal of attention has been given to the 'third mission' of universities beyond the first two of teaching and research. The third mission relates to outreach and 'engagement' between universities and the society in which they operate (Johnston and Howard 2003; Bjarnason and Coldstream 2003).

Some see outreach purely in economic, industry and business terms (commercialisation), whilst others see it in a more social, cultural and environmental context.

Several networks created by universities, research organisations and learned societies that have an 'outreach' focus in the context of the innovation system are described briefly below.

Commercialisation groups - bizNet Club

bisNet Club is an Australian network of researchers, entrepreneurs and interested parties supporting the commercialisation of technology businesses in the states of NSW and

ACT. It is operated by Australian Technology Park Innovations Pty Ltd (ATPi), which is jointly owned by four leading universities in Australia, and is headquartered at the Australian Technology Park in Sydney, Australia. Features of its operation include:

- A mission to facilitate the commercialisation of emerging technology businesses with particular emphasis on the ICT, biotechnology and electronics sectors;
- Designed to assist entrepreneurs commercialise emerging technologies by facilitating strategic thinking, linkages, deal-making and professional skills development
- Complementing the full business acceleration programs run by ATPi, and provides “outreach” to technology companies not physically located at the Australian Technology Park.

Budding and successful technology entrepreneurs are encouraged to join, and also other personnel involved in the commercialisation of emerging technology companies including; mentors and advisors, service providers, investors, government representatives, relevant industry or academic associations.

Technology transfer networks - Techno-L

Techno-L is a discussion forum for patent attorneys, technology transfer, and licensing professionals in universities, government, non-profit research institutions, and private industry. Techno-L has over 1,000 members worldwide representing universities, government, corporations, news services, and inventors' associations.

Topics of discussion range from the best practices for technology transfer including the details of technology assessment and license negotiation, to discussions of national and international policies regarding technology transfer.

Techno-L is a free and open forum. It is used extensively by university technology transfer offices.

Discipline oriented networks

Scholars in an academic environment network extensively through publication, correspondence, attending conferences. Conferences are major networking events.

In many scientific disciplines research personnel from industry attend conferences with a view to identifying current trends and directions in research and make contacts with researchers in the academy.

Researchers from industry and others interested in research application and adoption are not always welcomed with open arms at these events.

2.2.3 *ARC supported networks*

The ARC research networks program has supported a number of knowledge exchange projects at Australian universities. Projects currently in receipt of assistance are listed below.

Administering Organisation	ARC Research Network
Griffith University	The Governance Research Network (GovNet)
Macquarie University	ARC/NHMRC Fluorescence Applications in Biotechnology and Life Sciences
	Australia-New Zealand Research Network for Vegetation Function
Macquarie University	The ARC Earth System Science Network
The Australian National University	Asia-Pacific Futures Network
	Australian Nanotechnology Network
	Australian Research Network for Advanced Materials
	Complex Open Systems Network (COSNet)
The University of Adelaide	ARC/NHMRC Research Network in Genes and Environment in Development (NGED)

Administering Organisation	ARC Research Network
	Discovering the past and present to shape the future: networking environmental sciences for understanding and managing Australian biodiversity
The University of Melbourne	ARC Research Network on Intelligent Sensors, Sensor Networks and Information Processing Research Network for a Secure Australia (RNSA)
The University of Queensland	The Economic Design Network: Practical Policy Tools for Industry, Infrastructure, Services and the Environment ARC Research Network in Enterprise Information Infrastructure (EII) ARC Research Network in Spatially Integrated Social Science The Cultural Research Network
The University of Sydney	ARC/NHMRC Research Network in Ageing Well Molecular and Materials Structure Network
The University of Western Australia	ARACY/ARC/NHRMC Research Network: Future Generation ARC Research Network for Early European Research
University of South Australia	Australian Communications Research Network
University of Technology, Sydney	ARC/NHMRC Network for Parasitology Financial Integrity Research Network
University of Western Sydney	Enabling Human Communication: Tough problems in human communication with bold but informed solutions drawing on sound, speech, and language research capabilities.

The extent to which these networks will engage with people and organisations involved in the adoption of research outcomes is not clear.

2.2.4 University research centres and institutes

Many research centres have programs and initiatives to build engagement, particularly where there is substantial industry funding.

The Cooperative Research Centre (CRC) Guidelines encourage CRCs to work with small to medium enterprises (SMEs). One of the selection criteria in the 2004 selection round states that:

The CRC Committee will consider, among other things, the robustness of the assessment of market or other end-use opportunities; the quality of the planning and proposed resourcing of commercialisation/utilisation strategies; the strength of commitments by end-user participants *and the quality of strategies to engage SME end-users in the CRC's additional activities.*

Many CRCs have networking and technology 'brokerage' programs.

2.2.5 Scientific academies

Networking activities take place through their role in facilitating international exchanges of scientific knowledge and via activities surrounding scientific infrastructure that also involve industry.

There are some potentially significant developments in academic-industry KEN's surrounding the bio-medical Major National Research Facilities (MNRFs) and also the astronomy facilities.

The MNRFs also collect, exchange and diffuse knowledge beyond the Learned Academies.

2.3 Communities of practice involving industry, universities and government

Communities of practice involving industry, universities and government are seen as an important way for information to be shared among researchers and users. Two examples are provided below.

2.3.1 *Future Materials - Australian Materials Technology Network*

<http://www.future.org.au/index.html>

Future Materials is the marketing name for the Australian Materials Technology Network. It is an un-incorporated, not-for-profit, joint venture, which has received seed funding from the Commonwealth Government through AusIndustry. It is a national network whose founding partners include Australia's leading universities and TAFE.

The network brings together Australia's materials technology research institutions, and the Institute of Materials Engineering Australasia. Participants include:

- The University of Queensland - Brisbane Surface Analysis Facility
- University of NSW - School of Chemical Sciences
- Australian National University - Centre for Science and Engineering of Materials
- Monash University - Centre for Advanced Materials Technology
- Ian Wark Research Institute - University of South Australia
- Central TAFE - Advanced Manufacturing Technologies Centre

Future Materials was established to ensure Australian companies have access to a national materials technology network comparable to those already available in the USA, Japan and Europe. In these countries it has long been the norm for engineering and technology based companies to have close working ties with universities and research institutions.

Through the Network Australian companies have access services and equipment previously difficult to attain. These include:

- Materials characterization and evaluation
- Problem solving, such as investigating contaminants and materials failures.
- Studies and testing on coatings, thin films and surface modifications.
- Expert and independent opinion in litigation and IP matters.
- Collaborative research aiding the development of new products and processes.

Future Materials has over 1000 subscribers and a number of new projects in the pipeline. They have held some successful seminars and workshops on subjects such as IP and Materials, TIG Welding, Nanomaterials, Nanotechnology, Plastics and Polymers and the potential of R&D clusters.

2.3.2 *Australian Microelectronics network*

The Australian Microelectronics Network (AMN) is a national non-profit membership based network of microelectronics engineers. Members include major multinational R&D companies, leading high technology manufacturers, electronics design consultancies, universities and individuals passionate about microelectronics.

University members are listed below:

- Adelaide University, Department of Electrical and Electronic Engineering
- Curtin University of Technology, Australian Telecommunications Research Institute (ATRI)
- Edith Cowan University, School of Engineering and Mathematics and the Centre for Very High Speed Microelectronic Systems
- Griffith University, Faculty of Engineering and Information Technology (EIT), Schools of, Engineering, Information Technology, Microelectronic Engineering and Computing, and Information Technology
- La Trobe University,
- Macquarie University Department of Electronics
- NNTTF-Edith Cowan University, The National Network Teletesting Facility for Integrated Systems
- Queensland University of Technology, Electrical, Electronic and Computer Engineering Research and Education

- The University of Sydney, Electrical and Information Engineering including classes in microelectronic design and Computer Engineering Laboratory (CEL)
- The University of Western Australia, Department of Electrical and Electronic Engineering
- The Warren Centre for Advanced Engineering - an independent industry-linked institute committed to fostering excellence and innovation in engineering technology and industry development.
- University of Queensland, School of Information Technology and Electrical Engineering
- Victoria University - Telecommunication and Electronic Technologies Centre.

2.3.3 *Comment*

Participants in communities of practice quickly realise that the communication framework requires maintenance and resource commitment. Unless this resource comes from within the community, the arrangement will falter for basic economic reasons. In this regard, communities require a principal sponsor and coordinator. Industry and professional associations are generally well placed to do this.

For example, the Microelectronics Network became a forum of the Australian Electrical and Electronics Manufacturers Association (AEEMA) in January 2005. AMN members have been invited to become of AEEMA. A profile of AEEMA is provided at 2.4.2 below.

2.4 **Communities of practice supported by Industry associations**

2.4.1 *Overview*

The role of industry associations in technology diffusion and networking is becoming more important. As governments have worked towards creating better links between their investments in public research, workforce improvements and economic and industry development, new kinds of industry associations have started to emerge around the rapidly growing technology sectors of information technology, biotechnology, medical devices and environmental protection, preservation and restoration.

These newer industry associations are more focused on having strong and active science and technology programs, creating partnerships with government to address gaps and issues, and ensuring a strong higher education and research infrastructure. For governments, these newer associations have become important supporters of higher education programs which address issues such as the need for expanded graduate programs, targeted technician programs in the TAFE sector, and expanded ways for university faculty and students to connect with industry (Plosila 2004).

2.4.2 *Australian Electrical and Electronics Manufacturers Association (AEEMA)*

AEEMA represents Australia's information and communication technology (ICT), electronics and electrical manufacturing industries. Its members supply infrastructure, products and manufacturing-related services to Australian and world markets.

Through its many industry working groups and forums, AEEMA represents member interests by shaping government policy and assisting with the appropriate development of industry codes and regulation. AEEMA nominates some 290 representatives to 75 Standards Australia Committees. In addition, AEEMA helps new technologies to secure access to world markets by creating commercial and technical opportunities through a wide array of international alliances.

The Association covers technologies relating to communications, connected homes, data capture, defence, electrical capital equipment, electronics, hazardous area equipment, home appliances and accessories, IT security, lighting, photonics, smart cards and all

aspects of environmental regulation and codes. AEEMA maintains strong links with government agencies through their representation on several Forum Boards.

Industry development is a major focus: members identify new national and international business development opportunities, e.g. connected homes, telematics and trusted networks that have a positive impact on industry growth and wealth creation. AEEMA works closely with the Australian InnovationXchange.

AEEMA's networking facilities enable members and key stakeholders to access first hand industry and market information through a program of events, conferences and seminars. Regular industry and market news is available to members and other interested organisations through its on-line E-Bulletin.

2.4.3 *Australian Information Industries Association (AIIA)*

AIIA's is the Australian peak body representing the Information and Communication Technology (ICT) industry. It represents over 420 member companies that generate combined annual revenues of more than \$40 billion, employ over 100,000 Australians and have exports of over \$2 billion.

AIIA is involved in:

- Marketing the value and capability of the Australian information industry to other companies, countries, organisations and people.
- Providing forums for member organisations to debate important industry issues and encourage appropriate government policies for the industry.
- Providing members with up to date industry information and intelligence on the economic and policy environment.
- Providing specific tools and services such as our highly regarded Salary Survey.
- Providing business networking and briefing opportunities for members around Australia.
- Influencing Federal and State governments to improve your business environment.

AIIA supports the AIIA Software Showcase as one of the feature areas of CeBIT Australia 2005, Australasia's leading ICT exhibition. The Showcase enables up and coming Australian software developers to participate in this major international event to demonstrate their products and services to a professional local and international business audience of 30,000 potential customers, investment partners and distributors.

AIIA is to merge with the Australian Electrical and Electronics Manufacturers Association in 2005.

2.4.4 *Welding Institute of Australia*

The Welding Technology Institute of Australia (WTIA) was formed in 1989 by the amalgamation of the Australian Welding Institute and the Australian Welding Research Association. There are currently 350 member companies and 1,500 personal members.

WTIA's goal is to assist in making Australian industry locally and globally competitive in welding-related activities. Key strategies are in place to:

- create the correct cultures for competitiveness
- facilitate technology transfer to industry
- drive research and development
- provide a quality work force
- standardise qualification and certification throughout the country.

The organisation offers a wide range of services to its members, including technical advisory, library, and information services. It runs seminars and conferences throughout Australia, publishes the Australasian Welding Journal and Welding Research Supplement,

and conducts examinations for welders, inspectors, supervisors, technologists and engineers.

The WTIA is the Australian representative on the 41-member country International Institute of Welding and is the Authorised National Body administering the international qualifications program in this country. It is currently accrediting a network of IIW Approved Training Bodies and has introduced transitional arrangements for existing Australian qualifications to the new international scheme.

Through its Council, Boards, SMART and Industry Support Groups, and Technical Panels it has representation from a broad range of industry, government authorities and educational institutions both locally and internationally.

WTIA is a core partner of the Cooperative Research Centre (CRC) for Welded Structures.

In 1998 the WTIA launched the OzWeld Technology Support Centres Network Project with strong industry support. The OzWeld Network is now incorporated into the SMART (Save Money And Re-engineer with Technology) Project launched in 2000. The WTIA SMART TechNet Project aims to promote improvements in Australian industry through optimum use of Technology.

2.4.5 *AusBiotech*

AusBiotech is Australia's Biotechnology Industry Organisation, which represents over 2,400 members, covering the human health, agricultural, medical device, environmental and industrial sectors in biotechnology. It is dedicated to the development, growth and prosperity of the Australian biotechnology industry, by providing initiatives to drive sustainability and growth, outreach and access to markets, and representation and support for members nationally and around the world.

AusBiotech is represented in each Australian State and brings together all the relevant players to facilitate the commercialisation of Australian bioscience in the national and international marketplaces. The structure is a not-for-profit limited guarantee company managed by a Board elected by members.

The membership base includes biotechnology companies, ranging from start-ups to mature multinationals, research institutes and universities, specialist service professionals, corporate, institutional, individual and student members from Australia and globally.

2.4.6 *Australian Venture Capital Association*

The Australian Venture Capital Association Limited was established in 1992 as a forum for the emerging venture capital industry participants to meet, to pursue topics of common interest, to promote the local venture capital industry and to encourage investment in growing business enterprises.

AVCAL encourages the provision of courses aimed at increasing the supply of skilled venture capitalists and increasing the skills of Australia's entrepreneurs.

The following services are provided to members

- A Website - a virtual hub of venture capitalists and service;
- Networking events across Australia;
- Annual Australian venture capital conference;
- A range of industry tools, including non-disclosure agreements, valuation; guidelines, standard Industry Trust Deed;
- Information for entrepreneurs seeking capital;
- An employment database;
- Research information;
- A register of non-executive directors.

AVCAL has collaborated with government in the development of Australia's venture capital finance sector.

2.5 Communities of practice supported by professional associations

Professional associations make a major contribution to networking, particularly where membership is drawn from industry, government, higher education, and research organisations. Associations which have taken a major role in facilitation knowledge exchange are listed below.

2.5.1 *Knowledge Commercialisation Australasia (KCA)*

Members include universities, government research organisations and departments, medical research institutes, rural research and development corporations and TAFEs.

KCA's purpose is to assist in the development and maintenance of skills associated with knowledge transfer from public sector organisations. It also aims to promote the activities of its members in government, industry and commercial forums.

KCA objectives relate to:

- Provide professional development opportunities and information relevant to knowledge transfer;
- Be proactive in contributing to government and industry discussions on policies related to knowledge transfer from public sector organisations and encouraging awareness of these knowledge transfer activities;
- Provide a stimulating forum for members to share their ideas and experiences;
- Interact with government and industry with the aim of fostering better relationships and providing the opportunity to overcome commercialisation and collaborative barriers.

KCA membership is drawn from university technology offices, research organisations, rural research and development corporations, venture capital investors, lawyers and accountants.

KCA organises a national conference and several mid year events such as the Commercialisation Forum and Fair of Ideas in October 2005 in Melbourne. The event is funded by the Department of Education, Science and Training through the Australian Government's Backing Australia's Ability initiative.

2.5.2 *Licensing Executives Society (LES)*

LES is an international non-profit professional society whose members, as individuals worldwide, are actively involved in professional and business activities concerned with transfer of technology and industrial or intellectual property rights.

When LES was founded in 1965 in the United States, its purpose was to establish licensing as a profession, enabling its members to meet, learn from one another and encourage high professional standards among the individuals engaged in licensing of intellectual property rights and the transfer of technology.

Following its founding, LES has grown into a world-wide organisation with national or regional societies in 33 countries.

LES objectives are:

- Educating its members in basic skills (professional and business);
- Providing a forum for members to meet and share experiences;
- Monitoring developments in licensing practices, publishing reports, studies, and statistics;
- Facilitating contact between potential licensors and licensees;
- Encouraging high professional standards for members;

- Sensitising governmental and international bodies to licensing issues, providing information and briefing.

2.5.3 *Cooperative Research Centres Association*

The Cooperative Research Centres Association was established in 1994 to provide a national, coordinated voice for its member CRCs on all major issues affecting them in pursuit of their research objectives and in the conduct of the CRC Program.

The Association facilitates activities to establish and maintain recognition of CRCs as significant contributors to community welfare and wealth creation. The Association has put in place a series of electronic networks linking specialist CRC staff to assist in the flow and sharing of information on key aspects of the program and to maximise the collective efforts of the CRCs. These networks link CRC Directors, Business Managers, Educators and Communicators.

The Association's key objectives are to:

- act as the interface between CRCs and Government when dealing with broad issues affecting the CRC Program;
- promote awareness of the CRC Program and its value in linking researchers with users and in training technologists;
- promote financial commitment to CRCs through the CRC Program, and
- provide a forum for CRC members to access and share relevant information and experience concerning the operation of CRCs.

The CRC Association's target audiences include:

- CRC Chairs, CEOs, Business Managers, Education & Training Managers, Communication Managers
- Companies interested in exploring how technology can benefit their business
- Businesses that provide services to CRCs; law firms, accounting firms, patent attorneys, venture capitalists
- Groups contemplating applying for a CRC

The Association holds an Annual General Meeting at which general issues are discussed and determined. These meetings also provide an opportunity for member CRCs to 'show case' their achievements.

2.5.4 *Australian Industrial Research Group*

The AIRG is largely composed of managers responsible for technological innovation and R&D in public and private companies operating in Australia. It also has affiliate members from public research agencies, universities and service groups with interests in science and innovation.

AIRG sees its role as improving the quality of research management in Australia and stimulating the understanding of research and development as a force in economic, industrial and social activities.

Member-company representatives derive the following benefits:

- Opportunities for involvement in benchmarking discussions on technological innovation, R&D management and organisational issues within Australian businesses to identify and promote more effective operations,
- Access to forums and material delivered by experts in the field of technological innovation, concentrating on aspects of present-day management that are critical to high levels of competitive performance,
- Opportunities to build a network of contacts among peers in the field of technological innovation,

- Awareness and clarification of government policies affecting technological innovation, and the opportunity to influence policy development in this area,
- Access to conferences, information and material from international organisations active in technological innovation.

2.5.5 *Others*

Professional associations such as the Institute of Chartered Accountants, Australian Society of Accountants, Engineers Australia, Institute of Company Directors, Australian Institute of Management, are involved in networking services for members, including building relationships between industry and the academy.

2.6 **Communities of practice formed through government enterprise development programs**

As a by-product, and increasingly as a defined outcome, a number of government enterprise-development programs have stimulated the formation of networks that involve the sharing of knowledge about commercialisation best practice. Some programs have introduced provision for mentoring and advice.

Aspects of these programs are discussed below.

The Commercialising Emerging Technologies (COMET) program

A number of COMET supported companies have seen value in establishing COMET support groups to share and transfer knowledge during and after the Tailored Assistance for Commercialisation (TAC) plan process. Particular value was seen in maintaining contact after the TAC plan had been completed (Howard 2002).

The New Industries Development (NIDP) Program

The NIDP program supports regular meetings of NIDP supported companies for the purpose of exchanging experiences and perspectives about commercialisation (Howard 2002).

2.7 **Science and technology clusters**

2.7.1 *Background*

In recent years the concept clustering activities has received an increased attention as a platform for knowledge sharing, application and use. Geographers have analysed cluster development over many years using location theory and theories of agglomeration (Krugman 1996). Michael Porter renewed interested in the cluster concept from the perspective of business competition and industry and regional outcomes. He defines a cluster as a 'geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities' (Porter 1998, 1999).

The origins of clusters can lie in an investment in a piece of infrastructure, a government decision, a new technology, or a chance happening. Early commercial success leads to the entry of other players keen to be part of the action. This in turn feeds revenue streams that finance more infrastructure. This has been a characteristic of Silicon Valley and North East US clusters (Saxenian 1996). Clusters are intuitively understood by investors and real estate agents, and have been subject to extensive analysis by academics. There is now a strong interest in science and technology clusters as a forum for knowledge exchange between research organisations and businesses. Industry organisations have been taking a lead role in facilitating this form of cluster development.

The concept of a science and technology 'cluster', in the context of knowledge exchange, is distinct from the notion of an economic development 'cluster'. Science and technology

clusters are often specific to a firm or business and need not be limited by geography: they are defined in terms of *the interactions and relationships of scientists* in business and in research organisations and their respective fields of expertise. With information technology, such clusters may reflect a combination of regional, national and international dimensions.

A science and technology cluster can exist in a geographic sense when separate institutions, which are in close physical proximity, build a critical mass of utilisable knowledge through close collaboration. For example, in Parkville, Melbourne, the universities of Melbourne, the CSIRO and several medical research institutes have a world class capability in molecular biology. It is also an area that is of intense interest to companies.

Cluster-based forms of collaboration and interaction between organizations is becoming increasingly important in the context of globalisation, the cost and complexity of research and development, and the importance of supply and distribution channels. The commercialisation of inventions that occurs through collaboration between research organizations, research centres and businesses is of particular interest in this Review.

In most industries relationships with other organisations are a major criterion for success in competitive markets. These relationships cover supply, distribution and marketing – and increasingly, research and development. Research and development is now undertaken in close collaboration with specialised organisations, including universities and research centres. *Companies wish to tap into the richer innovation skills that outside suppliers offer.*

The secret of success in cluster based arrangements is leadership. 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. While in the US that leadership is often provided by universities, in the Australian context that leadership is being provided on an increasing scale by nationally oriented industry associations. This reflects the different history and development of relationships between universities and industry in the two societies. Whereas the US university system has had a long established relationship with the community and industry going back to the Land Grant universities and the model of the German (Humbolt) system, Australian universities have been largely modelled on the independent and scholastically autonomous and remote British (Newman) system.

2.7.2 *The role of industry associations as leaders in cluster development*

The common theme in the literature on clusters is the importance of *leadership* in promoting and stimulating cluster development, growth and sustainability. That leadership may come from the community in the form of civic entrepreneurship (Henton, Melville, and Walesh 1997), universities and research organisations (Walshok et al. 2002; Walshok 1995), government (Great Britain. Department of Trade and Industry 2003; National Governors Association 2002), and/or industry associations (Humphreys 2004).

As Porter notes, many industry associations do little more than lobby government, compile some statistics and host social functions, but the opportunities for associations to create and enhance cluster competitiveness is much greater. In addition to providing a neutral forum for identifying common needs, constraints and opportunities. Porter's research indicates that:

Associations often take the lead in organising national and international fairs and delegations; they create training programs in conjunction with local institutions, manage purchasing consortia, establish university based research programs and testing facilities, collect cluster related information, offer forums on common management problems, investigate solutions to environmental issues, and pursue many other common interests.

Associations fulfil especially important functions for clusters consisting of many small- and medium sized firms ... Such clusters have a particularly great need for a collective body to take on scale-intensive functions. (Porter 1998)

Through the collaboration of industry associations and institutes opportunities are being explored for these cluster based networks to perform the role of technology consortia. In this role, a research effort can be developed among business firms, government and universities that helps participating companies to maintain industrial leadership and gain a competitive edge over international competitors. AEEMA and collaborators are working towards the development and implementation of a *Tech Team* concept for technology based SMEs through cooperation between States, Territories, Australian Government agencies and relevant industry and commercial sectors.

2.7.3 *The Innovation Exchange cluster model*

The Australian *InnovationXchange* is in the process of developing a web-based e-cluster model with companies and organisations with converging interests participating in industry oriented virtual, on-line, communities. The *InnovationXchange* has already generated the world's first Life Sciences Cluster, with the support of the Australian and Victorian Governments.

The e-cluster offers an additional layer of exclusivity, enabling members - through *InnovationXchange* intermediaries, or 'honest brokers' - to share business development and R&D information with selected partners without the risk of inappropriate disclosure of information. This is referred to as the *bridge program*.

Members of the Life Sciences Cluster include:

- IBM Healthcare
- Johnson & Johnson Research
- Walter & Eliza Hall Medical Research Institute
- University of New South Wales
- and six listed BioTech companies:
- Acrux Ltd
- Amrad Corporation Ltd
- Biota Holdings Ltd
- Cytopia Pty Ltd
- Starpharma Pooled Development Ltd
- Virax Holdings Ltd

In discussions and consultations for this Study one university technology transfer company that was part of the Life Sciences Cluster was highly supportive due to the capacity of the 'honest broker' to allay a concern on the part of industry partners about 'contamination' of their IP in opening up direct discussions with the university.

New clusters are presently being built and connected to each other.

2.7.4 **NSW State Development Innovation Clusters Initiative**

The Department of State and Regional Development helps groups of businesses that want to create sustainable and commercially focussed business clusters through its *Business Cluster* program. Some of the specific initiatives are discussed briefly below.

Innovative Technology Network (ITN)

The Innovative Technology Network is a joint project of the University of Western Sydney and the NSW Department of State and Regional Development. The purpose of ITN is to promote business efficiency and competitiveness through the uptake of new technologies and innovative practices. ITN is funded under the Government's Technology Diffusion Program.

The ITN Program conducts monthly seminars bringing together local business people, academics and consultants to share successes, learn of new developments and tour local business. Participants are kept under 30 to encourage questioning and useful discussion of real business challenges. Venues are either University facilities or, more likely, local industry sites.

Western Sydney IT Cluster

The cluster aims to promote the capabilities of an estimated 1500 ICT businesses by expanding local and global markets and providing knowledge and technology diffusion opportunities. The cluster provides the opportunity for SMEs to network and collaborate and encourage interaction with professional and specialist service providers – several of whom are sponsors of the initiative. The cluster seeks to find business opportunities as well as access to funding and business support programs from government agencies.

There are 200 registered members of the cluster – regarded as being Australia's largest gathering of ICT SMEs. Specific services include:

- Market intelligence services from the Gartner Group
- Tender notification
- Market updates
- Access to business centre resources
- Access to the Western Sydney IT Cluster Website.

Other cluster initiatives

The NSW Department of State and Regional Development also supports the following cluster initiatives:

- Aquaculture Innovation Cluster
- Building and Construction Innovation Cluster
- Central Coast – ICT Innovation Cluster

2.8 **Conclusion**

This Section has explored the concepts of communities of practice and clusters in the context of knowledge exchange. A number of categories have been identified, including clusters supported by universities and research organisations, clusters supported by industry and professions associations and clusters supported by government agencies. The driving interest of business involvement in networks is their capacity to work on a collaborative basis with other firms, including overseas firms, and to tap into the innovation capacities and capabilities of research organisations.

The key to success in the cluster arrangement relates, quite fundamentally, to the skills, knowledge, and experience and leadership capacities of the intermediaries involved. Where commercial issues are involved, independence and confidentiality are also required - giving rise to the concept of 'honest brokers' (Howard and Johnston 2001).

Leaders have to have good technical knowledge, but more importantly, excellent commercial knowledge and understanding of business drivers. Absolute discretion is taken as a given.

Scrutiny of overseas models does however raise a concern that too rigid an approach to network-building is being adopted. This issue might arise as network arrangements move from a community and collective model involving informal and industry based support to an organisational and managed model of relationships when government subsidies, assistance and direction is provided.

Science and innovation networks require *flexibility*: the ability to build and re-configure linkages as learning takes place and events unfold. Rigid network financing 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).

From the information provided in this Section of the Report, knowledge communities and clusters with strong industry involvement, through industry associations, provide the strongest basis for the development of knowledge exchange networks. Leadership from industry associations provides the basis for effective involvement and engagement between industry, the academy and government. This role will develop as industry associations move from an industrial relations and lobbying focus to one of partnership in science and innovation policy.

Drawing on the example of the mining, agriculture and wine industries, where collaboration in research and development positioned these industries as world class, several industry associations in the 'new economy' are leading the way in this regard. The Australian Electrical and Electronics Manufacturers Association (AEEMA), the Welding Institute of Australia, and the Australian Industry Group (through the *InnovationXchange*) are important examples.

3 Knowledge exchange networks (markets for knowledge)

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 the context of the knowledge economy there has been an expansion in the market for knowledge – build around the production, distribution and exchange of what are often termed ‘intellectual products’.

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. Electronically enabled knowledge exchange networks have emerged as one form of knowledge market. These markets form the primary focus of discussion in this section.

3.1 Overview

Economists have promoted a view that the market is the ideal way to organise all economic activities. The market system emphasises voluntary exchange between parties.

The 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 organizations 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 (Davenport and Prusak 1997). 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

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. The processes for the transfer of knowledge from a higher education institution to a corporation are occurring in an increasingly sophisticated market structure.

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.

3.2 The role of intermediaries in the market for knowledge

This development of the market system has also seen a proliferation of intermediaries to stand between buyers and sellers as brokers, advisers, and arbitrageurs. Intermediaries include:

- Early stage venture capital investors;
- Commercialisation advisers and consultants;
- Lawyers, corporate and taxation advisers, and patent attorneys who advise on corporate law, business planning, marketing, taxation structures, and IP.

These intermediaries (generically referred to as service providers) usually work on a commission or fee for service basis. They are extensively involved in industry and professional networks and see this as a way of securing business. While this market is developing strongly, there is a market failure in the sense that some research providers lack the resources to effectively enter the market.

As technology users are most often the source of fee income, intermediaries are generally seen to reflect the interests of this side of the market. Whether real or only apparent, this issue is of major concern to research providers who do not have the resources to engage technology brokers directly.

The resolution of this issue is seen by many businesses and industry bodies in the use of independent and trusted intermediaries to facilitate the exchange of sensitive information among companies in what it has termed ‘innovation markets’. 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). The greater the information asymmetry between buyers and sellers, the greater is the demand for an independent and ‘trusted’ intermediary.

John Wolpert, formerly of IBM and now with the Australian *InnovationXchange*, 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).

The appointment of intermediaries, or brokers, has been at the basis of the evolution and transformation of the Australian *InnovationXchange* from a knowledge market to a knowledge community, or collective, focus, as described in Section 2 of this Report. This is discussed below.

3.3 Knowledge exchanges in Australia

In Australia, prominent examples of electronic knowledge exchanges include

- The InnovationXchange (initial version)
- Australian Technology Showcase
- Aussie Opportunities (Australian Institute for Commercialisation)

3.3.1 *Australian Industry Group (AiG) - InnovationXchange*

InnovationXchange (IXC) is an initiative of the Australian Industry Group, one of Australia's largest industry associations. It is supported with funding from the AiG, the Australian Government's Innovation Access Program-Industry and by the State Governments of New South Wales, Queensland and Victoria. It was initially established using an Internet based approach for the transfer of knowledge between universities, research organisations and industry.

The IXC now operates primarily around an Intermediary Service for bringing knowledge creators and potential users closer together for the commercialisation of technology. It was founded on the premise that with the global shift from an industrial to a knowledge economy, no single company can possibly have all the answers. The IXC has a focus on relationships between businesses as well as between businesses and research organisations.

The IXC is claimed to be the first-ever knowledge exchange network to provide a secure, managed environment for the exchange of insights and opportunities between firms, universities and governments. The Intermediary Service and Network membership model is based on the concept of *honest brokers* who work with creators and users of technology. The model is based on practice that emerged with IBM in the US several years ago (Wolpert 2002).

IXC intermediaries work inside member organisations under a strict Code of Ethics, with the task of searching for and creating connections for business growth. Under the confidential structure of their engagement, Intermediaries are able to access each member's intellectual property (IP) and research and development (R&D) base in order to learn what members need, and what they can offer. When an opportunity is established, IXC Intermediaries are then able to help members engage directly.

The IXC offers four levels of membership:

- Connect First - for start-ups and entrepreneurs.
- Connect Plus - designed to assist small firms.
- Growth Package - for a greater level of research, contact and connections.
- Leader Package - tailored to organisations that are strongly committed to innovation and commercial growth.

The InnovationXchange's strategic alliance with FBR Asia, a global leader in business and market intelligence for the Asia-Pacific, also gives companies and research institutes cost-effective access to more than 35 countries throughout the region to commercialise new technologies, search for joint-venture partners, access venture capital, find collaborative research partners or to connect with outsourcing centres such as China, Taiwan, Hong Kong, Korea and Singapore.

3.3.2 *Australian Institute for Commercialisation - Aussie Opportunities Web Site*

Aussie Opportunities is a web-enabled database that which seeks to match Australian research and technology projects with potential investors and partners who can help in the project development. It specifically targets potential partners and investors, both nationally and globally, for their involvement in Australia's early stage research projects. The site is intended to serve as a 'one stop shop' for early stage IP.

The website has been developed jointly between the Australian Institute for Commercialisation (AIC) and Pacific Capital Corporation Ltd with the support of Knowledge Commercialisation Australasia and the Australian Industry InnovationXchange Network. The project was co-funded by the New South Wales and Victorian governments.

The technology underpinning the site enables quick and efficient interaction between both parties.

For researchers, or project managers responsible for commercialising research, Aussie Opportunities is a cost effective way to showcase research outcomes, and it provides the basis to "test the waters" and ascertain likely interest in their proposal. The AIC suggests that this could be most beneficial at proof-of-concept phase or early stage development.

The key characteristics of the site from a Project managers' perspective include:

- Cost effective way to showcase research outcomes;
- Site enables regularly updating at key project stages;
- Standard format of project information and registration is easier to complete than a detailed business plan;
- Project Managers will receive direct enquiries from interested viewers;
- Distribution system to Australia, New Zealand and other Overseas interested parties;
- If required Aussie Opportunities joint venture partners can provide access to relevant professional services, including capital raising.

Viewers may be other interested researchers and project managers, investors, potential partners, commercial firms, advisers, consultants and government bodies. Their involvement could be a Joint Venture, Strategic Alliance, License, Mentoring or Investment.

Key characteristics of the site from the viewer's perspective include:

- Robust matching criteria, which allows viewers unlimited selection of potential projects;
- Easy to view highlights of project matches;
- Option to automatically receive information about newly listed projects;
- Very large choice of opportunities in the one system;
- Viewer can remain anonymous if so desired.

3.4 International knowledge markets and knowledge exchanges

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 development of Internet technologies has seen the development of a number of web based information and knowledge exchanges designed to facilitate the transfer of technologies in this market. The features of some of these exchanges are canvassed below.

3.4.1 *Yet2.com*

Yet2.com is an online technology marketplace. It has the objective of fostering the connection between technology needs and capabilities by:

- Maintaining an online marketplace of technology for license, available know-how, and technology needs;
- Providing consultative services around assessing a portfolio of intellectual property to help select which technologies are suited to out-licensing;
- Helping to identify an organisation's technology needs and assisting in finding the answers and solutions to those needs;

- Assisting in preparing technologies for market;
- Assistance in the deal-making process through their web site and access to a large fraction of the world's R&D.

Registered members gain free access to an overview and information about the technology which is for sale or license. With the Technology Marketplace as its engine, yet2.com offers other products for organizations that need an internal technology exchange or that want to offer their own technologies on their own web sites.

The technology providers represent many of the most respected names in technology and intellectual property. Yet2.com claims that most of the current introductions are between large and small companies: small companies have found technologies that help them meet a market need which are not large enough for the large corporation; large companies have found ideas from smaller companies that don't have the resources to commercialize them effectively.

The Technology Providers alone represent about a quarter of the world's R&D.

Yet2.com charges a commission for technology transfer arrangements executed by way of introduction from its site, with a \$5000 minimum.

3.4.2 **UTEK**

UTEK is a market-driven technology transfer company that enables public companies to rapidly acquire innovative technologies from universities and research laboratories. It claims to be the only company that facilitates the identification and acquisition of external technologies by clients in exchange for their equity, while allowing research institutions to enjoy 100 percent of the royalties.

The company identifies, acquires and finances the transfer of university technologies for its corporate customers. The company notes on its website that:

According to the Association of University Technology Managers, North American universities last year spent over \$38.5 billion on research that resulted in approximately 15,500 new invention disclosures.

With approximately 70 percent of these new technologies going unlicensed, UTEK provides an effective new approach for getting these technologies to market. Partnering with universities with similar R&D interests makes enormous sense to many smaller public companies that have a dramatic need for new technology infusion, but have a limited ability to conduct or finance research.

UTEK creates substantial value for universities and laboratory research centers by finding, acquiring and financing the transfer of university intellectual capital for technology firms. UTEK does not participate or share in the royalty stream but rather acquires an equity stake in the business which brings the technology to market. UTEK calls this new process U2B®.

The company's mission statement centres on building a strong bridge between university technology and companies that can bring useful new ideas to the marketplace.

UTEK is dedicated to building bridges between university-developed technologies and commercial organizations. UTEK, along with its TechEx, UVentures, Pharma-Transfer and Techno-L on-line services and its UTEK-PAX, UTEK-EKMS and UTEKip subsidiaries, identifies and transfers new technologies from universities and research centres to the marketplace. As a business development company, UTEK provides research-outsourcing services to commercial enterprises and technology-transfer services to research institutions.

The business model is based on:

- UTEK forms a strategic alliance and learns about a client's business. It then finds, acquires and finances new technologies for them from the best universities and research centres worldwide.
- UTEK empowers clients firm to acquire technology from it for unregistered stock..

UTEK aims to offer its clients access to new technologies through:

- Reviewing the world's largest online searchable database for the life sciences (TechEx) or the physical sciences (UVentures)
- Sourcing from Europe's leading educational institutions through UTEK Pax and Pharma-Transfer
- Access to intellectual property management software (UTEKip) to empower universities, patent professionals and technology companies of every kind to better manage their disclosures, pending applications, patents and trademarks
- Techno-L to disseminate the discussion of best practices among technology transfer professionals (see knowledge communities discussed above).

3.4.3 *Cordis.com*

CORDIS, the Community Research and Development Information Service, is a free service provided by the European Commission's Innovation/SMEs programme. It is a tool designed to assist the further exploitation and development of research results. Through the services provided, Cordis aims to help users to:

- keep up to date on current research findings and strategic directions;
- find information about projects and actions of the European Commission's 'Sixth Research & Development (R&D) Framework Programme' and on how to participate;
- identify various funding sources for R&D;
- find partners to cooperate in R&D activities and share expertise;
- promote and find transferable technologies.

Cordis offers assistance by providing information through a collection of searchable databases. It also offers an extensive document library. In addition, Cordis provides information services for specific EU programmes and EU-level R&D issues. In particular, services are available for enterprises to assist in the process of converting promising research into successful new products and services.

Cordis information can be accessed through their web page or Cordis focus, a free fortnightly publication that highlights current EU R&D news and is based on information from the daily on-line CORDIS News Service. 'Cordis focus' is available in English, German, French, Spanish and Italian.

3.4.4 *Canada: Transforum*

This communication and information service links the industry liaison offices to a growing number of universities, affiliated research institutes, colleges, technical institutes and centres of excellence across Canada.

It is currently under going a reconstruction.

3.4.5 *Corporate exchanges*

Many global corporations have established corporate networks to source and market technologies.

3.5 **Conclusion**

Despite the promise of linking buyers and sellers through the Internet, the reality is that Internet based technology markets function more as electronic yellow pages rather than as places where transactions actually take place. The Internet, as the platform for a knowledge exchange, suffers from most of the problems that relate to human communication: it presents information from the perspective of the provider, not the user.

Apart from routine transactions, the Internet has actually made human interface and interaction *more* important in negotiating complex business deals. Due to large information asymmetries between sellers and buyers about the nature and value of the knowledge being made available, trust becomes a key factor in the exchange.

Our discussions and consultations with university technology transfer offices during the project indicates that little use is made of electronic knowledge exchanges. Technology transfer managers advised that what they most often require is high quality, industry specific, market research – that which cannot be acquired through Internet searches – and experienced business development managers.

The vast volume of information generated from global research institutions and the number of e-based businesses filling the space between discovery to commercialisation (eg. tech-transfer, licensing, patenting, IP evaluation, networking, public relations) and particularly those based in the US and EU, make Australian efforts to gain international attention exceptionally challenging (and some might say futile). There are a number of implications that flow from this situation:

- The Internet is an initial point of call for the exchange of knowledge only and other forms of communication and interaction are essential and more effective for knowledge exchange;
- This 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 and intermediaries;
- There is scope for knowledge brokers to design and execute communications strategies and associated systems to ensure that information about publicly funded science and technology and which is commercially relevant (that is likely to be taken up in a new or existing business) is readily accessible to investors and business generally. This must be done giving attention to electronic *and* other means of communication.

The evolution of the InnovationXchange from an electronic information exchange to one that involves independent 'honest broker' agents points to the important role of 'market makers' - that is people to act as intermediaries between the suppliers and users of knowledge. A key aspect of the role is that it be independent and not perceived to have conflicts of interest by acting in an agency role for technology investors and service providers wishing to generate professional fees from the exchange of knowledge and its commercialisation. .

There is a strong case to support the continued development of technology brokers such as the InnovationXchange who are knowledgeable about university and business research, who can work with business (both small and large) in an independent intermediary role. This should not displace the market oriented role of a growing industry of professional technology advisers.

4 Knowledge management networks (knowledge organisations)

Parallel to the emergence of knowledge markets has been that of formally established relationships between universities and businesses, based on alliances or networks with many of the characteristics of communities. These are an alternative, or complement, to market-based transactions and are discussed in this Section.

4.1 Overview

Knowledge management networks, in the form of strategic alliances, partnerships and joint ventures are found in cooperative research centres, industrial research institutes, and other forms of formal collaborative government-industry-academy relationship. A critical characteristic of these organisations is building a formal relationship between knowledge creators and users.

It has been observed on many occasions that these arrangements do not suit the special situation and circumstances of new technology-based firms (NTBFs), particularly those which seek to access new discoveries and emerging technologies being developed in the academy. Moreover, these firms quite often need much more support and assistance in the development and application of technologies from a business perspective, in addition to accessing specific technologies.

4.2 Australian Institute for Commercialisation Initiatives

The Australian Institute for Commercialisation (AIC) fits the category of a knowledge exchange organisation.

The Institute was established by the Queensland Government as a national, not-for-profit company to deliver programs to improve commercialisation of Australia's research investment. The company commenced operations in July 2002 as a "Smart State" initiative and has received support from all States, the Northern Territory and a number of universities and research institutions.

AIC programs include:

- The delivery of AIC professional development programs targeted at improving commercialisation management skills.
- Collaborative analysis projects to provide information that facilitates better resource allocation and policy input.

4.2.1 *Professional development programs*

The AIC has developed three tiers of professional development programs aimed at improving the management skills and competencies of researchers, managers and directors in the commercialisation sector.

These courses are developed in partnership with universities and private service providers around the nation and will roll out continuously. Courses are being adapted for in-house presentation to government agency researchers.

Blue Sky Forums

InnovationXchange and the Australian Institute for Commercialisation are conducting a series of "Blue Sky Forums", which are industry briefings for researchers. The broad purpose of the forums is to build connections between industry and researchers to drive commercial outcomes. Industry leaders are invited to speak for 5 – 10 minutes about problems, challenges and "blue sky" opportunities facing their sector to which researchers can discuss with a view to applying their knowledge.

Commercialisation for Decisions Makers

Melbourne University Private (MU Private) and the Australian Institute for Commercialisation have jointly developed a Professional Development Course to improve Australian expertise in technology commercialisation.

This intensive program aims to enhance participant's practical experience with the advanced tools and knowledge to successfully undertake commercialisation of new technologies, products and service including business planning skills and capabilities; and capacity to secure project finance and knowledge in business strategy and its components.

Commercialisation Bootcamp

A two day "Commercialisation Bootcamp" has been developed to assist doctoral students and early career researchers appreciating the importance of commercialisation of their research and identifying the skills and knowledge required to commercialise research.

Delivered from the researcher's perspective, the course content covers the advantages of commercialisation of Intellectual Property (IP), the pitfalls in protecting IP and identifies what a commercial opportunity looks like, combined with the fundamentals of business planning and market research.

The workshop draws upon practical input from the finance community and commercial business managers working in early stage companies and undertakes case studies of their business successes and challenges.

Start-up Company: Fundamentals for directors and officers

(Offered in conjunction with Chartered Secretaries Australia.)

This course has been designed to address the unique and specific issues faced by directors in early stage companies. The course has been conducted a number of times in 2003 and 2004 which has enabled a more focused program to be developed.

Visiting Fellows Program

As part of the AIC Communications and Education Plan, the AIC is developing a Visiting Fellows program and as part of this, partner with various groups where appropriate. The benefits for such a program are primarily aimed at improved communication concerning commercialisation of research in Australia with the resultant increased profile for commercialisation activities both in the public and private sector.

4.2.2 *Techfast Initiative*

TechFast is a scheme designed to help progress the commercialisation of Australia's investment in the research and development performed at universities, CRCs, and other publicly funded research organisations. The scheme works to help small businesses grow by infusing innovative technology. With a \$2.5M election commitment from the Australian Government the AIC will progress its TechFast technology transfer pilot to a national phase.

This initiative is though to help both businesses and researchers in their respective endeavours. AIC suggests that Australia has significant strength in its research capability, but this is frequently inaccessible to business and dispersed across the country.

With their membership base and network reach, the AIC will be working with the Australian Industry Group to help transfer technology into small businesses, where it can best be developed to help them grow into larger and more sustainable companies.

TechFast funding will be applied to assist in the technology transfer process. After a possible match between an SME and a piece of target IP at a university or CRC has been

identified, the AIC will work together with commercialisation offices and private sector service providers to:

- Evaluate the IP and any encumbrances;
- Study the suitability of the technology;
- Undertake market research;
- Intermediate in the transfer;
- Prepare a commercialisation plan.

Service packages of up to \$100k will be provided to help transfer the technology into the SME.

The AIC is seeing expression of interest from universities, CRCs, and medical research institutes; commercialisation service providers; and SMEs.

4.3 Industry Techlink

Industry TechLink is a government funded, privately run service that helps small business get started with new and emerging technologies. It has a mission to provide business with impartial, confidential and expert links to technology information, products and people.

Consultants each possess in excess of 30 years industry experience and draw upon their knowledge base to answer technology related questions, and help business gain a competitive edge.

Advice is impartial and free – the network does not accept any payment for guidance and does not gain any material benefit from any product, service or company that is recommended.

4.4 Intelligent Manufacturing Systems (IMS)

IMS is an industry led, global, collaborative manufacturing R&D program involving:

- Large & small companies
- Users & suppliers
- Universities & research organisations and
- Governments

IMS is conducted under international arrangement between Australia, Canada, the European Union & Norway, Japan, Korea, Switzerland and the USA

IMS has the following objectives

- Create new processes, products and conditions that significantly enhance the quality of life in the world community;
- Improve the global environment through improved efficiency of using renewable & non-renewable resources;
- Enlarge and open markets world-wide;
- Disseminate knowledge about manufacturing improvements;
- Recommend global standards for manufacturing;
- Advance manufacturing professionalism.

IMS Technical Themes cover Total Product Life-cycle Issues, Virtual /Extended Enterprise Issues, Manufacturing Process Issues, Strategic Planning Design Tools, and Human/Organisation/Social Issues

IMS provides a support structure for conducting R&D projects within specific arrangements for the protection of intellectual property rights. Results of IMS projects are shared through a process of controlled information diffusion that protects and equitably allocates any intellectual property, both background and foreground.

Globally, IMS involves over 300 companies and 200 research institutions currently active in IMS research consortia.

4.5 The Triton Foundation

The Triton Foundation is a national, not-for-profit organisation founded by George Lewin. It has financial support from the Queensland Government.

Triton promotes a culture of innovation in Australia by educating and assisting inventors in the successful commercialisation of their ideas. Interstate inventors (outside Queensland) do not receive free services, but the Foundations does have a wide range of affordable products available.

When the inventors are ready, Triton provides them with mass media exposure, including showcasing on a planned prime-time TV series - working title "The Clever Country"TM. In showcasing these ideas, Triton endeavours to create market awareness, instant demand and easy distribution for the good ideas, and national market feedback for all inventions featured.

Through the TV series and its many other activities, the Foundation hopes to create a lot of innovation "heroes", and give them some of the national prominence that our sporting heroes enjoy today. By telling the stories behind their ideas and inventions, Triton seeks to educate the wider public and thus promote a culture of innovation and entrepreneurship in Australia.

The inspiration behind the Triton Foundation is the history of the highly-popular Triton saw bench. It was a classic "backyard invention" developed by a journalist, George Lewin. It almost died in the mid-70's, but because of a brief national exposure on "The Inventors" on ABC-TV in 1976 - it survived and went on to become a \$300m Australian hardware icon.

4.6 The Warren Centre for Advanced Engineering

The Warren Centre for Advanced Engineering is an independent, industry-linked institute committed to fostering excellence and innovation in advanced engineering throughout Australia. It is a self-funding, non-profit body operating within the University of Sydney, controlled by representatives from industry.

The activities of the Centre are initiated and performed by friends of The Warren Centre — a volunteer group of motivated and committed people who believe in The Centre and its objectives and donate their time and talent to achieve particular outcomes. The Centre's activities are guided by a voluntary board of directors from industry and the University, and supported by a small staff.

The Warren Centre brings together the leading edge people in a selected field of engineering technology to work as a major project team to:

- Focus on removing barriers to commercial success in that field,
- Develop new insights and knowledge in the technology; and
- Accelerate the technology's application in Australian industry.

These major projects invariably result in important breakthroughs in the technology itself and impact on Australian engineering practice and business enterprise. As part of these projects, The Centre organises seminars and other events and produces publications to disseminate the project findings.

4.7 Conclusion

Knowledge management organisations have been making an important contribution to the exchange and transfer of knowledge in the Australian system. In an environment where

there is a large amount of information about commercialisation processes and support services the most critical resource is the *attention* of existing and potential users.

Businesses and particularly SMEs often have major difficulties in accessing the research capacities and capabilities of universities and publicly funded research organisations (Howard 2004). Knowledge organisations filter and guide SMEs and new technology based firms through the large amount of information about technologies, innovation capabilities and research outcomes. In addition, they educate and train researchers and research organisations in commercialisation processes and business development skills.

The Australian Institute for Commercialisation's *Techfast* initiative, which was promised support of \$2.5m in the recent election is directed towards helping SMEs locate appropriate technologies within the nation's research centres and to assist with transfer into small business. It has a strong focus on the transfer of intellectual property. The performance of this initiative must await further evaluation in terms of its contribution to business development and sustainability and in relation to other avenues of assistance and support, including industry led cluster initiatives referred to in Section 2.

A significant amount of the emphasis on knowledge management networks has been on tangible technologies. Quite often the support that new and emerging businesses require is in the form of business consultancy and advice – they may already have a technology that they are endeavouring to commercialise. Knowledge transfer through consulting is being increasingly recognised as an important transfer process (Howard 2005).

Moreover, SMEs and NTBFs do not necessarily want to acquire a *technology* – they are more often interested in gaining access to a *capability* and a longer term relationships and assistance in building their businesses. That capability may be in the science and technology area as well as in management and social sciences.

Successful knowledge management organisations perform a critical role on building relationships between knowledge creators and users. They add value by facilitating knowledge transfer and providing a trust based environment for building collaborations, partnerships and alliances. Organisations supported by industry and the academy, such as the Warren Centre for Advanced Engineering, represent a form of best practice in this area.

Several universities are building up their advisory services and consulting activities as a basis for delivering technology and commercialisation support services to business. The emphasis in these initiatives is delivery of value to a client rather than generating income for the institution (or the individual). However, for all universities to provide such consultancy services would require investment in people and an organisational capability to provide the support that is required.

This area of capacity building has been largely ignored in discussion about linkages and relationships between research organisations and business in Australia. However, it is worth noting that the driver of the 'Cambridge Phenomenon'¹ was built around consulting rather than transfer of technology in the form of 'intellectual products'.

¹ The Cambridge Phenomenon refers to: the presence in and around Cambridge of many high-technology companies (computing, biotechnology, electronics & scientific instruments mainly); a very high proportion of young, small, independent and indigenous companies and a corresponding low proportion of subsidiaries of large companies based elsewhere; a long record of high-technology company formation; a tendency for high-technology companies to concentrate on research, design and development rather than production; many complex direct and indirect links between the companies and Cambridge University.

5 Electronic information, advertising and promotional services

Government agencies, and organisations supported by government grants, provide access to a great deal of 'free' information about innovation through electronic media, particularly websites and electronic newsletters. The focus of activity is on providing information from the perspective of the creators of knowledge and in many ways represents an equivalent of technology advertising and promotion.

Electronic information services do not focus on the *exchange* of knowledge between providers and users through an intermediary – such as a cluster leader, a technology market broker, or a knowledge organisation manager. Many information services enable and/or complement knowledge exchange networks by providing an information and resource base.

Websites and portals that focus on the provision of information in an innovation context are listed below.

5.1 National Innovation Website

<http://www.innovation.gov.au/>

This site is being developed to provide information to assist small to medium businesses become more innovative and to implement their innovative ideas. This information and the links provided will give access to a variety of assistance that can help in innovation and business development.

The site provides links to key program and assistance providers for small to medium businesses. These include

- Australian Governments - Innovation assistance and advice - links to sources of innovation assistance provided by the Australian and State Governments.
- Awards and Competitions in business websites - links to some innovation awards and competitions for businesses.
- Business Assistance Providers websites - links specifically for small business assistance providers in Australia.
- Education and skills development websites for business - links to help businesses improve innovation and entrepreneurial skills through courses, workshops and development programs
- Government Programs Supporting Innovation in Firms - information about a Government document containing a summary list of Commonwealth and State Government support programs for company innovation.
- Inventor Resources Websites - links to inventor websites that provide resources for inventors.
- Mentoring and Networks websites - links to mentoring and network programs for business.

5.2 IPAccess

<http://www.ipaccess.gov.au/index.phtml>

The Prime Minister's Innovation Action Agenda, Backing Australia's Ability, tasked the government agencies dealing with IP, such as IP Australia, AFFA, Attorney-General's and DCITA, with the development of a single-entry web facility - an IP Portal.

IP Access has been designed and marketed as Australia's premier web-site dealing with IP. It offers an integrated access point for information relating to all forms of IP, as well as having the long term goal of being a site that enables future resources and innovative initiatives to be added.

Initially IP Access is to serve the needs of Australian small to medium sized enterprises but it is anticipated that it will evolve into a site that meets the needs of many other IP users.

The site contains references to other sites. It has not been updated recently.

5.3 **The Australian Technology Showcase**

The ATS exists to promote leading-edge Australian technologies and to support the companies behind them. Through its promotional programs, including its web site, the ATS seeks to bring technology to the notice of likely business partners around the world. Technology sellers can link up with potential customers and licensees, investors and joint venturers.

The ATS enjoys the support of many Australian public and private sector organisations, who see the great value the ATS brings. These include

- the Australian Government through AusIndustry
- the Governments of New South Wales, Queensland, South Australia, the Australian Capital Territory and Victoria
- ATS Patrons and strategic partners, including Panasonic Australia, and Price-Waterhouse Coopers. .

Admission to the Australian Technology Showcase is free, and is made on the recommendation of panels of independent experts in each state or territory. These panels assess all applications against ten selection criteria. These are:

- Clearly innovative;
- Scientifically credible;
- Significant local content;
- Demonstrably marketable;
- Commercially attractive;
- Socially and environmentally beneficial;
- Readily exportable;
- Backed by skilled and committed stakeholders;
- Built on strength;
- Readily implementable.

The Australian Technology Showcase data is referenced by both the InnovationXchange and Australian Institute for Commercialisation.

5.4 **Australian Institute for Commercialisation databases**

The Australian Institute for Commercialisation maintains two information databases. These are described below.

Commercialisation service provider database

http://www.ausicom.com/02_service_centre/find_service_provider.asp

The commercialisation service provider database contains contact details of service providers, research centres, departments, funding agencies, experts, and advisers. It functions as searchable electronic 'yellow pages' with a specific focus on science and innovation. There is no information or assessment about capability, track record, or performance of the entities listed.

Research links library

http://www.ausicom.com/02_service_centre/research_library.asp

This is an extensive collection of commercialisation research, articles, reports and abstracts and is quite valuable in terms of bring together and cataloguing a very extensive literature on commercialisation policy and practice.

5.5 DITR Research Finder

Research Finder was an Internet search tool that enables discovery of Australia's researchers, research capability and emerging technologies. It was funded by Department of Industry, Tourism and Resources but is no longer maintained.

Research Finder was based on spider/crawler technology P@NOPTIC. It operated on a specified set of web sites and domains, rather than the world wide web as a whole. This enabled it to provide more specific information than would generally be achievable by using some of the more generic based web browsers.

Research Finder covered 190 government-funded research and research-support organizations, institutions, departments and agencies. The list comprised: 63 Cooperative Research Centres; 41 universities; 29 technology transfer organizations; 15 Research and R&D Councils and Corporations; 12 Department of Industry, Science and Resources portfolio agencies; 17 other government organizations involved in research; 13 medical and biotechnology research institutes and organizations.

Research Finder could only guarantee the existence of a web page with text on it. This text could be in any format or layout and there was no assurance as to minimum content or the quality of that content. As with the other portals, it was necessary to go to component websites to find specific information.

Research finder was a function specific tool. It was not a database type application which when properly designed and implemented will provide one or more of the following: standardised data; orderly classification; proper data integrity (entry and storage); uniform presentation of stored data and results; centralised/ consistent approach to data update and collection; consistent use of terminology and language, etc.

The project has been discontinued but is still functional although no new content is being added.

5.6 Sci Tech

The US Government SciTech Resources website, <http://www.scitechresources.gov> 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.

5.7 Conclusion

The economic value of electronic advertising and promotion services as sources of information about innovation is uncertain. Many government websites and publications are developed from an information provider and technology perspective rather than from a thorough understanding of how target audiences receive, comprehend and act on information. From a communication perspective, target audiences react strongly to information provided from a 'trusted source'. It is difficult to establish a stand alone web-site as a trusted and authoritative source of information and knowledge.

Web-based services require ongoing maintenance, investments and commitment. They rapidly lose credibility if the information is out of date, inaccurate or difficult to locate. Websites that do not include information about how to establish direct and personal contact for follow up inquiry lack credibility. However, websites can complement the search processes of technology adopters and users. In many ways, electronic information

sources make interpersonal interaction even more important as a basis for building trust based relationships.

Developing information websites can avoid the pitfalls that Research Finder encountered by giving attention to the form and content of the messages. Raw data provided by research organisations is rarely in a form or format that can be received, understood and acted upon by potential research users. Such initiatives require an investment in 'translation' of researcher provided material to a form that makes sense from a business perspective.

To the extent that knowledge transfer and exchange is about engagement and involvement between research providers and users, then the *institutions of engagement* will necessarily involve an interpersonal dimension. That dimension will be reflected in:

- Leadership, and particularly industry leadership, in the case of knowledge communities and technology clusters
- The performance of knowledge brokers in the case of markets for knowledge
- The skills and experience of knowledge managers in the case of knowledge networks based around organisations.

Websites and publications (electronic or otherwise) can only support and enable interpersonal communication – they cannot substitute for it. However, in that context, information oriented websites provide a very valuable reference point for intermediaries and can potentially increase their productivity and performance by providing pointers to sources of information that they might not be aware of.

In this environment intermediaries perform a role similar to reference librarians by making users aware of information sources and providing comment on the quality of the content. They perform an important analysis, filtering and prioritising role. In larger corporations this role can be performed by corporate librarians: in small organisations, managers do not have access to this level of staff support and can, potentially, turn to publicly supported knowledge exchange networks as described earlier in this Report.

6 Assessing economic impact

Approaches to industry, regional and national economic development point to the importance of critical mass and collaborative interactions as a means to promote large scale business investment – on the part of both large and small companies. Knowledge exchange networks based on knowledge communities (clusters), knowledge markets and knowledge organisations can work towards building critical mass.

The exchange of knowledge, be it on the basis of sharing, trading, or management, can only serve to enhance capacity and capability or economic benefit when examining issues from a regional, state or national perspective.

Building knowledge networks focuses on the externalities, linkages, spillovers and supporting institutions that are important to competition. By improving the interactions between firms, suppliers, related industries, service providers, and institutions, government initiatives and investment address problems and issues common to many firms without necessarily affecting competition. Government initiatives aimed at building network capacity may yield a higher return than those aimed at individual firms, or industries, or the economy.

It is not possible to assess the contribution of individual knowledge exchange network initiatives to increments to national output and economic wealth creation (that is, contribution to Gross Domestic Product) due to the small size and scale in the overall aggregation of data. The practice in assessing economic impact is to use proxy measures of contribution to GDP. These include:

- Increases in sales – to indicate increases in production (output);
- Increases in exports;
- Increase in profits;
- Increases in employment associated with an intervention;
- Increases in capital investment (to indicate the likely effect of multiplier influences);
- Increased expenditure on research and development (to indicate innovation commitment).

These measures are used to assess economic outcomes in Australian Government industry and enterprise development programs such as the Commercialising Emerging Technology (COMET) and Innovation Investment Fund (IIF) programs, the New Industries Development Program (NIDP) and the National Food Industry Strategy (NFIS).

The measures referred to above should form the focus for assessment of knowledge exchange network initiatives. That is, the contribution of a knowledge exchange network to GDP can be measured in terms of the extent to which it stimulates increases in sales from companies in the network, increases in profitability, exports and employment, and increases levels of investment. This data has been provided for the wine industry cluster (Australian Business Foundation, 2003)

The collaborative research and product development initiatives of the rural plant and animal production sectors (through the rural research and development corporations and market development corporations – in some cases now combined) and in the mining sector have been instrumental in promoting and growing those industries on a global basis. There have been many studies that point to the overall economic impact of research collaborations using economic forecasting and modelling techniques – which generally show impressive results. Many CRCs demonstrate impact by using economic modelling techniques.

Results based on economic modelling can, however, be significantly distorted (and usually over-stated) by the underlying assumptions and parameters build into models –

such as the adoption and application of research will involve minimal transactions costs and understatement of required investments in complementary asserts to bring technologies into commercial application and use.

Mary – I have not deliberately ignored your comments, but I cannot put a Howard Partners imprimatur to dodgy figures. The material on the Bayh Dole Act is open to serious doubt: many see Bayh Dole as unique to the US and others consider the impacts, restricted mainly to the life sciences area, would have happened anyway. I do think, however, that some good results will come out of using the metrics I referred to. It would be the most appropriate way to assess the AEEMA initiative,

7 Conclusions

The failure by universities and research organisations to have much of their discoveries and technological inventions welcomed by businesses, and particularly SMEs may be that the results of research may not fit the way in which business is done in the majority of SMEs. Much of the discussion about SMEs centres on the way in which companies that are expecting to receive venture capital backing should perform – a sort of “ideal type”. Very few successful companies fit the venture capital model of growth and development (Bhidé 2000).

The research undertaken for this Study indicates that a number of knowledge exchange network initiatives have been successful, or have the potential to be successful in bringing the gap between discovery and invention on the one hand and commercial application on the other. These include:

- The knowledge cluster model being developed by the Australian Electrical and Electronic Manufacturers Association (AEEMA);
- The evolving ‘honest broker’ arrangement being developed by the Australian Industry Group under the auspices of the InnovationXchange and increasingly involving an industry cluster based arrangement;
- The business commercialisation support programs being offered by the Australian Institute for Commercialisation in areas where professional services firms have not found it either beneficial or profitable to being involved.

Underlying many of the observations about SME behaviours by scientists and policy makers has been a presumption of a “linear flow” of information and knowledge where scientists and researchers in universities and research organisations having something to offer that is of value to businesses. Previous studies has suggested that lack of success in this form of transfer is a problem in “receptor” capability which could be resolved by informing SMEs through electronic networks about what universities and research organisations can do for their businesses.

The reality is that research organisations need to know much more about the business and commercial environment and where contributions can be made and be in a position to *engage* more effectively with SMEs in relation to how knowledge can firstly be developed and then applied. Universities and research organisations need to identify the attributes of SMEs with whom they want to commercialise their research and seek them out. However, research organisations have an approach to risk that makes working with SMEs very difficult to initiate.

It has almost become part of the popular culture to say that SMEs are not committed to research. Yet, it is generally recognised that industrial innovation is strongly associated with the work of new technology based firms (NTBFs). It would be more accurate to say that some (perhaps most) SMEs do not undertake R&D – but they want access to the results of research. In many cases this involves establishing strategic alliances, joint ventures and partnerships as organisations. Success in organisations is closely associated with the management skills, competencies and capabilities.

Business models for knowledge exchange networks based on advertising, marketing and hopefully selling technologies without the involvement of intermediaries are unlikely to succeed. People do not acquire technologies like they purchase a book. They want to know how it works and ask questions (and expect answers) in relation to issues such as scalability, security of IP and its relationship to a company's own IP suite, cost of development, safety and other business related matters.

Approaches built around collaboration, cooperation and consulting, with the involvement of industry leaders (in a community and cluster context), technology brokers (in a market context), and knowledge managers (in an organisational context) are more likely to be

successful in the longer term. Knowledge networks built around these parameters can provide longer term benefits to both the creators and the users of knowledge as well as to the economy more generally. These benefits will be reflected in increased output, increased employment and higher levels of investment in business development and growth.

8 Recommendations

From the research and analysis contained in this Report, and recent research in the area of university-industry relationships, knowledge exchange networks should be seen in the overall context of *open innovation* that is emerging in industry and which will require the development of closer collaborations between universities, research organisation and businesses. Open innovation requires effective *engagement* between business and higher education.

Increasingly 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. Companies have shifted more of their focus from internal innovation to a range of outside sources such as customers, research companies, business partners and universities. However, both companies and universities advise that developing effective collaborations through innovation partnerships, alliances and joint ventures is very difficult.

Part of the difficulty arises on account of the absence of appropriate structures, management capabilities, and career opportunities to manage at the interface between higher education institutions and businesses. While the Cooperative Research Centre is one model, it has many disadvantages from a business and commercial perspective.

Our recent consultations have indicated that the CRC commercialisation framework is very well suited for creating *industry* solutions, but is less relevant for *business* solutions where companies do not wish to share IP with competitors. The model has worked well in agriculture, mining and the environment, but less so in manufacturing and services (Howard 2003).

It is therefore recommended that:

- The BIHECC undertake a review of the strategies, structures, management arrangements, and research capabilities required for effective university-business innovation partnerships, joint ventures and alliances - with a view to identifying best practice.
- In identifying best practice, BIHECC examine the management and performance of Australian and overseas industrial research centres and institutes - particularly in North America and Europe.
- The review identify ways to accommodate the divergent missions, motivations, and cultures between the two sectors in the design and development of effective innovation partnerships.

References

- Allen Consulting Group. 2004. *Building Effective Systems for the Commercialisation of University Research*. Canberra: Australian Vice Chancellor's Committee and Business Council of Australia.
- Australia. PMSEIC Independent Working Group. 2001. *Commercialisation of Public Sector Research*. Canberra: Prime Minister's Science, Engineering and Innovation Council.
- Baumol, William J. 2002. *The Free-Market Innovation Machine: Analysing the Growth Miracle of Capitalism*. Princeton: Princeton University Press.
- Bennis, Warren, and Patricia Ward Biederman. 1996. *Organizing Genius: The Secrets of Creative Collaboration*. Reading, MA: Addison-Wesley.
- Bhidé, Amar V. 2000. *The Origin and Evolution of New Businesses*. New York: Oxford University Press.
- Bjarnason, Svava, and Patrick Coldstream, eds. 2003. *The Idea of Engagement: Universities in Society*. London: Association of Commonwealth Universities.
- Davenport, Thomas, and Laurence Prusak. 1997. *Information Ecology: Mastering the Information and Knowledge Environment*. New York: Oxford University Press.
- . 1997. *Working Knowledge: How Organizations Manage What they Know*. Boston: Harvard Business School Press.
- Donahue, John D, and Joseph S Nye. 2001. Market Ascendancy and the Challenge of Governance. In *Governance Amid Bigger, Better Markets*, edited by J. D. Donahue and J. S. Nye. Washington: Brookings Institution.
- Drucker, Peter F. 2001. *The Essential Drucker: Selections from the Management Works of Peter F. Drucker*. New York: Harper Business.
- Florida, Richard. 2002. *The Rise of the Creative Class and How it's Transforming Work, Leisure, Community and Everyday Life*. New York: Basic Books.
- Great Britain. Department of Trade and Industry. 2003. *A Practical Guide to Cluster Development*. A Report to the Department of Trade and Industry and the English RDAs by Ecotec Research & Consulting ed. London.
- Henton, Douglas, John Melville, and Kimberly Walesh. 1997. *Grassroots Leaders: How Civic Entrepreneurs Are Building Prosperous Communities, Jossey Bass Public Administration Series*. San Francisco: Jossey Bass.
- Howard, John H. 2002. Evaluation of the New Industries Development Program: A Report to the Department of Agriculture, Fisheries and Forestry. Canberra: Howard Partners.
- . 2002. Interim Evaluation of the Commercialising Emerging Technologies (COMET) Program: A Report to the Department of Industry, Tourism and Resources. Canberra: Howard Partners.
- . 2003. Evaluation of the Cooperative Research Centres Programme: A Report to the Department of Education, Science and Training. Canberra: Howard Partners.
- . 2004. Business, Higher Education and Innovation: Institutions for Engagement in a Mode 2 Society, Faculty of Engineering, The University of Sydney, Sydney.
- . 2004. Digital Factories: the Hidden Revolution in Australian Manufacturing: A Report to the Department of Communications, Information Technology and the Arts. Canberra: Howard Partners.
- . 2004. The Emerging Business of Knowledge Transfer: Creating Value From Intellectual Products and Services: A Report the Department of Education, Science and Training. Canberra: Howard Partners.
- . 2004. Interactions Between Research Organisations SMEs in the ICT Sector: A Report to the Department of Communications, Information Technology and the Arts. Canberra: Howard Partners.
- . 2005. *The Emerging Business of Knowledge Transfer: Creating Value From Intellectual Products and Services: A Study for the Department of Education, Science and Training*. Canberra: Department of Education, Science and Training.

- Howard, John H, and Ron Johnston. 2001. *Securing Our Manufacturing Future: Small Business Manufacturing to 2015 and Beyond: A Report to the NSW Small Business Development Corporation*. Sydney: Howard Partners.
- Howard, John H, Ron Johnston, and Craig Fowler. 2001. *The Feasibility and Efficacy of Commercialising Research Outcomes from Australian Research Council Funded Research: Phase 1. A Report to the Australian Research Council*. Canberra: Howard Partners.
- . 2001. *The Feasibility and Efficacy of Commercialising Research Outcomes from Australian Research Council Funded Research: Phase 2*. Canberra: Howard Partners.
- Howard, John H, and Mark Matthews. 2001. *Mapping the Nature and Extent of Business-University Interaction in Australia*. Canberra: Australian Research Council.
- Humphreys, John. 2004. *AEEMA - Enhancing National Economic Benefits Through a New Cluster Paradigm*. Brisbane: Global Innovation Centre.
- Johnston, Ron, and John H Howard. 2003. *Engagement in an Era of Industrialisation*. In *The Idea of Engagement: Universities in Society*, edited by S. Bjarnason and P. Coldstream. London: Association of Commonwealth Universities.
- Krugman, Paul. 1996. *Development, Geography and Economic Theory*. Cambridge, MA.: MIT Press.
- Marsh, Ian, and Brendan Shaw. 2000. *Australia's Wine Industry: Collaboration and Learning as Causes of Competitive Success*. Sydney: Australian Business Foundation.
- Morse, M Howard. *The Limits of Innovation Markets* 2002 [cited. Available from www.dbr.com].
- National Governors Association. 2002. *A Governor's Guide to Cluster-Based Economic Development*. Washington: National Governors Association.
- Pinchot, Gifford. 1998. *Building Community in the Workplace*. In *The Community of the Future*, edited by F. Hesselbein, M. Goldsmith, R. Beckhard and R. F. Schubert. San Francisco: Jossey Bass.
- Plosila, Walter H. 2004. *State Science- and Technology-Based Economic Development Policy: History, Trends and Developments and Future Directions*. *Economic Development Quarterly* 18 (2):113-126.
- Porter, Michael. 1998. *Clusters and Competition: New Agendas for Companies, Governments and Institutions*. In *On Competition*. Boston: Harvard Business School Press.
- . 1999. *Clusters and the New Economics of Competition*. In *Managing in the New Economy*, edited by J. Magretta. Boston: Harvard Business School Press.
- Saxenian, Annalee. 1996. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge, MA.: Harvard University Press.
- United States. Council on Competitiveness. 2004. *Innovate America: National Innovative Initiative Report - Thriving in a World of Challenge and Change*. Washington.
- Walshok, Mary L. 1995. *Knowledge Without Boundaries: What America's Research Universities can do for the Economy*. San Francisco: Jossey Bass.
- Walshok, Mary L, Edward Furtek, Carolyn W B Lee, and Patrick H Windham. 2002. *Building Regional Innovation Capacity: the San Diego Experience*. *Industry and Higher Education* 16 (1):27-42.
- Wenger, Etienne C., Richard McDermott, and William M Snyder. 2002. *Cultivating Communities of Practice: A Guide to Managing Knowledge*. Boston: Harvard Business School Press.
- Wenger, Etienne C., and William M Snyder. 2000. *Communities of Practice: The Organizational Frontier*. *Harvard Business Review*:139-145.
- Wolpert, John D. 2002. *Breaking Out of the Innovation Box*. *Harvard Business Review* 80 (2):77-83.